
THREATENED AND PRIORITY FLORA SURVEY OF THE YELLOW SANDPLAIN VEGETATION - MT WALTON ROAD

**Prepared for
Polaris Metals Pty Ltd**

**Prepared by
Mattiske Consulting Pty Ltd
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Mattiske Consulting Pty Ltd

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TABLE OF CONTENTS

	Page
1. SUMMARY	1
2. INTRODUCTION	3
2.1 Location and Scope of Proposal.....	3
2.2 Climate	3
2.3 Western Australia's Flora – A Legislative Perspective	4
2.3.1 Threatened and Priority Flora.....	4
2.3.2 Threatened and Priority Ecological Communities	5
2.3.3 Clearing of Native Vegetation.....	6
2.4 Declared Plant Species	6
2.5 Local and Regional Significance.....	7
2.6 Declared Plant Species	8
2.7 Local and Regional Significance.....	8
3. OBJECTIVES.....	9
4. METHODS	10
4.1 Desktop Survey	10
4.2 Field Survey	10
4.3 Survey Limitations and Constraints	11
5. DESKTOP SURVEY	13
5.1 Soils and Topography.....	13
5.2 Current Land Use.....	13
5.3 IBRA Bioregion	13
5.4 Historical Surveys within the Eastern Goldfields	14
5.4.1 Flora of the Interior of Western Australia (Spencer Le Marchant Moore 1899)	14
5.4.2 Plant Life of Western Australia (Diels 1906).....	14
5.4.3 Historical Mapping by John Beard.....	15
5.4.4 Biological Survey of the Eastern Goldfields (Dell <i>et al.</i> 1985)	17
5.4.5 Previous Surveys by Mattiske Consulting Pty Ltd (2009 – 2011)	18
5.5 Threatened Ecological Communities	20
5.6 Priority Ecological Communities.....	20
5.7 Threatened and Priority Flora.....	20
6. FIELD SURVEY RESULTS	24
6.1 Flora.....	25
6.2 Proportion of Flora Sampled	25
6.3 Threatened Flora	25
6.4 Priority Flora	25
6.4.1 <i>Leucopogon</i> sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1).....	26
6.4.2 <i>Hakea rigida</i> (P2).....	31
6.4.3 <i>Acacia formidabilis</i> (P3)	32
6.4.4 <i>Astartea</i> ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3)	32
6.4.5 <i>Banksia lullfitzii</i> (P3)	32
6.4.6 <i>Calytrix creswellii</i> (P3)	33
6.4.7 <i>Cryptandra crispula</i> (P3).....	35
6.4.8 <i>Eutaxia</i> ? <i>nanophylla</i> (P3)	35
6.4.9 <i>Mirbelia</i> sp. Helena & Aurora (B.J. Lepschi 2003) (P3).....	35
6.4.10 <i>Homalocalyx grandiflorus</i> (P3)	36
6.4.11 <i>Lepidosperma lyonsii</i> (P3).....	37
6.4.12 <i>Stylidium choreanthum</i> (P3)	37
6.4.13 <i>Sowerbaea multicaulis</i> (P4).....	38
6.5 <i>Lepidosperma</i> Taxa.....	39

TABLE OF CONTENTS

	Page
6.5.1 <i>Lepidosperma</i> sp. Aurora Sandplain (R.L. Barrett 2809B).....	40
6.5.2 Un-named <i>Lepidosperma</i> taxa.....	40
6.6 Photographic Record of Survey Sites	40
7. DISCUSSION	42
7.1 Flora and Vegetation	42
7.2 Threatened and Priority Flora.....	43
7.3 <i>Lepidosperma</i> species	44
7.4 Novel Taxa.....	44
8. CONCLUSIONS	44
9. ACKNOWLEDGEMENTS.....	45
10. PERSONNEL	45
11. REFERENCES.....	46

TABLES

1:	Geographic coordinates delineating corners of survey blocks set out in Ministerial Statement 852.
2:	Potential flora and vegetation survey limitations for the survey area
3:	Priority flora recorded in the vicinity of the sandplain survey areas along Mount Walton Road
4:	Location and population of <i>Leucopogon</i> sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) recorded in the yellow sandplain vegetation
5:	Location and population of <i>Hakea rigida</i> (P2) recorded in the yellow sandplain vegetation
6:	Location and population of <i>Acacia formidabilis</i> (P3) recorded in the yellow sandplain vegetation
7:	Location and population of <i>Astartea</i> ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) recorded in the yellow sandplain vegetation
8:	Location and population of <i>Banksia lullfitzii</i> (P3) recorded in the yellow sandplain vegetation
9:	Location and population of <i>Calytrix creswellii</i> (P3) recorded in the yellow sandplain vegetation
10:	Location and population of <i>Cryptandra crispula</i> (P3) recorded in the yellow sandplain vegetation
11:	Location and population of <i>Eutaxia ?nanophylla</i> (P3) recorded in the yellow sandplain vegetation
12:	Location and population of <i>Mirbelia</i> sp. Helena & Aurora (B.J. Lepschi 2003) (P3) recorded in the yellow sandplain vegetation
13:	Location and population of <i>Homalocalyx grandiflorus</i> (P3) recorded in the yellow sandplain vegetation
14:	Location and population of <i>Lepidosperma lyonsii</i> (P3) recorded in the yellow sandplain vegetation
15:	Location and population of <i>Stylidium choreanthum</i> (P3) recorded in the yellow sandplain vegetation
16:	Location and population of <i>Sowerbaea multicaulis</i> (P4) recorded in the yellow sandplain vegetation
17:	Location and population of <i>Lepidosperma</i> sp. Aurora Sandplain (R.L. Barrett 2809B) recorded in the yellow sandplain vegetation
18:	Location and population of un-named <i>Lepidosperma</i> species recorded in the yellow sandplain vegetation

FIGURES

- 1: Locality map
- 2: Rainfall and temperature data for Southern Cross
- 3: Pre-European vegetation
- 4: Distribution of survey quadrats within the yellow sandplain vegetation
- 5: Averaged randomised species accumulation curve
- 6: Priority flora recorded at each survey site within the sandplain survey areas delineated in Schedule 3 of Ministerial Statement 852
- 7: Distributions maps for *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) and *Hakea rigida* (P2)
- 8: Distributions maps for *Acacia formidabilis* (P3), *Astartea* sp. Bungalbin Hill (K.R. Newbey 8989) (P3), *Banksia lullfitzii* (P3) and *Calytrix creswellii* (P3)
- 9: Distributions maps for *Cryptandra crispula* (P3), *Eutaxia nanophylla* (P3), *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3) and *Homalocalyx grandiflorus* (P3)
- 10: Distributions maps for *Lepidosperma lyonsii* (P3), *Stylidium choreanthum* and *Sowerbaea multicaulis* (P4)
- 11: Representation of vascular plant families in the yellow sandplain vegetation

APPENDICES

- A1: Definition of Threatened and Priority Flora Species (Department of Environment and Conservation)
- A2: Definitions of Threatened Flora Species (*EPBC Act 1999*).
- A3: Definition of Threatened Ecological Communities (Department of Environment and Conservation)
- A4: Definition of Threatened Ecological Communities (Department of Sustainability, Environment, Water, Population and Communities)
- A5: Definition of Priority Ecological Communities (Department of Environment and Conservation 2012d)
- A6: Vegetation Condition Scale Definitions (Keighery 1994)
- B: Survey area locations along Mount Walton Road
- C: Vascular plant species recorded at survey sites within the sandplains
- D: Vascular plant species recorded at each survey site within the sandplain survey areas delineated in Schedule 3 of Ministerial Statement 852
- E: Photographic record of survey sites within the sandplain survey areas
- F: Priority flora report forms (Department of Environment and Conservation)

1. SUMMARY

Mattiske Consulting Pty Ltd was commissioned in August 2011 by Polaris Metals Pty Ltd to undertake a search for the presence of threatened and priority flora within four designated areas along Mount Walton Road and within the vicinity of the Jaudri Rail Siding, Figure 1.

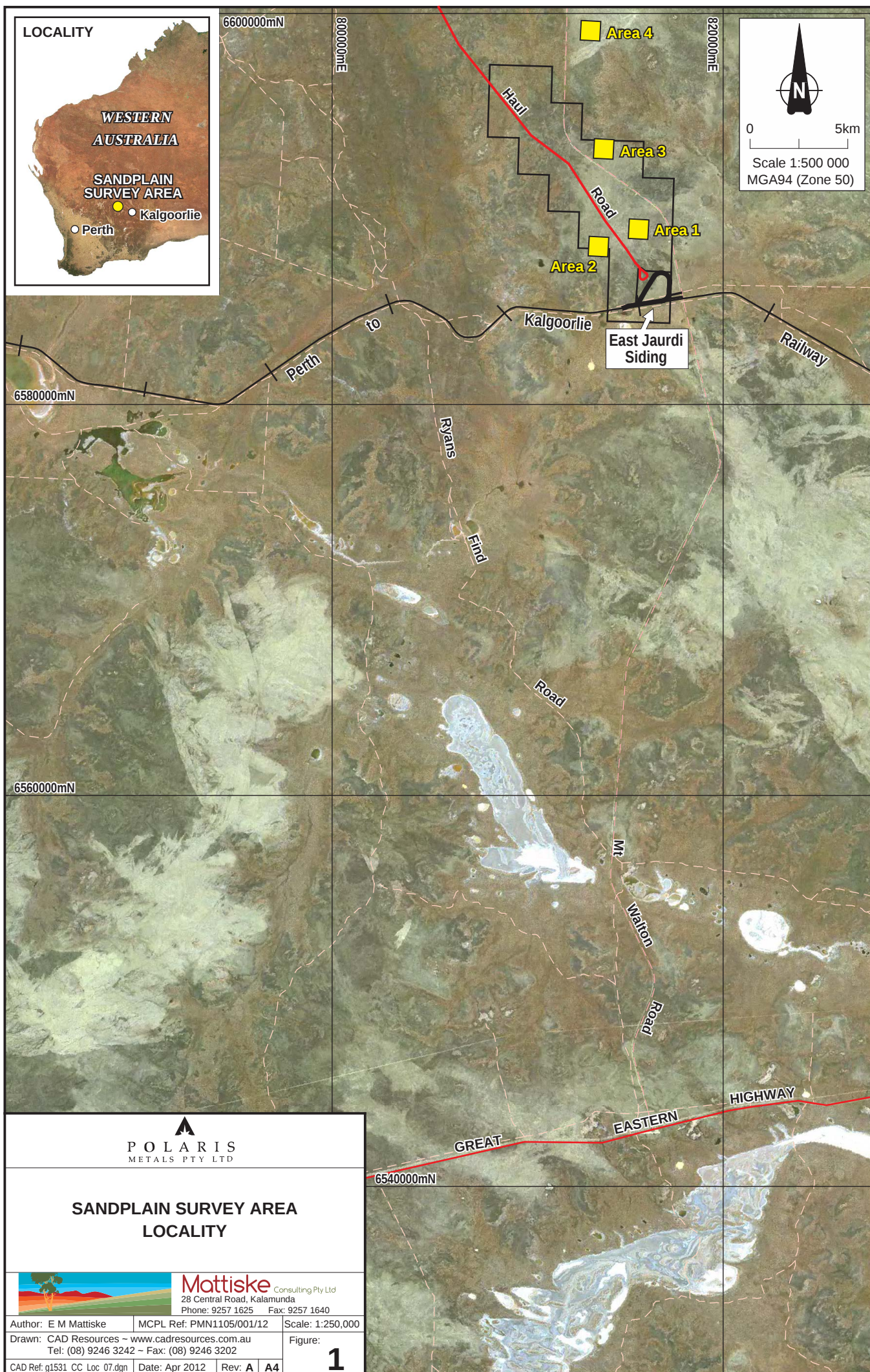
The purpose of the survey was to address Ministerial Statement No. 852, "Statement That a Proposal May Be Implemented (Pursuant to the Provisions of the *Environmental protection Act 1986*) - Carina Iron Ore Mine", Condition 7-1 (Government of Western Australia 2011). Ministerial Statement 852, Condition 7-1 states that, quote:

"Within 18 months of ground disturbance the proponent shall undertake a flora survey within the areas delineated by MGA coordinates provided in Schedule 3 that are located within the yellow sandplain vegetation type to determine the presence and abundance of priority flora species present."

The results of the survey revealed that the yellow sandplain vegetation to be floristically diverse. To date, 331 vascular plant taxa have been recorded across 151 survey quadrats. The range of priority flora taxa that had been recorded during both the present and previous surveys of the yellow sandplain vegetation undertaken by Mattiske Consulting Pty Ltd between 2009 and 2011 on behalf of Polaris Metals Pty Ltd were distributed across a broad area. This outcome provides a level of confidence that the mining proponent's operations will have a lesser impact on conservation significant taxa than may have been originally thought.

Additionally a number of novel plant taxa, predominantly *Lepidosperma* species, have been recorded and collected. These are still awaiting formal identification at the Western Australian Herbarium. Preliminary investigations suggest that they are likely to represent un-named taxa represented from only a few collections. It is not possible at present to state if any represent new taxa. One new species of *Leucopogon* has been identified from a relatively restricted area adjacent to the Trans- Australian rail line. None of these taxa have been formally named. However, on present information they should be considered potentially to be of conservation significance.

The outcomes of the surveys by Mattiske Consulting Pty Ltd indicate that the priority flora growing in the vicinity of the Polaris Metals Pty Ltd operations are more widely distributed in the yellow sandplain vegetation. The surveys have also revealed the presence of potential new taxa. Given this and the pristine nature of the yellow sandplain vegetation, it is imperative that impacts to the vegetation be minimised.



2. INTRODUCTION

Mattiske Consulting Pty Ltd was commissioned in August 2011 by Polaris Metals Pty Ltd to undertake a search for the presence of threatened and priority flora within four designated areas along Mount Walton Road and within the vicinity of the Jaudri Rail Siding.

The purpose of the survey was to address Ministerial Statement No. 852, "Statement That a Proposal May Be Implemented (Pursuant to the Provisions of the *Environmental protection Act 1986*) - Carina Iron Ore Mine", Condition 7-1 (Government of Western Australia 2011). Under this Ministerial Statement, Condition 7-1 states that, quote:

"Within 18 months of ground disturbance the proponent shall undertake a flora survey within the areas delineated by MGA coordinates provided in Schedule 3 that are located within the yellow sandplain vegetation type to determine the presence and abundance of priority flora species present."

2.1 Location and Scope of Proposal

Mount Walton Road intersects the Great Eastern Highway 94 km east of the town of Southern Cross. Mount Walton Road was constructed to provide access to the intractable waste disposal facility at Mount Walton East. The four survey areas designated in Ministerial Statement 852 are located along Mount Walton Road to the north of its intersection with the Trans-Australian Rail line (Figure 1). The survey areas lie within the Coolgardie Botanical District (Beard 1990). The scope of the survey, the results of which are set out in this report, was to identify the presence of threatened and priority flora, within the four areas detailed in Schedule 3 of Ministerial Statement No. 852 (Government of Western Australia 2011). In addition, this report incorporates botanical survey data from surveys of the yellow sandplain vegetation which were undertaken on behalf of Polaris Metals Pty Ltd between 2009 and 2011.

2.2 Climate

Beard (1990) described the climate of the Coolgardie Botanical District as arid non-seasonal to semi arid Mediterranean, characterised by an arid climate with cool winters and hot, dry summers. Annual precipitation in the Coolgardie Botanical District ranges from 200 mm to 300 mm, with the bulk of the precipitation falling in the winter months, with sporadic summer cyclonic rainfall. Southern Cross, which is located to the southwest of the survey area, has an annual rainfall of 294 mm (Bureau of Meteorology 2012). Rainfall and temperature data for Southern Cross is illustrated in Figure 2.

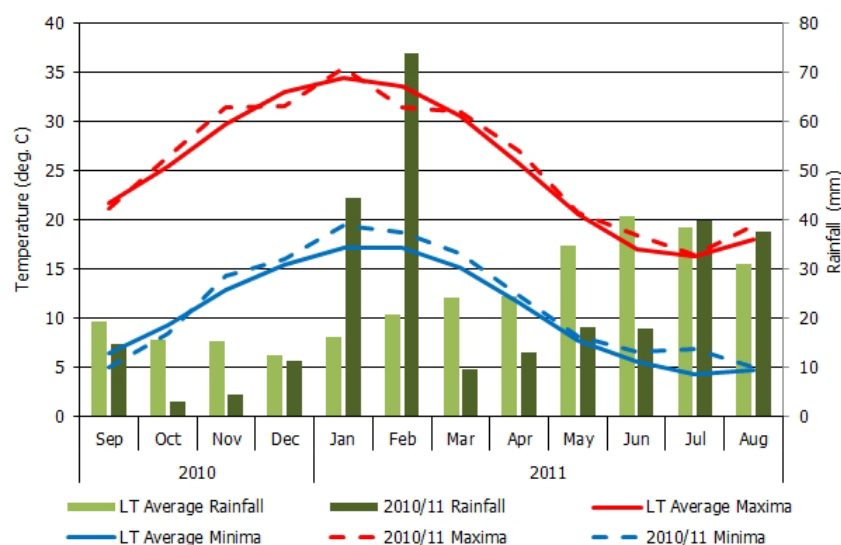


Figure 2: Rainfall and temperature data for the township of Southern Cross

Long term average rainfall and temperature data, together with monthly rainfall and average maximum and minimum temperature data for the period September 2010 to August 2011 are shown.

2.3 Western Australia's Flora – A Legislative Perspective

Western Australia has a unique and diverse flora, and is recognised as one of the world's 34 biodiversity hotspots (Myers *et al.* 2000). In this context, Western Australia possesses a high degree of species richness and endemism. This is particularly pronounced in the south-west region of the state. There are currently over 12,000 plant species known to occur within Western Australia (Department of Environment and Conservation 2012a), and scientific knowledge of many of these species is limited.

The legislative protection of flora within Western Australia is principally governed by three Acts. These are:

- The *Wildlife Conservation Act 1950*;
- The *Environmental Protection Act 1986*; and
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The unique flora of Western Australia is potentially under threat due to historical clearing practices associated with agricultural, mining and human habitation activities. As a consequence of these historical clearing practices a number of flora species have become threatened or have the potential to become threatened as their habitat is impacted by human activity. In addition, some areas of the State have been affected by past clearing practices such that entire ecological communities are under threat. The following sections describe these threatened and priority flora and ecological communities, and outline the legislative protection afforded to them.

At the State level, the *Wildlife Conservation Act 1950* provides for taxa of native flora (and fauna) to be specially protected because they are subject to identifiable threats. Protection of these taxa has been identified as being warranted because they may become extinct, are threatened, or are otherwise in need of special protection. Ecological communities that are deemed to be threatened are afforded protection under the *Environmental Protection Act 1986*. Listings of threatened species and communities are reviewed annually by the Western Australian Threatened Species Scientific Committee (TSSC), which is a body appointed by the Minister for the Environment and supported by the Department of Environment and Conservation. The TSSC reviews threatened and specially protected flora (and fauna) listings on an annual basis. Recommendation for additions or deletions to the listings of specially protected flora (and fauna) is made to the Minister for the Environment by the TSSC, via the Director General of the Department of Environment and Conservation, and the WA Conservation Commission. Under Schedule 1 of the *Wildlife Conservation Act 1950*, the Minister for the Environment may declare that a class or description of flora to be threatened flora throughout the State, by notice published in the *Government Gazette* (Department of Environment and Conservation 2012b).

At the Commonwealth level, under the *Environment Protection and Biodiversity Conservation Act 1999*, a nomination process exists, to list a threatened species or ecological communities. Additions or deletions to the lists of threatened species and communities are made by the Minister for Sustainability, Environment, Water, Populations and Communities, on advice from the Federal Threatened Species Scientific Committee. *Environment Protection and Biodiversity Conservation Act 1999* lists of threatened flora and ecological communities are published on the Department of Sustainability, Environment, Water, Populations and Communities website (2012a, 2012b).

2.3.1 Threatened and Priority Flora

Flora within Western Australia that is considered to be under threat may be classed as either threatened flora or priority flora. Where flora has been gazetted as threatened flora under the *Wildlife Conservation Act 1950*, it is an offence "to take" such flora without the written consent of the Minister. The *Wildlife Conservation Act 1950* states that "to take" flora includes to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.

Priority flora constitute species which are considered to be under threat, but for which there is insufficient information available concerning their distribution and/or populations to make a proper evaluation of their conservation status. Such species are considered to potentially be under threat, but do not have legislative protection afforded under the *Wildlife Conservation Act 1950*.

The Department of Environment and Conservation categorises priority flora according to their conservation priority, using five categories, P1 to P5, to denote the conservation priority status of such species, with P1 listed species being the most threatened, and P5 the least. Priority flora species are regularly reviewed, and may have their priority status changed when more information on the species becomes available. Appendix A1 sets out definitions of both threatened and priority flora (Department of Environment and Conservation 2012c).

At the Commonwealth level, under the *Environment Protection and Biodiversity Conservation Act 1999*, threatened species can be listed as extinct, extinct in the wild, critically endangered, endangered, vulnerable, or conservation dependent, by the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. Refer to Appendix A2 for a description of each of these categories of threatened species. Under the *Environment Protection and Biodiversity Conservation Act 1999*, a person must not take an action that has or will have a significant impact on a listed threatened species without approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act.

The current *Environment Protection and Biodiversity Conservation Act 1999* list of threatened flora may be found on the Department of Sustainability, Environment, Water, Population and Communities (2012a) website.

2.3.2 Threatened and Priority Ecological Communities

An ecological community is defined as a naturally occurring biological assemblage that occurs in a particular type of habitat composed of specific abiotic and biotic factors. At the State level, ecological communities may be considered as threatened once they have been identified as such by the Western Australian Threatened Ecological Communities Scientific Advisory Committee. A threatened ecological community is defined, under the *Environmental Protection Act 1986*, as an ecological community listed, designated or declared under a written law or a law of the Commonwealth as threatened, endangered or vulnerable. There are four State categories of threatened ecological communities, or TECs: presumed totally destroyed (PD); critically endangered (CR); endangered (EN); and vulnerable (VU) (Department of Environment and Conservation 20120d). A description of each of these categories of TECs is presented in Appendix A3. Threatened ecological communities are gazetted as such (Department of Environment and Conservation 2012e). At the Commonwealth level, some Western Australian TECs are listed as threatened, under the *Environment Protection and Biodiversity Conservation Act 1999*.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, a person must not take an action that has or will have a significant impact on a listed threatened ecological community without approval from the Commonwealth Minister for the Sustainability, Environment, Water, Population and Communities, unless those actions are not prohibited under the Act. A description of each of these categories of TECs is presented in Appendix A4. The current *Environment Protection and Biodiversity Conservation Act 1999* list of threatened ecological communities can be located on the Department of Sustainability, Environment, Water, Population and Communities (2012b) website.

Ecological communities identified as threatened, but not listed as threatened ecological communities, can be classified as priority ecological communities (PECs). These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status. The Department of Environment and Conservation categorises priority ecological communities according to their conservation priority, using five categories, P1 to P5, to denote the conservation priority status of such ecological communities, with P1 communities being the most threatened and P5 the least. Appendix A5 sets out definitions of priority ecological communities (Department of Environment and Conservation 2012d). A list of current priority ecological communities can be viewed at the Department of Environment and Conservation (2012f) website.

2.3.3 Clearing of Native Vegetation

Under the *Environmental Protection Act 1986*, the clearing of native vegetation requires a permit to do so, from the Department of Environment and Conservation or the Department of Mines and Petroleum, unless that clearing is exempted under specific provisions listed in Schedule 6 of the Act, or are prescribed in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Under the *Environmental Protection Act* (1986), “native vegetation” means indigenous aquatic or terrestrial vegetation, and includes dead vegetation unless that dead vegetation is of a class declared by regulation to be excluded from this definition but does not include vegetation in a plantation. Under the *Environmental Protection Act 1986*, Section 51A, “clearing” means the killing or destruction of, the removal of, the severing or ringbarking of trunks or stems of, or the doing of any other substantial damage to, some or all of the native vegetation in an area, and includes the draining or flooding of land, the burning of vegetation, the grazing of stock, or any other act or activity, that causes any of the aforementioned consequences or results.

Under the *Environmental Protection Act 1986*, ten principles are set out, under which native vegetation should not be cleared. These principles state that native vegetation should not be cleared, if:

- a. it comprises a high level of biological diversity;
- b. it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;
- c. it includes, or is necessary for the continued existence of, threatened flora;
- d. it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community;
- e. it is significant as a remnant of native vegetation in an area that has been extensively cleared;
- f. it is growing in, or in association with, an environment associated with a watercourse or wetland;
- g. the clearing of the vegetation is likely to cause appreciable land degradation;
- h. the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;
- i. the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; or
- j. the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, under Regulation 5, sets out prescribed clearing actions that do not require a clearing permit, as defined in Section 51C of the *Environmental Protection Act 1986*.

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, under Regulation 6 –“Environmentally sensitive areas” are defined as “the area covered by vegetation within 50 m of threatened flora, to the extent to which the vegetation is continuous with the vegetation in which the threatened flora is located”.

Under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* - Regulation 6 (Environmentally sensitive areas), the area covered by a threatened ecological community, is similarly considered an environmentally sensitive area and therefore non-permitted, unless Ministerial approval is granted.

2.4 Declared Plant Species

The *Agricultural and Related Resources Protection Act 1976*, Section 35, makes provision for classes of plants to be listed as declared in respect of parts of, or the entire State. According to the *Agricultural and Related Resources Protection Act 1976*, a declared plant is defined as a plant belonging to a class of plants declared under section 35 of the Act to be declared plants and includes any part of such a plant and/or the product of such a plant.

The *Agricultural and Related Resources Protection Act 1976* provides for declared plants to be assigned to specific categories, P1 to P5, which determines the form of control which applies to the declared plant. Appendix A6 lists the categories of control codes for declared plants and the associated management requirements.

The current listing of declared plant species is available at the Department of Agriculture and Food website (Department of Agriculture and Food 2012).

2.5 Local and Regional Significance

Flora or vegetation may be locally or regionally significant in addition to statutory listings by the State or Federal Government.

In regards to flora; species, subspecies, varieties, hybrids and ecotypes may be significant other than as threatened flora or priority flora, for a variety of reasons, including:

- a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
- relic status
- anomalous features that indicate a potential new discovery;
- being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- the presence of restricted subspecies, varieties, or naturally occurring hybrids;
- local endemism/a restricted distribution; and
- being poorly reserved (Environmental Protection Authority 2004).

Vegetation may be significant because the extent is below a threshold level and a range of other reasons, including:

- scarcity;
- unusual species;
- novel combinations of species;
- a role as a refuge;
- a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- being representative of the range of a unit (particularly, a good local and/or regional example of a unit in “prime” habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- a restricted distribution (Environmental Protection Authority 2004).

Vegetation communities are locally significant if they contain priority Flora species or contain a range extension of a particular taxon outside of the normal distribution. They may also be locally significant if they are very restricted to one or two locations or occur as small isolated communities. In addition, vegetation communities that exhibit unusually high structural and species diversity are also locally significant.

Vegetation communities are regionally significant where they are limited to specific landform types, are uncommon or restricted plant community types within the regional context, or support populations of threatened flora.

Determining the significance of flora and vegetation may be applied at various scales, for example, a vegetation community may be nationally significant and governed by statutory protection as well as being locally and regionally significant.

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Determining the significance of flora and vegetation may be applied at various scales, for example, a vegetation community may be nationally significant and governed by statutory protection as well as being locally and regionally significant.

3. OBJECTIVES

The aim of this survey was to fulfil the requirements of Ministerial Statement 852, Condition 7-1 (Government of Western Australia 2011). This condition states that, quote:

“Within 18 months of ground disturbance the proponent shall undertake a flora survey within the areas delineated by MGA coordinates provided in Schedule 3 that are located within the yellow sandplain vegetation type to determine the presence and abundance of priority flora species present”.

In addition to fulfilling this requirement, the scope of work was expanded to include the following objectives:

- Record all vascular plant species within survey quadrats established within the areas delineated by MGA coordinates provided in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011);
- Search for threatened and priority flora species within survey sites established within the areas delineated by MGA coordinates provided in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011), and record their abundance;
- Undertake opportunistic collecting and recording of threatened and priority flora species, whilst walking between survey quadrats established within the areas delineated by MGA coordinates provided in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011);
- Incorporate data from flora surveys within the yellow sandplain vegetation areas undertaken on behalf of Polaris Metal Ptd Ltd between 2009 and 2011, to provide a broader perspective of both the flora, and specifically, threatened and priority flora within the yellow sandplain vegetation areas;
- Review the conservation status of the vascular plant species recorded by reference to current literature and current listings by the Department of Environment and Conservation (2012b) and plant collections held at the Western Australian State Herbarium (Department of Environment and Conservation 2012g), and listed by the Department of Sustainability, Environment, Water, Population and Communities (2012a) under the *Environment Protection and Biodiversity Conservation Act 1999*;
- Prepare a report summarising the findings of the survey.

4. METHODS

The survey areas consisted of four 1 km x 1 km blocks within the yellow sandplain vegetation in the vicinity of the Polaris Metals Pty Ltd operations near the intersection of the Trans-Australian Rail Line and Mount Walton Road. Two of the survey areas were located between the Carina mine accommodation village and the Trans-Australian Rail Line. The other two survey areas were located 3 km and 9 km respectively, north of the Carina mine accommodation village (Figure 3). In addition to the four areas designated for survey in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011), additional data from previous surveys undertaken within the yellow sandplain vegetation by Mattiske Consulting Pty Ltd on behalf of Polaris Metals Pty Ltd, was incorporated into the final data set.

4.1 Desktop Survey

A desktop assessment was conducted using the Department of Environment and Conservation and Department of Sustainability, Environment, Water, Population and Communities databases to identify the possible occurrence of threatened and priority flora, and threatened and priority ecological communities within the yellow sandplain vegetation type in the vicinity of the Polaris Metals Pty Ltd operations. In addition, historical documentation and vegetation mapping of the region, as well as data recorded by Mattiske Consulting Pty Ltd during previous surveys in the area, was reviewed.

4.2 Field Survey

The assessment of the flora and vegetation of the survey areas was undertaken by two experienced botanists from Mattiske Consulting Pty Ltd between the 19th and 23rd September 2011. Both botanists held valid collection licences to collect flora for scientific purposes, issued under the *Wildlife Conservation Act 1950*. Aerial photographic maps of the survey area were prepared CADResources of Carine, Western Australia.

The survey areas consisted of four 1 km x 1 km blocks within the yellow sandplain vegetation in the vicinity of the Polaris Metals Pty Ltd operations (Figure 1). The MGA coordinates delineating the four blocks are set out in Table 1 (Government of Western Australia 2011). Within each of the 1 km x 1 km survey blocks, four 20 m x 20 m quadrats were established to sample the vegetation. Aerial photographic maps were used to aid the selection of locations to establish the quadrats, in an effort to sample the greatest degree of floristic variation present within the four blocks. All quadrats were permanently marked with four fence droppers, and their positions were recorded using a GPS unit. A photographic record of each quadrat, taken from the north-west corner, was made. The GPS coordinates of each of the 16 survey quadrats is set out in Appendix B. In addition to the flora sampled within the quadrats, opportunistic collecting of plants within each 1 km x 1 km block was undertaken whilst walking between survey sites. The field survey was conducted according to standards set out in Guidance Statement 51 (Environmental Protection Authority 2004). In addition to the 16 survey quadrats established within the areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011), data recorded on behalf of Polaris Metals Pty Ltd during surveys within the yellow sandplain vegetation between 2009 and 2011 was incorporated into the final data set. The data from previous surveys were related to the following flora surveys, associated with proposed infrastructure development, carried out on behalf of Polaris Metals Pty Ltd:

1. Carina mine transport route (Mattiske Consulting Pty Ltd 2009)
2. Carina mine accommodation village (Mattiske Consulting Pty Ltd 2010a)
3. Jaudri rail siding (Mattiske Consulting Pty Ltd 2010b)
4. East Jaudri aerodrome (Mattiske Consulting Pty Ltd 2011a)
5. Powerline corridor (Mattiske Consulting Pty Ltd 2011b)
6. Carina mine vegetation monitoring plot (Mattiske Consulting Pty Ltd 2011c)
7. Mt Walton Rd gravel pits (Mattiske Consulting Pty Ltd 2011d)

The locations of the additional 135 survey sites, drawn from these historical surveys, are set out in Appendix B.

Table 1: Geographic coordinates delineating corners of survey blocks set out in Schedule 3 of Ministerial Statement 852

Survey Block	MGA94 Zone 51							
	Northwest corner		Northeast corner		Southwest corner		Southeast corner	
	Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)
Area 1	241000	6591000	242000	6591000	241000	6590000	242000	6590000
Area 2	239000	6590000	240000	6590000	239000	6589000	240000	6589000
Area 3	239000	6595000	240000	6595000	239000	6594000	240000	6594000
Area 4	238000	6601000	239000	6601000	238000	6600000	239000	6600000

The flora and vegetation was described and sampled systematically at each survey site. At each survey site the following floristic and environmental parameters were noted:

- GPS location (based on GDA94 datum),
- Topography,
- Soil type and colour,
- Gravel type and size,
- Outcropping rocks and their type,
- Percentage litter cover and Percentage bare ground,
- Time since fire, and
- Percentage cover and average height of each vegetation stratum.

For each vascular plant species, the average height and percentage cover (both live and dead material) was recorded.

All plant specimens collected during the field surveys were dried and processed in accordance with the requirements of the Western Australian Herbarium. The plant species were identified through comparisons with pressed specimens housed at the Western Australian Herbarium. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the Department of Environment and Conservation (2012g).

4.3 Survey Limitations and Constraints

An assessment of the survey against a range of factors which may have had an impact on the outcomes of the present survey was made (Table 2). Based on this assessment, the present survey has not been subject to constraints which would affect the thoroughness of the survey, and the conclusions which have been formed.

Table 2: Potential flora and vegetation survey limitations for the survey area

Potential Survey Limitation	Impact on Survey
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	Not a constraint: Existing vegetation information of the area has historically been based on the vegetation surveys of John Beard. This, together with access to online information on flora collection in the region, together with previous surveys undertaken by Mattiske Consulting Pty. Ltd. and Recon Environmental, provided adequate information on the vegetation of the survey area.
Scope (i.e. what life forms, etc., were sampled).	Not a constraint: Vascular flora were the focus of the survey. These were thoroughly sampled.
Proportion of flora collected and identified (based on sampling, timing and intensity).	Not a constraint: The focus of the survey was a search for threatened and priority flora. Quadrature based sampling was used to record species.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	Not a constraint: The survey area was covered fully.
Mapping reliability.	Not a constraint: Not a relevant factor for the present survey. Actual locations for the surveys were available as shape files stored on hand held GPS units.
Timing, weather, season, cycle.	Not a constraint: The survey was carried out in September 2011, in spring after the main winter rainfalls. Rainfall in the months preceding the survey was above the long-term average (Figure 2).
Disturbances (fire flood, accidental human intervention, etc.).	Not a constraint: All survey areas were located in undisturbed areas of vegetation, which had not been subject to recent fires, human activity or other forms of disturbance.
Intensity (in retrospect, was the intensity adequate).	Not a constraint: The survey intensity is considered to have been thorough. Additional survey data from other surveys within the sandplain area was incorporated into the final data set.
Resources (i.e. were there adequate resources to complete the survey to the required standard).	Not a constraint: Resources, in terms of time, equipment, support and personnel were adequate to undertake and complete the survey.
Access problems (i.e. ability to access survey area).	Not a constraint: The survey area was easily accessible from the Mount Walton Road by foot. There were no obstacles to surveying the designated area.
Experience levels (e.g. degree of expertise in plant identification to taxon level).	Not a constraint: The botanists who undertook the field work have undertaken previous surveys in the area and are familiar with the vegetation and flora of the area.

5. DESKTOP SURVEY

The four survey locations along Mount Walton Road lie within the Coolgardie Botanical District, as defined by Beard (1990). More recently, the vegetation of Western Australia has been assigned to bioregions and subregions under the Interim Biogeographical Regionalisation for Australia (IBRA), with the survey areas lying within the Southern Cross (C002) sub-region of the Coolgardie Bioregion.

5.1 Soils and Topography

The four survey locations delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) lie within the south-western portion of the Kalgoorlie 1:250,000 geological survey sheet (Wyche 1998). The 1:250,000 geological series (Wyche 1998) describes the survey areas as Cainozoic sandplains (Czs), Cainozoic colluvial (Czc) and Cainozoic lateritic (Czl). This area also lies within the Jaudri System, as defined by Beard (1972a). The Jaudri System is underlain by granite and covered in residual sandplain. The sand varies in colour and composition from red sandy loams through to yellow sands. The topography of the terrain is relatively flat with gentle undulations. Granite outcrops are a feature of the area. Dell *et al.* (1985) further classifies the survey area into sandplains and broad valleys which consist of a mixture of alluvial, colluvial and aeolian deposits. These two landforms differ only slightly in the degree to which the landscape is angled, and the presence of calcrete in the soil (Dell *et al.* 1985).

5.2 Current Land Use

Mount Walton Road was constructed for access to the intractable waste disposal facility at Mount Walton East. With the commencement of operations of the Carina iron ore mine in 2011, Mount Walton Road has also become the main access road for vehicles travelling to the mine facilities and accommodation village located near the intersection of Mount Walton Road and the Trans-Australian Rail line. With the exception of the intersection of the Trans-Australian Rail line with Mount Walton Road, the remainder of the land along Mount Walton Road is virtually undisturbed native bush land occupying land classed as unallocated crown land. Three of the four survey areas fall within the exploration lease E 15/1196. The fourth and most northerly survey area lies outside any current mining tenement alongside the Jaurdi Station Pastoral Lease FNA/2939 (Department of Mines and Petroleum 2012a). Historically, all four of the survey areas have been passively explored for diamonds (Department of Mines and Petroleum 2012a) using aeromagnetic analysis (Department of Mines and Petroleum 2012b).

5.3 IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) delineated 85 bioregions across Australia, based on a range of biotic and abiotic factors, including climate, vegetation, fauna, geology and landform (Thackway and Cresswell 1995, Environment Australia 2000). IBRA Version 6.1 refined the original 85 bioregions (and 354 sub-regions), by expanding the number of sub-regions to 403. The sub-regions represent more localised and homogenous geomorphological units in each bioregion. The four sand plain survey areas lie within the Southern Cross (C002) sub-region of the Coolgardie Bioregion.

Cowan *et al.* (2001) described the Southern Cross (C002) sub-region as physically comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills. The valleys have Quaternary duplex and gradational soils, and include chains of saline playa lakes. Floristically, the sub-region supports diverse *Eucalyptus* woodlands (*Eucalyptus salmonophloia*, *Eucalyptus salubris*, *Eucalyptus transcontinentalis*, *Eucalyptus longicornis*) rich in endemic eucalypts, occurring around these salt lakes, on the low greenstone hills, valley alluvial soils and broad plains of calcareous earths. The salt lake surfaces support dwarf shrublands of samphire. The granite basement outcrops at mid-levels in the landscape and supports swards of *Borya constricta*, with stands of *Acacia acuminata* and *Eucalyptus loxophleba*. Upper levels in the landscape are the eroded remnants of a lateritic duricrust yielding yellow sandplains, gravelly sandplains and laterite breakaways. Mallees (*Eucalyptus leptopoda*, *Eucalyptus platycorys* and *Eucalyptus scyphocalyx*) and scrub-heaths (*Allocasuarina corniculata*, *Callitris preissii*, *Melaleuca uncinata* and *Acacia beauverdiana*) occur on these uplands. The scrubs are rich in endemic *Acacia* species and Myrtaceae.

5.4 Historical Surveys within the Eastern Goldfields

The present survey areas and the surrounding region have been the subject of a number of vegetation surveys since the late 19th century. The earliest reported surveys, by Spencer Le Marchant Moore (1899) and Diels (1906) were incorporated into texts which provided the earliest descriptions of plant life in Western Australia. Whilst written in a relatively narrative style, and considering the scale of the work and the access and conditions present at the time of the surveys, they are consistent with current day observations, taken at a broad scale. A considerable period of time elapsed prior to the publication of John Beard's historical surveys which were published in the 1960's and 1970's, together with detailed vegetation covering the state of Western Australia. A series of monographs by Dell *et al.* (Western Australian Museum Records Supplements) were subsequently published, in which more detailed survey work on the flora of the eastern Goldfields were described. The most recent survey efforts in the broader region have been reported by Neil Gibson and co-workers (Gibson *et al.* 1997, Gibson and Lyons 1998a, 1998b, 2001a, 2001b, Gibson 2004a, 2004b), whose studies focused on the vegetation of the banded ironstone ranges of the region. These results of these surveys have not been included in this review because banded ironstone ranges did not form part of the present survey effort.

5.4.1 Flora of the Interior of Western Australia (Spencer Le Marchant Moore 1899)

The first extensive floral description of the survey area was given in '*Flora of the Interior of Western Australia*' by Spencer Le Marchant Moore in 1899 (Diels 1906). In his expedition, Spencer travelled from the town of Southern Cross north-east to the town of Siberia, through the central goldfields and the sand plains of the survey area. Spencer (1899) described the division between the eucalypt woodlands of the Southern Cross region and the shrub sandplains as sudden, with the introduction of the yellow or white sands overlying granite, and the presence of much lower and thicker shrubs.

Although many of the species recorded by Spencer (1899) have been revised, he reported several major families as being commonly present across this area, namely, Myrtaceae (mainly from the Chamelaucieae group), Asteraceae (predominantly annual herbs) and Fabaceae (mainly from the Mimosoideae and Caesalpinioideae group). Spencer (1899) also reported the high diversity of plant species in this region, despite the lack of water and high summer temperatures, with special note to the remarkable post rain, but brief response of many annual herbs. A final feature described as being unique to this area was the presence of *Xanthorrhoea*, which Spencer (1899) noted was almost completely absent east of Southern Cross.

5.4.2 Plant Life of Western Australia (Diels 1906)

In 1906, Diels produced a text describing the major trends in vegetation across Western Australia. While this work focused primarily on the changes at a broad scale, it brought into context some of the ideas presented by Spencer (1899) and others. Diels (1906) described the Eremaean province as fairly uniform with changes to vegetation being largely influenced by soils. The four survey areas, which are the focus of the present survey, lie within the southern Eremaean, as described by Diels (1906), being defined as below 30°S. Diels (1906) described the major vegetation of the southern Eremaean as light woodlands of *Eucalyptus* over *Melaleucas*, *Acacias*, *Eremophilas*, *Dodonaeas* and *Casuarinas* alternating with sandy shrub heaths. In addition to this, Diels (1906) made special note of several families that were not present (or present in low numbers), as compared to other parts of Western Australia. These included *Zamiaceae*, *Proteaceae*, *Epacridaceae*, *Orchidaceae* and *Restionaceae* (Diels 1906). Diels (1906) attributed the vegetation of the southern Eremaean to the winter rain that reached its most northern and eastern extent within this area.

Within the southern Eremaean, Diels (1906) identified the sand heaths to be distinctly different to the light woodlands. In these areas, vegetation is less dominated by *Eucalyptus* species; with *Callitris* and *Grevillea* species being more prominent (Diels 1906). Diels (1906) described the sand plains as open and low, with an understorey dominated by Myrtaceae species (mainly *Calytrix* and *Melaleuca*), *Lamiaceae* species (mostly *Lachnostachys*, *Newcastelia* and *Dicrastylis*), *Goodeniaceae* species and *Rutaceae* species such as *Philothea* and *Phebalium*. Diels (1906) also made special note of the significant presence of *Triodia rigidissima*, the occasional occurrence of *Codonocarpus cotinifolius*, and also of *Lepidobolus*, as its family, *Restionaceae*, is poorly represented in the wider Eremaean region.

5.4.3 Historical Mapping by John Beard

The four survey areas, which were the focus of the present survey, lie within the Coolgardie Botanical District, as defined by Beard (1990). Beard (1972a, 1972b) mapped the vegetation of the Coolgardie Botanical District at a scale of 1:250,000. The dominant plant families within the Coolgardie Botanical District include Myrtaceae (myrtles such as Eucalypts and Melaleucas), Asteraceae (daisies), Chenopodiaceae (salt bushes) and Poaceae (grasses). The Coolgardie Botanical District is characterized by Eucalypt woodlands and covers 5% of the State of Western Australia (Beard 1990).

The survey areas lie within the Jaurdi vegetation system, defined by Beard (1972a, 1972b). Beard (1969) defined a vegetation system as a particular series of plant communities recurring in a catenary sequence or mosaic pattern, linked to topographic, pedological, and/or geological features. A vegetation system is a sub-division of a botanical district. The Jaurdi system consists of residual sandplains underlain by granite. Granite outcrops are common, and the topography is gently undulating. The surface sand are usually yellow, although, in lower lying areas the soils are red in colour, usually sandy at the surface where they lie in close proximity to the sandplains, becoming heavier in texture towards valley bottoms and at the same time more calcareous (Beard 1972b).

Beard (1972b) described the predominant vegetation types within the sandy areas of the Jaurdi system as being composed of thickets of *Acacia* species and other shrubs. The dominance of individual thicket species varies across the Jaurdi systems, with thickets grading into one another in terms of species dominance. Typical thicket species recorded by Beard (1972b) include *Acacia resinimarginea*, *Acacia* spp., *Banksia elderiana*, *Callitris preissii*, *Allocasuarina acutivalvis*, *Allocasuarina corniculata*, *Eucalyptus leptopoda*, *Eucalyptus oldfieldii*, *Grevillea excelsior*, *Grevillea paradoxa*, *Hakea multilineata*, *Melaleuca uncinata*, *Xanthorrhoea thorntonii*, *Thryptomene kochii*, *Melaleuca cordata*, *Baeckea* spp., and *Triodia rigidissima*. The Jaurdi system merges gently into the adjoining country, with the soil becoming red in colour and becoming loamier. Beard (1972b) described the signs of transition as being the appearance of *Eucalyptus loxophleba*, *Santalum acuminatum* and *Brachychiton gregorii* in the thickets. This gradually grades into *Eucalyptus loxophleba* woodland as the thicket species drop out.

Figure 3 illustrates the pre-European vegetation mapping of the broader area surrounding the present survey area. All four survey areas lie within Beard's vegetation association, number 435. Within the Jaurdi system, two vegetation types are described:

- A mosaic of *Acacia resinimarginea*, *Acacia* sp., *Eucalyptus leptopoda*, *Banksia elderiana*, and *Callitris* shrub/mallee over *Thryptomene kochii*, *Baeckea* sp., *Thryptomene urceolaris*, *Thryptomene aspera* (*Aluta aspera*), *Melaleuca cordata* shrubland over hummock grasses on the sandplains; and
- A mosaic of *Eucalyptus loxophleba* and *Brachychiton gregorii* over *Acacia resinimarginea*, *Acacia acuminata*, *Eucalyptus leptopoda*, *Banksia elderiana*, *Callitris preissii* shrub/mallee over *Thryptomene kochii*, *Baeckea* sp., *Thryptomene urceolaris*, and *Thryptomene* sp. where the sandplain transitions to woodland.

It should be noted in Figure 3, that there are a number of unnatural boundaries (straight lines) delineating some vegetation units. One notable one is directly above the Area 4 marker. These boundaries are not artefacts, but formed part of the dataset supplied and used to generate the map.

Polaris Regional Projects Pre-European Vegetation



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Author: E M Mattiske MCPL Ref: PMN1105/001/12 Scale: 1:500,000

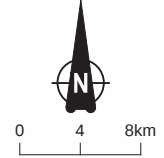
Drawn: CAD Resources ~ www.cadresources.com.au
Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202

Figure:

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Date: Jan 2012 Rev: A A4

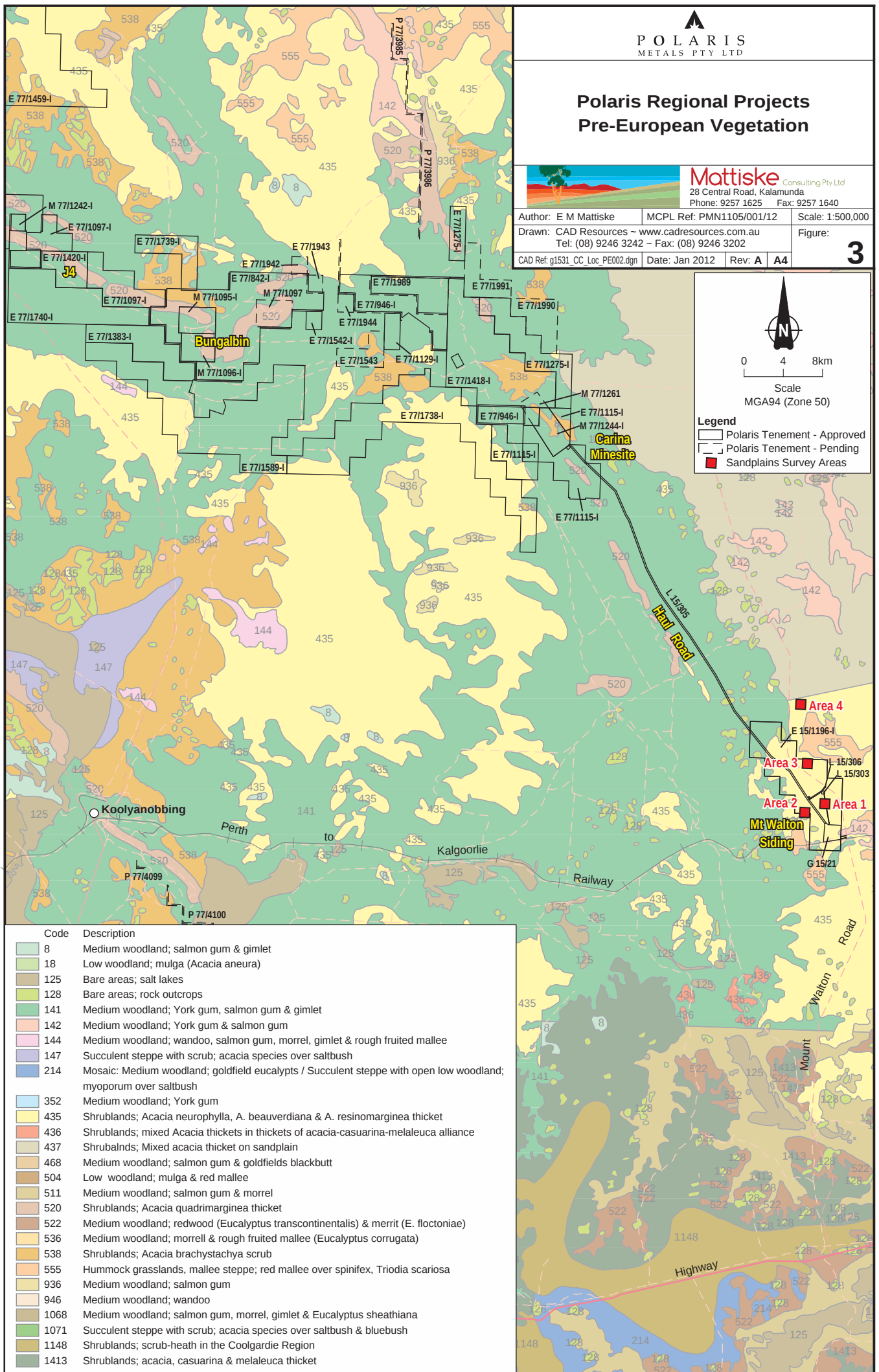
3



Scale
MGA94 (Zone 50)

Legend

- Polaris Tenement - Approved
- Polaris Tenement - Pending
- Sandplains Survey Areas



Code	Description
8	Medium woodland; salmon gum & gimlet
18	Low woodland; mulga (Acacia aneura)
125	Bare areas; salt lakes
128	Bare areas; rock outcrops
141	Medium woodland; York gum, salmon gum & gimlet
142	Medium woodland; York gum & salmon gum
144	Medium woodland; wandoo, salmon gum, morrel, gimlet & rough fruited mallee
147	Succulent steppe with scrub; acacia species over saltbush
214	Mosaic: Medium woodland; goldfield eucalypts / Succulent steppe with open low woodland; myoporium over saltbush
352	Medium woodland; York gum
435	Shrublands; Acacia neurophylla, A. beauverdiana & A. resinomarginea thicket
436	Shrublands; mixed Acacia thickets in thickets of acacia-casuarina-melaleuca alliance
437	Shrublands; Mixed acacia thicket on sandplain
468	Medium woodland; salmon gum & goldfields blackbutt
504	Low woodland; mulga & red mallee
511	Medium woodland; salmon gum & morrel
520	Shrublands; Acacia quadrimarginea thicket
522	Medium woodland; redwood (Eucalyptus transcontinentalis) & merrit (E. floetoniae)
536	Medium woodland; morrell & rough fruited mallee (Eucalyptus corrugata)
538	Shrublands; Acacia brachystachya scrub
555	Hummock grasslands, mallee steppe; red mallee over spinifex, Triodia scariosa
936	Medium woodland; salmon gum
946	Medium woodland; wandoo
1068	Medium woodland; salmon gum, morrel, gimlet & Eucalyptus sheathiana
1071	Succulent steppe with scrub; acacia species over saltbush & bluebush
1148	Shrublands; scrub-heath in the Coolgardie Region
1413	Shrublands; acacia, casuarina & melaleuca thicket

5.4.4 Biological Survey of the Eastern Goldfields (Dell *et al.* 1985)

Dell *et al.* (1985) divided the Jackson and Kalgoorlie 1:250000 geological map sheets (Wyche 1998) into seven landform types and described several vegetation complexes within them. Dell *et al.* (1985) described the sand plains of the Eastern Goldfields by assigning two vegetation types, namely, 'sandplain' and 'broad valley'. Three of the four current survey areas (Area 1, Area 2 and Area 3) lie entirely within the 'sandplain' landform, whilst one are Area (Area 4) lies within 'sandplain' landform and partially within the landform 'broad valley' (Dell *et al.* 1985). Dell *et al.* (1985) further divided the sandplain landform type into 11 subgroups using the dominant vegetation. Although Dell *et al.* (1985) described the soil of the landform 'broad valley' to contain a high quantity of sand, the presence of calcareous and clay soils do not make it relevant to this survey. The 'sandplain' vegetation subgroups, as defined by Dell *et al.* (1985), are described below.

***Acacia* aff. *aneura* Tall Shrubland on deep sands**

Tall shrubland of *Acacia* aff. *aneura*, *Grevillea obliquistigma*, *Hakea minyma* and *Phebalium canaliculatum* with occasional mallee of *Eucalyptus leptopoda* or *Eucalyptus loxophleba*, over low shrubs of *Baeckea elderiana*, *Eremophila granitica*, *Leucopogon* sp. (KRN 6954) and *Prostanthera grylloana*, over *Chrysocoryne pusilla* (*Gnephosis tenuissima*), *Helipterum roseum* (*Rhodanthe chlorocephala* subsp. *rosea*), *Myriocephalus gracilis* (*Gilberta tenuifolia*), *Schoenia cassiniana*, *Velleia rosea*, *Waitzia acuminata*, *Amphipogon* aff. *strictus* and *Danthonia caespitosa* (*Rytidosperma caespitosum*).

***Acacia aneura* Low Woodland on shallow red sands with ironstone gravel**

Low woodland of *Acacia aneura* over tall shrubland of *Acacia acuminata*, *Acacia* aff. *aneura* and *Acacia prainii* var. *prainii* (*Acacia prainii*) over low shrubs of *Eremophila granitica* and *Prostanthera baxteri*, over *Bellida graminea*, *Blennospora drummondii*, *Gilruthia osbornii* (sic. *Gilruthia osbornei*), *Helipterum roseum* (*Rhodanthe chlorocephala* subsp. *rosea*), *Velleia rosea*, *Waitzia acuminata* and *Danthonia caespitosa* (*Rytidosperma caespitosum*).

***Acacia coolgardiensis* Tall Shrubland on deep sands**

Tall shrubland of *Acacia coolgardiensis*, *Grevillea juncifolia*, *Hakea minyma* and *Phebalium filifolium*, over low shrubs of *Baeckea maidenii* (*Euryomyrtus maidenii*), *Thryptomene aspera* (*Aluta aspera*) and *Thryptomene urceolata* (sic. *Thryptomene urceolaris*), over *Helipterum laeve* (*Rhodanthe laevis*), *Schoenia cassiniana*, *Waitzia acuminata*, *Triodia scariosa*, *Danthonia caespitosa* (*Rytidosperma caespitosum*) and *Lepidosperma viscidum*.

***Allocasuarina acutivalvis* Tall Shrubland on sand with lateritic gravel**

Tall shrubland of *Allocasuarina acutivalvis*, *Allocasuarina campestris* subsp. *campestris*, *Grevillea filifolia* (*Grevillea acacioides*), *Leptospermum roei* and *Melaleuca uncinata*, over low shrubs of *Calothamnus gilesii*, *Grevillea paradoxa*, *Melaleuca cordata* and *Prostanthera semiteres* subsp. *semiteres*, over *Enneapogon* sp. (KRN 7755) (*Amphipogon caricinus*), *Triodia scariosa*, *Lepidobolus preissianus* and *Schoenus brevisetis*.

***Allocasuarina campestris* subsp. *eriochlamys* (*Allocasuarina eriochlamys*) Tall Shrubland on sand with lateritic gravel**

Tall shrubland of *Allocasuarina campestris* subsp. *eriochlamys* (*Allocasuarina eriochlamys*), *Acacia coolgardiensis* and *Calothamnus gilesii*, over *Amphipogon* aff. *strictus* and *Triodia scariosa*.

***Banksia elderiana* Tall Shrubland on deep sands**

Tall Shrubland of *Banksia elderiana* and *Grevillea filifolia* (*Grevillea acacioides*) over *Calytrix creswellii*, *Conospermum stoechadis* and *Pachnema junceum* (*Hibbertia sphenandra* (F.Muell. & Tate)), over *Triodia scariosa*, *Lepidobolus preissianus* and *Lepidosperma resinosum*.

***Callitris preissii* subsp. *verrucosa* (*Callitris preissii*) Tall Shrubland on deep sands**

Tall shrubland of *Callitris preissii* subsp. *verrucosa*, *Allocasuarina corniculata*, *Calothamnus gilesii*, *Grevillea didymobotrya* and *Leptospermum roei*, over low shrubs of *Banksia audax*, *Conospermum stoechadis*, *Petrophile ericifolia* var. *scabriuscula* (*Petrophile scabriuscula*) and *Verticordia roei*, over *Triodia scariosa*, *Lepidobolus preissianus*, *Mesomelaena preissii* and *Schoenus brevisetis*.

***Eucalyptus corrugata* Low Woodland on shallow sands**

Low woodland of *Eucalyptus corrugata* and *Eucalyptus loxophleba*, over tall shrubland of *Acacia acuminata* and *Eremophila oldfieldii*, over low shrubs of *Acacia erinacea* over *Gilruthia osbornii* (*Gilruthia osbornei*), *Myriocephalus gracilis* (*Gilberta tenuifolia*) and *Plectrachne* sp. (KRN5925) (*Neurachne annularis*).

***Eucalyptus foecunda* (*Eucalyptus leptophylla*) Mallee on deep sands**

Low woodland of *Eucalyptus foecunda* over tall shrubland of *Acacia signata*, *Allocasuarina corniculata* and *Leptospermum roei*, over low shrubs of *Baeckea maidenii* (*Euryomyrtus maidenii* (Ewart & Jean White)), *Beaufortia* sp. (KRN 9247), *Melaleuca* aff. *leptospermoides* and *Petrophile* sp. (KRN 8756) (*Petrophile stricta*), over *Triodia scariosa*, *Lepidobolus preissianus* and *Schoenus brevisetis*.

***Eucalyptus leptopoda* Mallee on deep sands**

Mallee of *Eucalyptus leptopoda* over tall shrubland of *Allocasuarina acutivalvis*, *Grevillea didymobotrya*, *Grevillea nematophylla* and *Leptospermum roei*, over low shrubs of *Phebalium canaliculatum*, over *Triodia scariosa*, *Amphipogon* aff. *strictus* and *Lepidobolus preissianus*.

***Eucalyptus oldfieldii* Mallee on deep sands**

Mallee of *Eucalyptus oldfieldii* over tall shrubland of *Acacia signata*, *Baeckea elderiana* and *Callitris preissii* subsp. *verrucosa* (*Callitris preissii*), over low shrubs of *Baeckea maidenii* (*Euryomyrtus maidenii* (Ewart & Jean White)), *Melaleuca cordata*, *Phebalium tuberosum* subsp. *megaphyllum* (*Phebalium megaphyllum*) and *Thryptomene kochii*.

Due to the ongoing revision of species within Western Australia, *Eucalyptus foecunda* is no longer recognised as occurring in the goldfields (Department of Environment and Conservation 2012g). All inland references to *Eucalyptus foecunda* have been assigned to *Eucalyptus leptophylla* (Brooker and Kleinig 1990). Similarly, *Grevillea filifolia*, *Pachynema junceum* and *Petrophile ericifolia* var. *scabriuscula* have been revised to *Grevillea acacioides* (McGillivray and Makinson 1993), *Hibbertia sphenandra* (F.Muell. & Tate) and *Petrophile scabriuscula* respectively. However, in the latter two cases, the revision in these species has indicated new distributions that no longer include the survey area.

5.4.5 Previous Surveys by Matiske Consulting Pty Ltd (2009 – 2011)

Matiske Consulting Pty Ltd has undertaken a number of surveys in the yellow sandplain areas of the Jaudri system associated with the development of the Carina iron ore mine. These surveys provide a valuable source of information on the flora of the area, because historically, there have been few detailed botanical surveys conducted in the area. The results of these surveys have been used to provide information concerning vegetation structure of the surrounding area and threatened and priority flora which may potentially be encountered during the survey. The surveys undertaken by Matiske Consulting Pty Ltd, in this context, are associated with the Carina iron ore mine haul road (2009), accommodation village (2010a), rail siding (2010b), airstrip (2011a), power line corridor (2011b), permanent monitoring plots (2011c) and Mt Walton Rd gravel pits (2011d). These surveys have resulted in a number of vegetation communities being defined. These are described below.

- S9:** Low scrub of *Melaleuca acuminata* and *Melaleuca eleuterostachya* over *Triodia desertorum* and mixed herbs on brown sandy clay soil on seasonally wet depressions.
- S10:** Scrub of *Callitris preissii* and *Melaleuca nematophylla* with emergent *Eucalyptus leptopoda* subsp. *subluta* over *Leptospermum fastigiatum*, *Beaufortia interstans*, *Leucopogon hamulosus*, *Grevillea acacioides*, *Calytrix creswellii* (P3) and mixed shrubs over *Triodia ?desertorum* on yellow sandy soils on lower to mid-slopes.
- S11:** Scrub of *Acacia resinimarginea*, *Callitris preissii*, *Eucalyptus pileata* and mixed *Allocasuarina* species over *Melaleuca hamata* and *Leptospermum fastigiatum* over *Baeckea* sp. Mt Clara (R.J. Cranfield 11693) and mixed shrubs on lateritic yellow sandy soils on mid to upper slopes.

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- S12:** Scrub of *Allocasuarina corniculata* and mixed *Banksia* and *Eucalyptus* species with emergent *Callitris preissii* over *Melaleuca cordata*, *Grevillea didymobotrya* subsp. *didymobotrya* and mixed shrubs over *Triodia desertorum* and occasional *Lepidobolus preissianus* subsp. *volubilis* and *Schoenus hexandrus* on yellow sandy soils on gently undulating plains.
- S12 (b):** Scrub (fire disturbed) of *Allocasuarina corniculata* and occasional mixed *Eucalyptus* species over *Melaleuca cordata*, *Euryomyrtus maidenii* and mixed shrubs over *Triodia desertorum* on yellow sandy soils on gently undulating plains.
- S16:** Open scrub of *Allocasuarina corniculata*, *Allocasuarina campestris*, *Eucalyptus leptopoda* subsp. *subluta* and *Banksia elderiana* over *Leptospermum fastigiatum*, *Calothamnus gilesii* and mixed shrubs on lateritic orange sandy soils on slopes.
- S17:** Open low scrub of *Allocasuarina corniculata*, *Acacia ?sibina*, *Gyrostemon racemiger* and *Eucalyptus leptopoda* subsp. *subluta* over mixed shrubs over *Triodia scariosa* and *Triodia desertorum* species on yellow sandy soils on gently undulating plains.
- S17 (b):** Open low (fire disturbed) scrub of *Allocasuarina corniculata*, *Acacia ?sibina*, *Gyrostemon racemiger* and *Eucalyptus leptopoda* subsp. *subluta* over mixed shrubs over *Triodia scariosa* and *Triodia desertorum* species on yellow sandy soils on gently undulating plains.
- S30:** Open low woodland to low woodland of *Eucalyptus horistes* and *Eucalyptus leptopoda* subsp. *subluta* with occasional emergent *Callitris preissii* over *Allocasuarina spinosissima*, *Beyeria brevifolia*, *Beyeria sulcata*, *Leucopogon* sp. Coolgardie (M. Hislop & F. Hort MH 3197) and mixed shrubs over *Triodia scariosa* on yellow sandy soils on flats.
- S31:** Mosaic of open scrub to scrub of *Acacia resinimarginea*, *Callitris preissii* and occasional *Allocasuarina spinosissima* with occasional emergent *Eucalyptus horistes* and *Eucalyptus leptopoda* subsp. *subluta* over *Leptospermum fastigiatum* and *Melaleuca hamata* over *Phebalium canaliculatum*, *Phebalium filifolium*, *Micromyrtus monotaxis* and mixed shrubs over *Triodia scariosa* on lateritic yellow sandy soils on lower to mid-slopes.
- S32:** Scrub of *Acacia resinimarginea* with occasional *Callitris preissii* and occasional emergent *Eucalyptus leptopoda* subsp. *subluta* over *Leptospermum fastigiatum*, *Melaleuca hamata*, *Phebalium canaliculatum*, *Phebalium filifolium* and mixed shrubs on lateritic yellow sandy soils on flats and lower slopes.
- S33:** Hummock grassland of *Triodia scariosa* with emergent *Prostanthera semiteres* subsp. *semiteres* on coarse yellow-white sandy soils in seasonally wet depressions.
- S34:** Tall shrubland of *Acacia resinimarginea* and mixed *Allocasuarina* species with emergent *Eucalyptus leptopoda* subsp. *subluta* and *Callitris preissii* over *Leptospermum fastigiatum*, *Beyeria brevifolia*, mixed *Phebalium* species, *Malleostemon peltiger*, *Malleostemon roseus*, *Baeckea* ?sp. Mt Clara (R.J. Cranfield 11693) and other mixed low shrubs and grasses on yellow to orange sand plains.
- S35:** Open tall shrubland of *Acacia resinimarginea* with emergent *Eucalyptus leptopoda* subsp. *subluta* over *Leptospermum fastigiatum*, *Baeckea* ?sp. Mt Clara (R.J. Cranfield 11693) and other low mixed shrubs and grasses on yellow to orange sand plains.
- S36:** Open low shrubland of mixed emergent Myrtaceous shrubs over *Triodia ?rigidissima* on light orange-brown sands on flats.
- W29:** Low woodland of *Eucalyptus ?comitae-vallis*, *Eucalyptus horistes* and *Callitris preissii* over *Melaleuca hamata* and *Acacia jennerae* over *Micromyrtus erichsenii*, *Phebalium canaliculatum* and mixed shrubs over *Triodia scariosa* and *Triodia ?desertorum* on yellow sandy soils on flats.
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- W45:** Low woodland of *Eucalyptus horistes* and *Eucalyptus oleosa* subsp. *oleosa* with occasional *Callitris preissii* over mixed shrubs over *Triodia scariosa* on yellow sandy soils on flats.
- W45 (b):** Low woodland (fire disturbed) of *Eucalyptus horistes* and *Eucalyptus oleosa* subsp. *oleosa* with occasional *Callitris preissii* over mixed shrubs over *Triodia scariosa* on yellow sandy soils on flats.
- W46:** Open woodland of *Eucalyptus oleosa* subsp. *oleosa* with emergent *Callitris preissii* over *Acacia resinimarginea* and mixed *Allocasuarina* species over mixed *Phebalium* species and other mixed shrubs and grasses on orange-brown sandy loam flats.

The results of these surveys have demonstrated that the shrublands of the yellow sandplains around the Carina mine infrastructure are highly variable in structure, with many of the communities being defined by the relative dominance of species present. In addition to this, much of the yellow sandplains area in the vicinity of the Carina mine development has a history of recent fire disturbance. The results of these surveys have also demonstrated that some of the current priority flora are more common in the yellow sandplain vegetation than previously known. This is a consequence of an increased survey effort covering a broader area. This pattern is likely to continue with increased surveys in the area.

5.5 Threatened Ecological Communities

No threatened ecological communities, pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* and as listed by the Department of Environment and Conservation (2012b), are currently listed in the Coolgardie Botanical District. No threatened ecological communities, pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*, and as listed by the Department of Sustainability, Environment, Water, Population and Communities (2012b), are currently listed in the Coolgardie Botanical District.

5.6 Priority Ecological Communities

There are 58 priority ecological communities (PECs) defined and listed in the Goldfields Region (Department of Environment and Conservation 2012f). Of these, nine are located in the broader area surrounding the four sandplain survey areas. These are:

- Koolyanobbing vegetation complexes (banded ironstone formation) (P1)
- Die Hardy Range/Diemels vegetation complex (banded ironstone formation) (P1)
- Mount Jackson Range vegetation complex (banded ironstone formation) (P1)
- Mt Dimer vegetation complexes (banded ironstone formation) (P1)
- Windarling Ranges vegetation complex (banded ironstone formation) (P1)
- Finnerty Range vegetation complexes (banded ironstone formation) (P1)
- Helena and Aurora Range vegetation complexes (banded ironstone formation) (P1)
- Mount Manning Range vegetation complex (banded ironstone formation) (P1)
- Yilgarn Hills vegetation complex (P3)

The four survey areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) do not impact on any of these PECs.

5.7 Threatened and Priority Flora

The desktop survey for threatened and priority flora which may potentially occur within the Jaudri sandplain area was undertaken using the resources of NatureMap (Department of Environment and Conservation 2007), the Western Australian Herbarium (Department of Environment and Conservation 2012g), and the Department of Sustainability, Environment, Water, Population and Communities (2012a). A 25 km buffer either side of the centre of Mount Walton Road, between its intersection with the Great Eastern Highway, and the turnoff from Mount Walton Road to the Mt Dimer haul road, 45 km north of the Trans-Australian Rail line, was used to determine the presence of known threatened and priority taxa in the vicinity of the survey areas.

In addition to data which was accessed through NatureMap (Department of Environment and Conservation 2007-), data from previous surveys of the sandplain area near to the current survey area, undertaken by Mattiske Consulting Pty Ltd (2009, 2010a, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d), were incorporated into the desktop survey results to provide a more comprehensive list of threatened and priority taxa which may be encountered in the survey area.

In the vicinity of the four sandplain survey areas located along Mount Walton Road, there is one known threatened flora taxon, and 19 known priority flora taxa, including two Priority 1, two Priority 2, 12 Priority 3 and three Priority 4 species (Department of Environment and Conservation 2012g).

One threatened flora taxon, pursuant to subsection (2) of section 23F of the Wildlife Conservation Act 1950, and as listed by the Department of Environment and Conservation (2012b), has been recorded within the 25 km buffer about the proposed survey areas. This taxon was *Gastrolobium graniticum*. *Gastrolobium graniticum* is currently listed as an endangered species, pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*, and as listed by the Department of Sustainability, Environment, Water, Population and Communities (2012a). A brief description of this taxon and its potential to be recorded within the survey areas is set out below.

- ***Gastrolobium graniticum* (T) Fabaceae**

Erect, open shrub to 2.5 m high, recorded growing on sand, sandy loam and granite, on granite outcrops and along drainage lines, and produces yellow, orange and red flowers between August and September.

Potential to occur in survey areas: unlikely - preferred soil type/habitat not known to be present.

Eighteen Priority flora taxa have been recorded within the 25 km search buffer about the proposed gravel pit survey areas (Department of Environment and Conservation 2012g). These are listed in Table 3. A brief description of each taxon and its potential to be recorded within the survey areas is set out below Table 3.

Table 3: Priority flora recorded in the vicinity of the sandplain survey areas along Mount Walton Road. SCC = State Conservation Code (DEC).

Species	Family	SCC
<i>Acacia adinophylla</i>	Fabaceae	P1
<i>Leucopogon</i> sp. Yellowdine (M. Hislop & F. Hort MH 3194)	Ericaceae	P1
<i>Elachanthus pusillus</i>	Asteraceae	P2
<i>Lissanthe scabra</i>	Ericaceae	P2
<i>Acacia crenulata</i>	Fabaceae	P3
<i>Acacia formidabilis</i>	Fabaceae	P3
<i>Astartea</i> sp. Bungalbin Hill (K.R. Newbey 8989)	Myrtaceae	P3
<i>Austrostipa blackii</i>	Poaceae	P3
<i>Banksia lullfitzii</i>	Proteaceae	P3
<i>Calytrix creswellii</i>	Myrtaceae	P3
<i>Gnephosis</i> sp. Norseman (K.R. Newbey 8096)	Asteraceae	P3
<i>Homalocalyx grandiflorus</i>	Myrtaceae	P3
<i>Lepidosperma lyonsii</i>	Cyperaceae	P3
<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155-109)	Lamiaceae	P3
<i>Stylidium choreanthum</i>	Stylidiaceae	P3
<i>Myriophyllum petraeum</i>	Haloragaceae	P4
<i>Sowerbaea multicaulis</i>	Asparagaceae	P4
<i>Wurmbea murchisoniana</i>	Colchicaceae	P4

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- ***Acacia adinophylla* (P1) Fabaceae**
Prostrate or erect tangled shrub, 0.15 to 1.6 m high, to 3 m wide, recorded growing on stony loam or sandy soils, ironstone ridges and undulating plains, which produces yellow flowers between September and November.
Potential to occur in survey areas: unlikely - preferred soil type/habitat not known to be present.
 - ***Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) Ericaceae**
Prostrate or erect tangled shrub, 0.15 to 1.6 m high, to 3 m wide, recorded growing on stony loam or sandy soils, ironstone ridges and undulating plains, which produces yellow flowers between September and November.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Elachanthus pusillus* (P2) Asteraceae**
Ascending or decumbent annual herb to 0.15 m high, producing yellow flowers between August and October.
Potential to occur in survey areas: medium – field survey at appropriate time of year.
 - ***Lissanthe scabra* (P2) Ericaceae**
Rigid, erect, fairly densely branched shrub, to 1 m high, recorded growing on white to orange-brown clay, sandy gravel loams, granite, on breakaways and uplands, producing white flowers in August.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Acacia crenulata* (P3) Fabaceae**
Bushy shrub or tree, from 0.7 m to 3 m high, found growing on clay, sandy clay, yellow sands, rocky rises, granite outcrops and breakaways, which produces yellow flowers.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Acacia formidabilis* (P3) Fabaceae**
Diffuse, pungent shrub, from 0.2 m to 0.6 m high, recorded growing yellow or red-brown sandy soils on plains and hillsides, which produces yellow flowers between August and September.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Astartea* sp. Bungalbin Hill (K.R. Newbey 8989) (P3) Myrtaceae**
Spreading shrub, 0.1 m to 0.4 m high, found growing on deep yellow sand, which produces white or pink flowers between September and December.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Austrostipa blackii* (P3) Poaceae**
Tufted perennial grass to 1 m high, recorded as producing flowers between September and November.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Banksia lullfitzii* (P3) Proteaceae**
Lignotuberous shrub, 0.8-2 m high, recorded growing on yellow sand plains, which produces yellow-orange/orange-brown flowers between March and May.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Calytrix creswellii* (P3) Myrtaceae**
Spreading shrub, from 0.25 m to 1 m high, recorded growing on yellow sandy soils, with or without lateritic gravel, which produces white flowers between September and December.
Potential to occur in survey areas: high - preferred soil type/habitat known to be present.
 - ***Gnephosis* sp. Norseman (K.R. Newbey 8096) (P3) Asteraceae**
Low spreading annual, herb, 0.03–0.07 m high, recorded growing on sub-saline loam on moderately exposed flats.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
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- ***Homalocalyx grandiflorus* (P3) Myrtaceae**
Spreading shrub, from 0.20 m to 0.50 m (to 2 m) high, recorded growing on yellow sandy soils, which produces purple, red or pink flowers between October and December.
Potential to occur in survey areas: high - preferred soil type/habitat known to be present.
 - ***Lepidosperma lyonsii* (P3) Cyperaceae**
Tufted rhizomatous, perennial, herb (sedge), recorded growing on pale orange skeletal sandy loam with banded ironstone gravel & rock, well-drained shallow stony loamy with quartz, on gentle hill slopes, upper slopes of large hills.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109) (P3) Lamiaceae**
Shrub, 0.35 to 1 m high, recorded growing on rocky loam, sandy or skeletal soil, clay, on sandplains and hills, producing blue and white flowers between September and November.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Stylidium choreanthum* (P3) Stylidiaceae**
Creeping perennial herb, from 0.01 to 0.03 m high, recorded growing on white, yellow or red sandy soils, which produces pink to white flowers between September and November.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Myriophyllum petraeum* (P4) Haloragaceae**
Aquatic annual herb, recorded growing in ephemeral rock pools on granite outcrops, which produces white flowers between August and December.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.
 - ***Sowerbaea multicaulis* (P4) Asparagaceae**
Tufted perennial, herb, 0.075–0.25 m high, recorded growing on yellow-brown sand, and which produces violet flowers between October and January.
Potential to occur in survey areas: medium - preferred soil type/habitat known to be present.
 - ***Wurmbea murchisoniana* (P4) Colchicaceae**
Cormous, perennial herb, 0.1–0.26 m high, recorded growing on clay, sandy clay, and loam soils, in seasonally inundated clay hollows and rock pools, and which produces white flowers between July and September.
Potential to occur in survey areas: low - preferred soil type/habitat not known to be present.

6. FIELD SURVEY RESULTS

The survey areas consisted of four, one square kilometre areas, as delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) and as set out in Table 1. Within each of these areas, four representative vegetation quadrats were established (Figures 1 & 3). In addition to the data recorded during the present survey (16 quadrats), the results of flora and vegetation surveys undertaken by Mattiske Consulting Pty Ltd, on behalf of Polaris Metals Pty Ltd, in the yellow sandplain vegetation between 2009 and 2011 (135 quadrats) have been incorporated to provide a broader perspective. The locations of all survey quadrats within the yellow sandplain vegetation are illustrated in Figure 4.

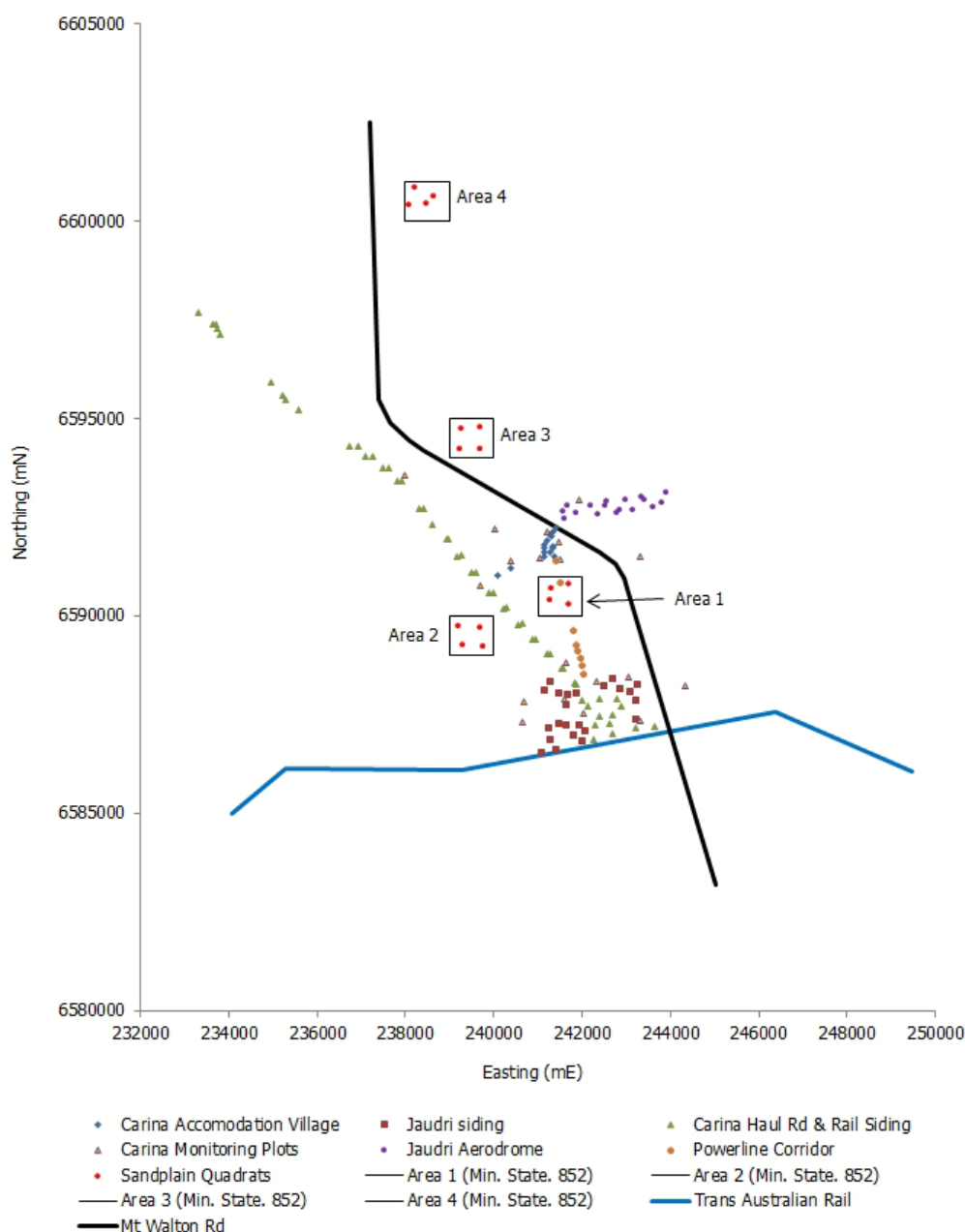


Figure 4: Distribution of survey quadrats within the yellow sandplain vegetation
The survey areas, as delineated in Ministerial Statement 852, together with the locations of past survey quadrats established by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation, are shown in relation to Mt Walton Rd, and the Trans-Australia rail line.

6.1 Flora

A total of 124 vascular plant taxa representative of 71 genera and 32 families were recorded across all four survey areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011). The majority of taxa recorded were representative of the Myrtaceae (27 taxa), Proteaceae (21 taxa), Cyperaceae (14 taxa) and Fabaceae (11 taxa) families (Appendix C). The taxa recorded from these four families represented 59% of all species recorded during the survey. A listing of the plant species recorded at each of the 16 survey quadrats sites within the four survey areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) set out in Appendix D.

When the data from the additional 135 survey quadrats in the yellow sandplain vegetation are incorporated into the present dataset, the result is that a total of 331 vascular plant taxa, representative of 105 genera and 38 families have been recorded. The majority of taxa recorded across all 151 survey quadrats were representative of the Myrtaceae (73 taxa), Fabaceae (47 taxa), Proteaceae (40 taxa), Cyperaceae (21 taxa), Ericaceae (13 taxa), Goodeniaceae (13 taxa), Lamiaceae (12 taxa) and Rutaceae (12 taxa) families (Appendix C). The taxa recorded from these eight families represented 70% of all species recorded during the survey.

6.2 Proportion of Flora Sampled

A species accumulation plot, based on accumulated species versus sites surveyed was prepared, using the field data from both the present and past surveys undertaken by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation. The species accumulation plot was used to provide both an estimate of the potential number of species present, and the proportion sampled to date. As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic.

The species accumulation curve (Figure 5), based on the species accumulation analysis of Colwell (2006) was used to evaluate the data. The asymptotic value was determined using Michaelis-Menten modelling. Using this analysis, the incidence based coverage estimator of species richness (ICE, Chao 2004) was calculated to be 380.48. Based on this value, and the total of 331 species recorded during both the present and past surveys of the yellow sandplain vegetation, approximately 87% of the flora species potentially present within the survey area have been recorded.

6.3 Threatened Flora

No threatened flora pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* and as listed by the Department of Environment and Conservation (2012b) were recorded at any of the 16 survey quadrats within areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) or during past surveys undertaken by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

No threatened flora pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* and as listed by the Department of Sustainability, Environment, Water, Population and Communities (2012a) were recorded at any of the 16 survey quadrats within areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) or during past surveys undertaken by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

6.4 Priority Flora

Five priority flora species were recorded during the survey of the four areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011). The taxa recorded were *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1), *Hakea rigida* (P2), *Calytrix creswellii* (P3), *Cryptandra crispula* (P3), and *Homalocalyx grandiflorus* (P3). Department of Environment and Conservation threatened and priority flora report forms, relevant to the priority flora recorded during the present survey, are included as Appendix F.

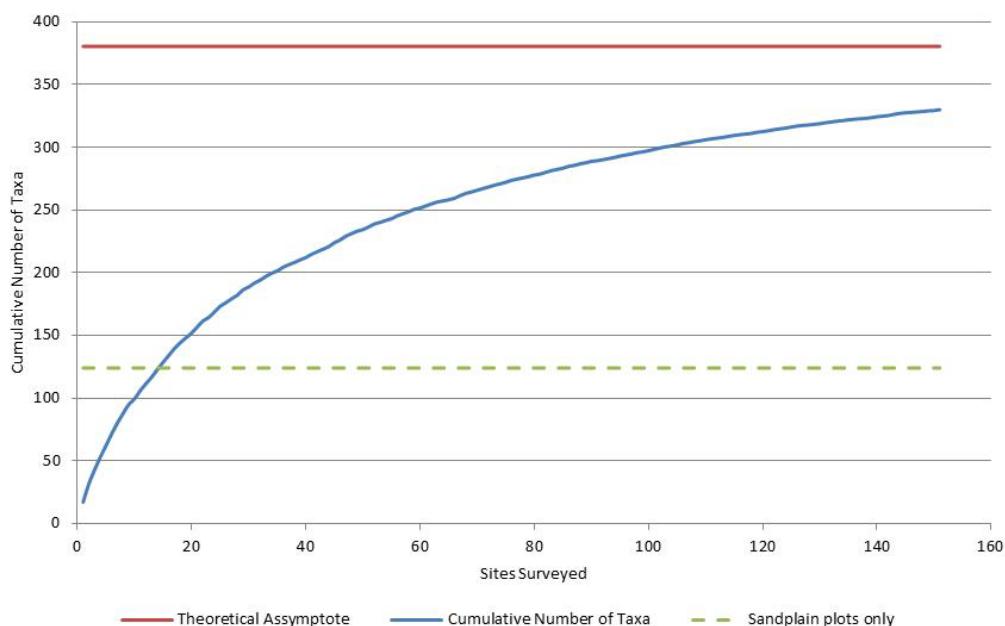


Figure 5: Averaged randomised species accumulation curve

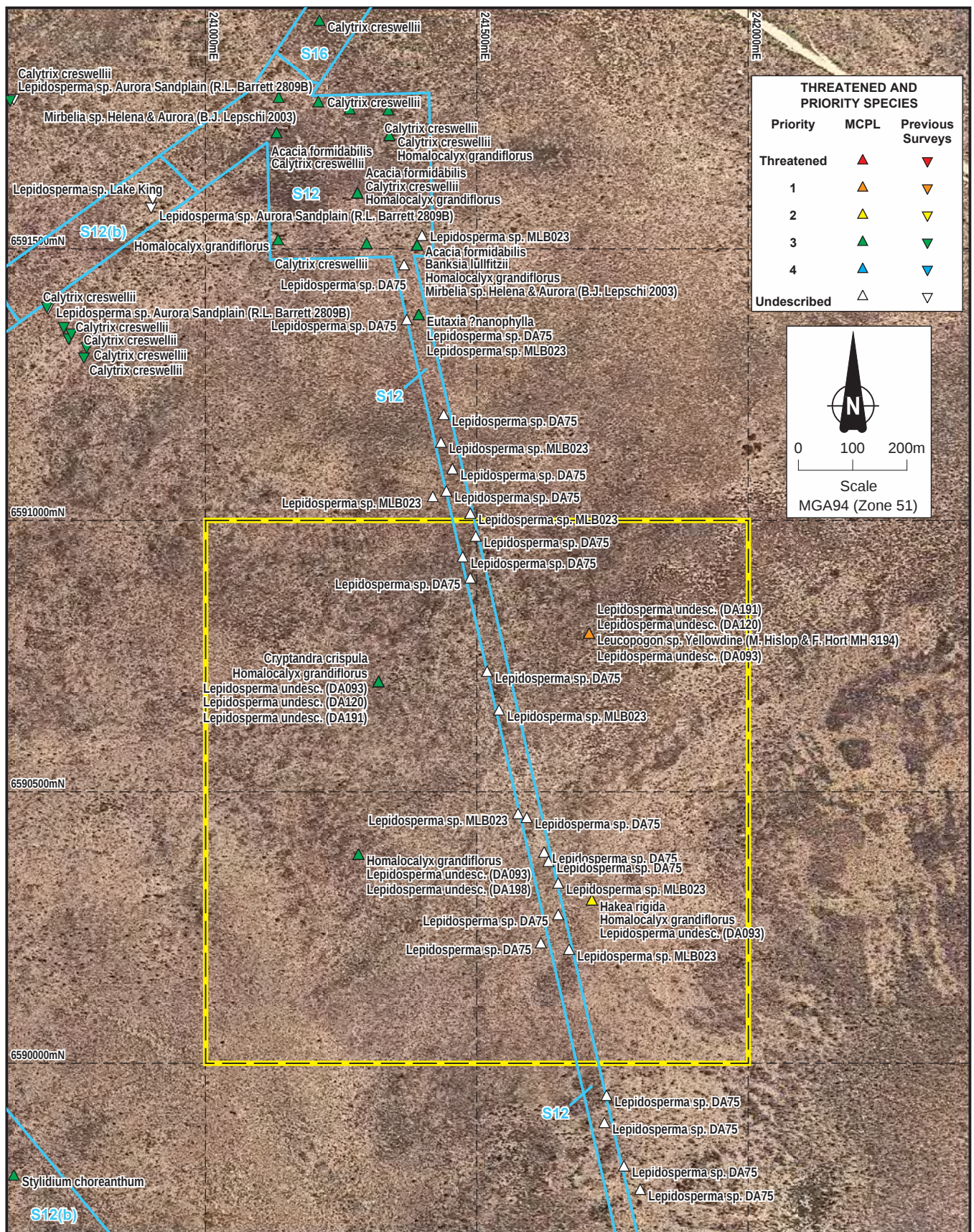
Field survey data was used to calculate both a species accumulation curve and a theoretical maximum number of species (asymptotic value) within the survey areas. The green dashed line represents the number of species recorded during the survey of 16 quadrats within the survey areas delineated in Schedule 3 of Ministerial Statement 852.

When the data from surveys of the yellow sandplain vegetation undertaken by Mattiske Consulting Pty Ltd between 2009 and 2011 are incorporated into the dataset, the result is that a total of 13 priority flora species have been recorded across 151 survey quadrats. The taxa recorded were *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1), *Hakea rigida* (P2), *Acacia formidabilis* (P3), *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3), *Banksia lullfitzii* (P3), *Calytrix creswellii* (P3), *Cryptandra crispula* (P3), *Eutaxia ?nanophylla* (P3), *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3), *Homalocalyx grandiflorus* (P3), *Lepidosperma lyonsii* (P3), *Stylidium choreanthum* (P3) and *Sowerbaea multicaulis* (P4). The distribution of the priority species recorded both within the four areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) and the surrounding areas are shown in Figure 6-1 through 6-4.

The locations and populations of each of the priority flora recorded are set out in the sections 6.4.1 through 6.4.13. The areas surveyed in the yellow sandplain vegetation, between 2009 and 2011, by Mattiske Consulting Pty Ltd (MCPL) on behalf of Polaris Metals Pty Ltd in the yellow sandplain vegetation are: haul road (MCPL 2009), accommodation village (MCPL 2101a), Jaudri siding (MCPL 2101b), East Jaudri aerodrome (MCPL 2011a), power line corridor (MCPL 2011b), Carina mine monitoring plots (MCPL 2011c) and Mt Walton Rd gravel pits (MCPL 2011d).

6.4.1 *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1)

Leucopogon sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) has only been recorded at survey quadrats established within the areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). The locations and populations of *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) recorded during these surveys are set out in Table 4. There are six records of *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently only known from the Coolgardie bioregion of the Eremaean province (Figure 7).



Vegetation Legend

- S12** Scrub of *Allocasuarina corniculata*, mixed *Banksia* and *Eucalyptus* species with emergent *Callitris preissii* over *Melaleuca cordata*, *Grevillea didymobotrya* subsp. *didymobotrya* and mixed shrubs over *Triodia desertorum* and occasional *Lepidobolus preissianus* subsp. *volubilis* and *Schoenus hexandrus* on yellow sandy soils on gently undulating plains.
- S12 (b)** Scrub (fire disturbed) of *Allocasuarina corniculata*, mixed *Banksia* and *Eucalyptus* species with emergent *Callitris preissii* over *Melaleuca cordata*, *Grevillea didymobotrya* subsp. *didymobotrya* and mixed shrubs over *Triodia desertorum* and occasional *Lepidobolus preissianus* subsp. *volubilis* and *Schoenus hexandrus* on yellow sandy soils on gently undulating plains.
- S16** Open scrub of *Allocasuarina corniculata*, *Allocasuarina campestris*, *Eucalyptus leptopoda* subsp. *subluta* and *Banksia elderiana* over *Leptospermum fastigiatum*, *Calothamnus gilesii* and mixed shrubs on lateritic orange sandy soils on slopes.

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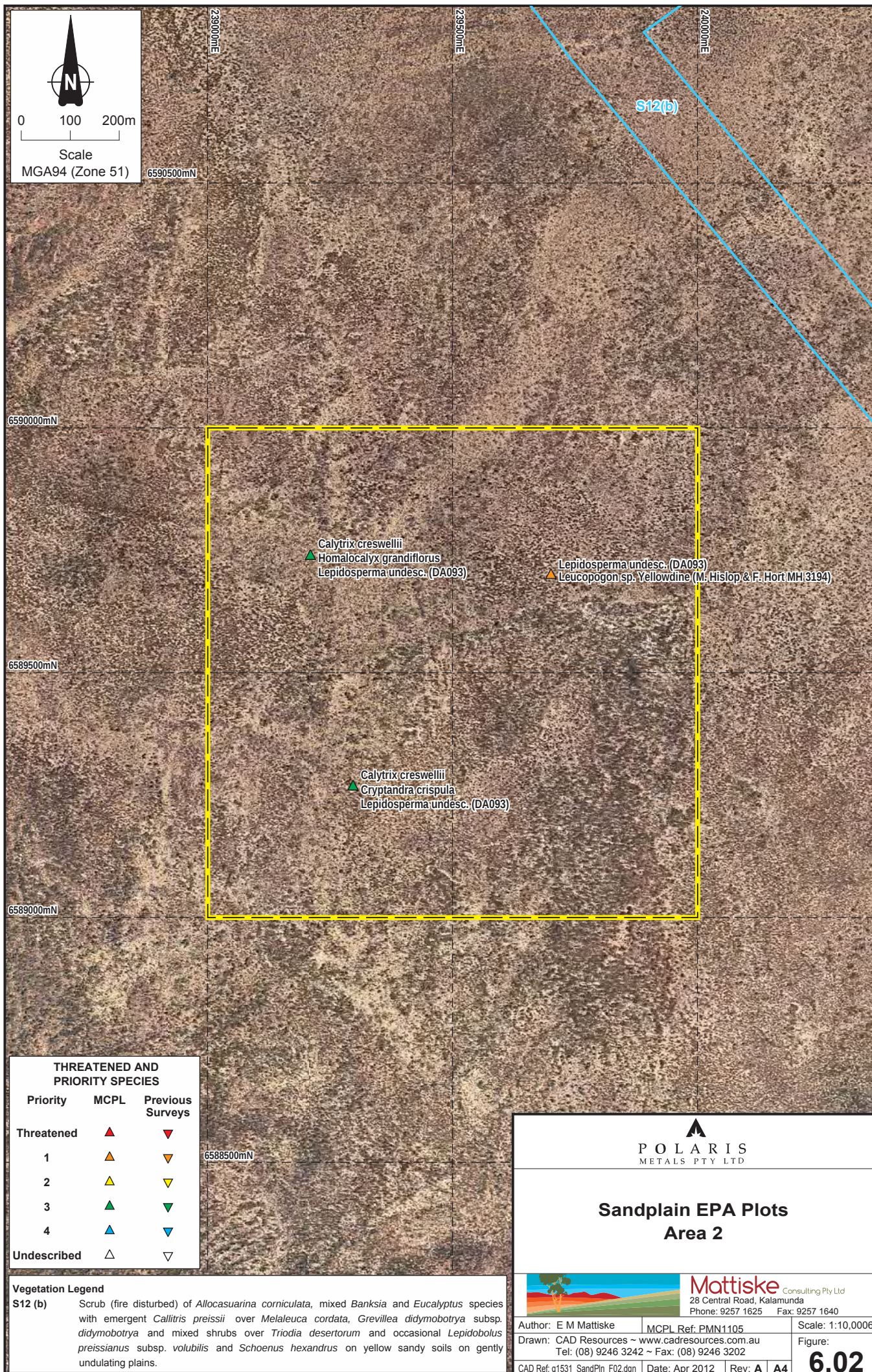
Sandplain EPA Plots Area 1

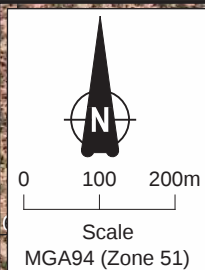


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CAD Ref: g1531_SandPln_F01.dgn	Date: Apr 2012	Rev: A A4

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THREATENED AND PRIORITY SPECIES		
Priority	MCPL	Previous Surveys
Threatened	▲	▼
1	▲	▼
2	▲	▼
3	▲	▼
4	▲	▼
Undescribed	△	▽

6595000mN

6594500mN

6594000mN

6593500mN

239000mE

239500mE

240000mE

▲ *Calytrix creswellii*
Lepidosperma undesc. (DA093)

▲ *Calytrix creswellii*
Lepidosperma undesc. (DA120)
Lepidosperma undesc. (DA152)

▲ *Calytrix creswellii*
Lepidosperma undesc. (DA093)
Homalocalyx grandiflorus
Lepidosperma undesc. (DA152)
Leucopogon sp. Yellowdine (M. Hislop & F. Hort MH 3194)

▲ *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194)
Lepidosperma undesc. (DA093)
Lepidosperma undesc. (DA182)


POLARIS
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Sandplain EPA Plots Area 3



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CAD Ref: g1531_SandPln_F03.dgn Date: Apr 2012 Rev: A A4

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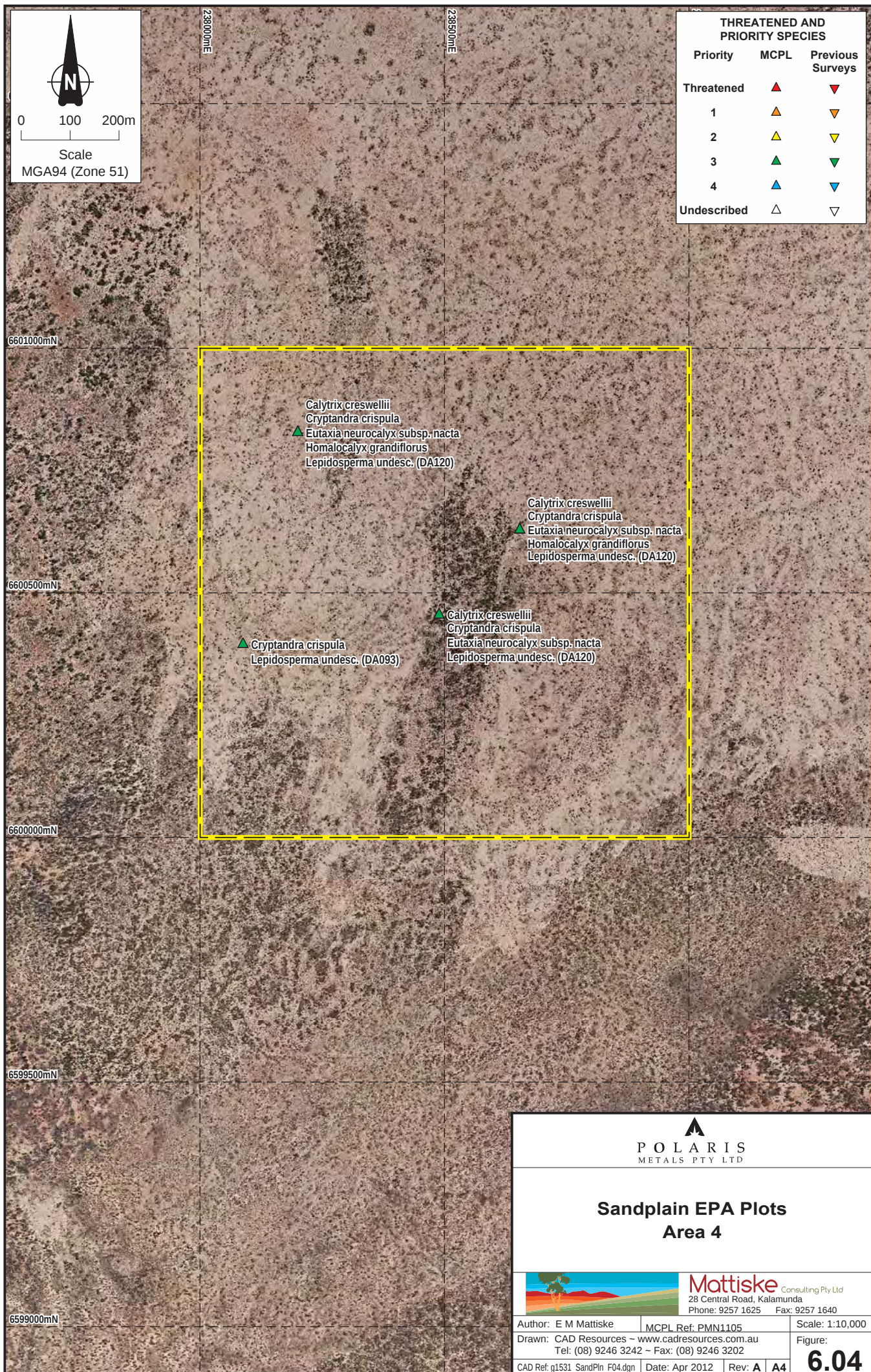


Table 4: Location and population of *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
MS852: Area 1	241707	6590789	1
MS852: Area 1	239701	6589699	1
MS852: Area 3	239222	6594213	1
MS852: Area 3	239697	6594226	1

6.4.2 *Hakea rigida* (P2)

Hakea rigida (P2) was recorded at one survey quadrat established within the areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). The locations and populations of *Hakea rigida* (P2) recorded during these surveys are set out in Table 5. There are 16 records of *Hakea rigida* (P2) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Avon Wheatbelt bioregions of the Eremaean and South-West provinces (Figure 7).

Table 5: Location and population of *Hakea rigida* (P2) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
MS852: Area 1	241712	6590298	1

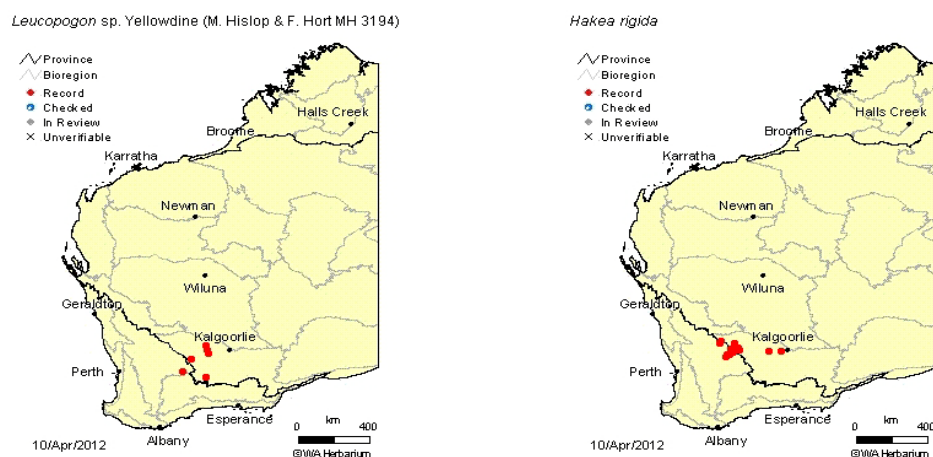


Figure 7: Distributions maps for *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) and *Hakea rigida* (P2) (Department of Environment and Conservation 2012g).

6.4.3 *Acacia formidabilis* (P3)

Acacia formidabilis (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Acacia formidabilis* (P3) recorded during these surveys are set out in Table 6. There are 14 records of *Acacia formidabilis* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Yalgoo bioregions of the Eremaean province (Figure 8).

Table 6: Location and population of *Acacia formidabilis* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: haul road	238927	6591940	1
Carina: accommodation village	241131	6591711	1
Carina: accommodation village	241280	6591600	1
Carina: accommodation village	241390	6591504	1
Carina: monitoring plots	241044	6591473	21

6.4.4 *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3)

Astartea ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) recorded during these surveys are set out in Table 7. There are 18 records of *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie bioregion of the Eremaean province (Figure 8).

Table 7: Location and population of *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: accommodation village	241422	6592218	1
Carina: accommodation village	241422	6592218	1
Carina: accommodation village	241268	6592035	1

6.4.5 *Banksia lullfitzii* (P3)

Banksia lullfitzii (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Banksia lullfitzii* (P3) recorded during these surveys are set out in Table 8. There are 19 records of *Banksia lullfitzii* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie, Mallee and Esperance Plains bioregions of the Eremaean and South-West provinces (Figure 8).

Table 8: Location and population of *Banksia lullfitzii* (P3) recorded in the yellow sandplain vegetation. Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Matiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: accommodation village	241390	6591504	2
Carina: Mt Walton gravel pits	239693	6594568	1
Carina: Mt Walton gravel pits	241557	6591101	1
Carina: Mt Walton gravel pits	241537	6591101	1

6.4.6 *Calytrix creswellii* (P3)

Calytrix creswellii (P3) was recorded at nine survey quadrats established within the areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), as well as during past surveys by Matiske Consulting Pty Ltd in the yellow sandplain vegetation. The locations and populations of *Calytrix creswellii* (P3) recorded during these surveys are set out in Table 9. There are 16 records of *Calytrix creswellii* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Murchison bioregions of the Eremaean province (Figure 8).

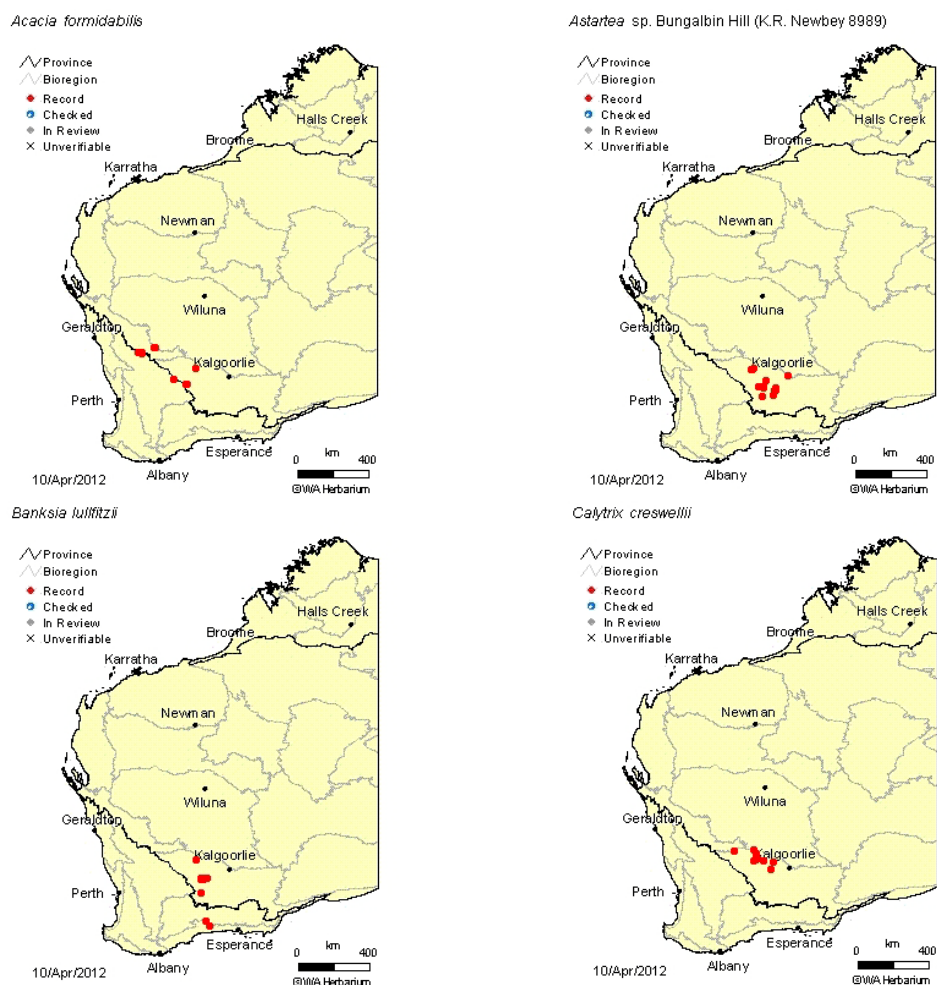


Figure 8: Distributions maps for *Acacia formidabilis* (P3), *Astartea* sp. Bungalbin Hill (K.R. Newbey 8989) (P3), *Banksia lullfitzii* (P3) and *Calytrix creswellii* (P3) (Department of Environment and Conservation 2012g).

Table 9: Location and population of *Calytrix creswellii* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
MS852: Area 2	239210	6589738	2-5
MS852: Area 2	239297	6589267	26-50
MS852: Area 3	239222	6594213	1
MS852: Area 3	239700	6594762	6-10
MS852: Area 3	239222	6594213	1
MS852: Area 3	239255	6594745	25-50
MS852: Area 4	238654	6600629	1
MS852: Area 4	238489	6600455	1
MS852: Area 4	238200	6600828	1
Carina: haul road	242798	6587881	5-10
Carina: haul road	242903	6587708	5-10
Carina: haul road	242708	6587498	5-10
Carina: accommodation village	241299	6592016	2-5
Carina: accommodation village	241210	6591918	26-50
Carina: accommodation village	241337	6591753	51-100
Carina: accommodation village	241131	6591711	15
Carina: accommodation village	241339	6591706	51-100
Carina: accommodation village	241280	6591600	12
Carina: accommodation village	241270	6591971	10
Carina: accommodation village	241252	6591962	3
Carina: accommodation village	241223	6591955	2
Carina: accommodation village	241208	6591768	1
Carina: accommodation village	241266	6591755	26-50
Carina: accommodation village	241297	6591507	51-100
Carina: rail siding	241263	6588325	25-50
Carina: rail siding	241864	6588055	1
Carina: rail siding	242798	6587881	1
Carina: rail siding	242903	6587708	1
Carina: rail siding	242708	6587498	1
Carina: monitoring plots	241462	6591855	8
Carina: monitoring plots	241506	6591413	8
Carina: power line corridor	241955	6588937	50-100
Carina: power line corridor	241861	6589262	6
Carina: power line corridor	241801	6589632	1
Carina: power line corridor	241837	6589464	11
Carina: power line corridor	241812	6489585	6
Carina: Mt Walton gravel pits	243071	6589968	6-10
Carina: Mt Walton gravel pits	243074	6589960	1
Carina: Mt Walton gravel pits	243091	6589953	1
Carina: Mt Walton gravel pits	243125	6589905	1
Carina: Mt Walton gravel pits	243125	6589905	11-25
Carina: Mt Walton gravel pits	243131	6589846	11-25
Carina: Mt Walton gravel pits	243152	6590009	2-5
Carina: Mt Walton gravel pits	243076	6589978	6-10
Carina: Mt Walton gravel pits	241285	6592213	6-10
Carina: Mt Walton gravel pits	241302	6592206	1
Carina: Mt Walton gravel pits	241306	6592337	1
Carina: Mt Walton gravel pits	241368	9592368	6-10
Carina: Mt Walton gravel pits	241382	6592366	2
Carina: Mt Walton gravel pits	241413	6592342	1

6.4.7 *Cryptandra crispula* (P3)

Cryptandra crispula (P3) was recorded at six survey quadrats established within the areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). The locations and populations of *Cryptandra crispula* (P3) recorded during these surveys are set out in Table 10. There are six records of *Cryptandra crispula* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie bioregion of the Eremaean province (Figure 9).

Table 10: Location and population of *Cryptandra crispula* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
MS852: Area 1	241319	6590700	1
MS852: Area 2	239297	6589267	1
MS852: Area 4	238489	6600455	1
MS852: Area 4	238654	6600629	1
MS852: Area 4	238200	6600828	1
MS852: Area 4	238088	6600395	1

6.4.8 *Eutaxia ?nanophylla* (P3)

Eutaxia ?nanophylla (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The location and population of *Eutaxia ?nanophylla* (P3) recorded during these surveys are set out in Table 11. There are nine records of *Eutaxia ?nanophylla* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie, Mallee, Murchison and Jarrah Forest bioregions of the Eremaean and South-West provinces (Figure 9).

Table 11: Location and population of *Eutaxia ?nanophylla* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: power line corridor	241393	9591376	1

6.4.9 *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3)

Mirbelia sp. Helena & Aurora (B.J. Lepschi 2003) (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3) recorded during these surveys are set out in Table 12. There are 24 records of *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Avon Wheatbelt bioregions of the Eremaean and South-West provinces (Figure 9).

Table 12: Location and population of *Mirbelia sp. Helena & Aurora* (B.J. Lepschi 2003) (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: accommodation village	241135	6591776	1
Carina: accommodation village	241390	6591504	1
Carina: haul road	238617	6592617	1

6.4.10 *Homalocalyx grandiflorus* (P3)

Homalocalyx grandiflorus (P3) was recorded at seven survey quadrats established within the areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). The locations and populations of *Homalocalyx grandiflorus* (P3) recorded during these surveys are set out in Table 13. There are 13 records of *Homalocalyx grandiflorus* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Murchison bioregions of the Eremaean province (Figure 9).

Table 13: Location and population of *Homalocalyx grandiflorus* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
MS852: Area 1	241319	6590700	1
MS852: Area 1	241282	6590382	1
MS852: Area 1	241712	6590298	1
MS852: Area 2	239210	6589738	1
MS852: Area 3	239222	6594213	1
MS852: Area 4	238654	6600629	1
MS852: Area 4	238200	6600828	1
Carina: accommodation village	240097	6591035	1
Carina: accommodation village	240389	6591219	1
Carina: accommodation village	241339	6591706	1
Carina: accommodation village	241280	6591600	1
Carina: accommodation village	241134	6591514	1
Carina: accommodation village	241390	6591504	1
Carina: haul road	239272	6591520	1
Carina: monitoring plots	240042	6592199	11
Carina: monitoring plots	239683	6590759	2
Carina: monitoring plots	241506	6591413	4
Carina: rail siding	242848	6588158	1

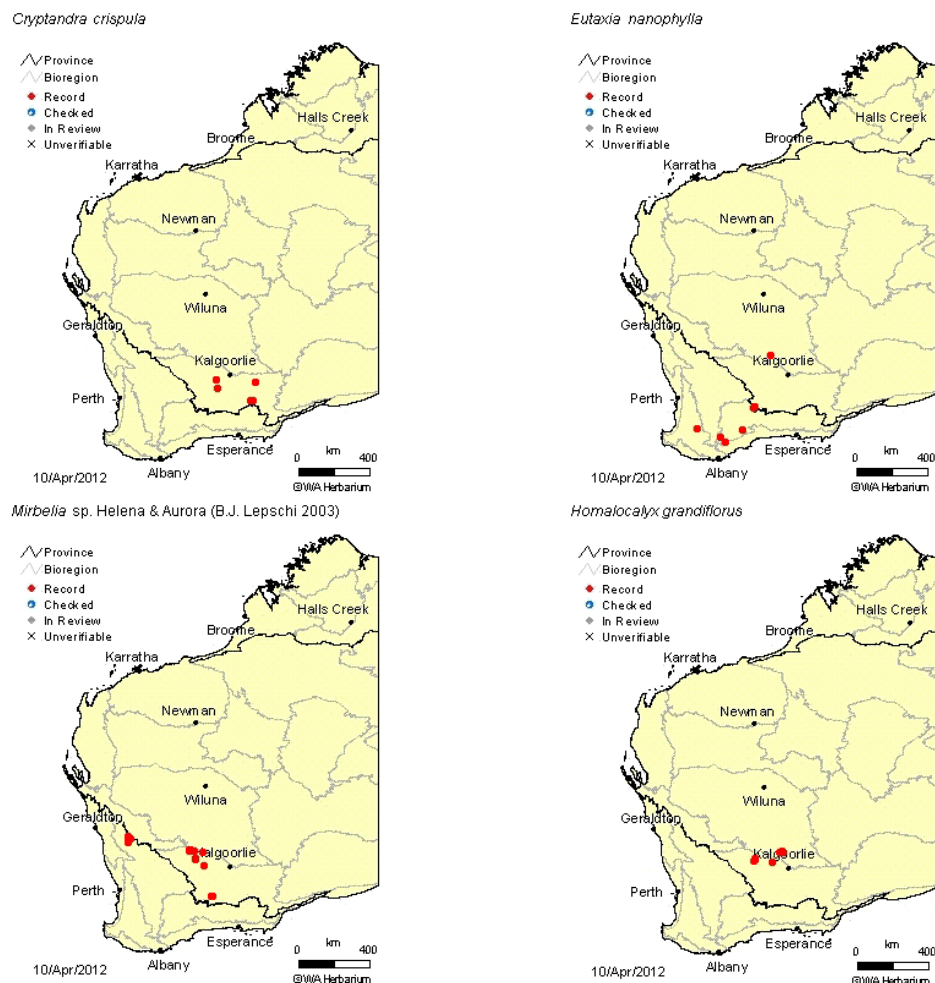


Figure 9: Distributions maps for *Cryptandra crispula* (P3), *Eutaxia nanophylla* (P3), *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3) and *Homalocalyx grandiflorus* (P3) (Department of Environment and Conservation 2012g).

6.4.11 *Lepidosperma lyonsii* (P3)

Lepidosperma lyonsii (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Lepidosperma lyonsii* (P3) recorded during these surveys are set out in Table 14. There are five records of *Lepidosperma lyonsii* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie bioregion of the Eremaean province (Figure 10).

6.4.12 *Stylidium choreanthum* (P3)

Stylidium choreanthum (P3) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Mattiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Stylidium choreanthum* (P3) recorded during these surveys are set out in Table 15. There are 27 records of *Stylidium choreanthum* (P3) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie and Avon Wheatbelt bioregions of the Eremaean and South-West provinces (Figure 10).

Table 14: Location and population of *Lepidosperma lyonsii* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Matiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: haul road	231331	6600219	2-5
Carina: haul road	233307	6597691	10-20
Carina: haul road	235212	6595582	10-20
Carina: haul road	235314	6595581	2-5
Carina: haul road	235568	6595215	2-5
Carina: haul road	236185	6594880	1
Carina: haul road	242708	6587498	10-20

Table 15: Location and population of *Stylidium choreanthum* (P3) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Matiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: haul road	237816	6593416	5-10
Carina: haul road	238324	6592710	5-10
Carina: haul road	238421	6592714	3
Carina: haul road	238617	6592310	5-10
Carina: haul road	238969	6591942	200+
Carina: haul road	239272	6591520	20
Carina: haul road	240565	6589780	5-10
Carina: haul road	240647	6589791	200+
Carina: haul road	240868	6589418	5-10
Carina: haul road	240942	6589414	200+

6.4.13 *Sowerbaea multicaulis* (P4)

Sowerbaea multicaulis (P4) was not recorded in quadrats established in areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), but has previously been recorded by Matiske Consulting Pty Ltd during surveys in the yellow sandplain vegetation. The locations and populations of *Sowerbaea multicaulis* (P4) recorded during these surveys are set out in Table 16. There are 20 records of *Sowerbaea multicaulis* (P4) on the Western Australian Herbarium database (Department of Environment and Conservation 2012g). This taxon is currently known from the Coolgardie, Murchison, Mallee and Jarrah Forest IBRA bioregions of Beard's (1990) Eremaean and South-West provinces (Figure 10).

Table 16: Location and population of *Sowerbaea multicaulis* (P4) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: haul road	241247	6592267	1
Carina: haul road	241259	6592252	1
Carina: haul road	241362	6592220	1

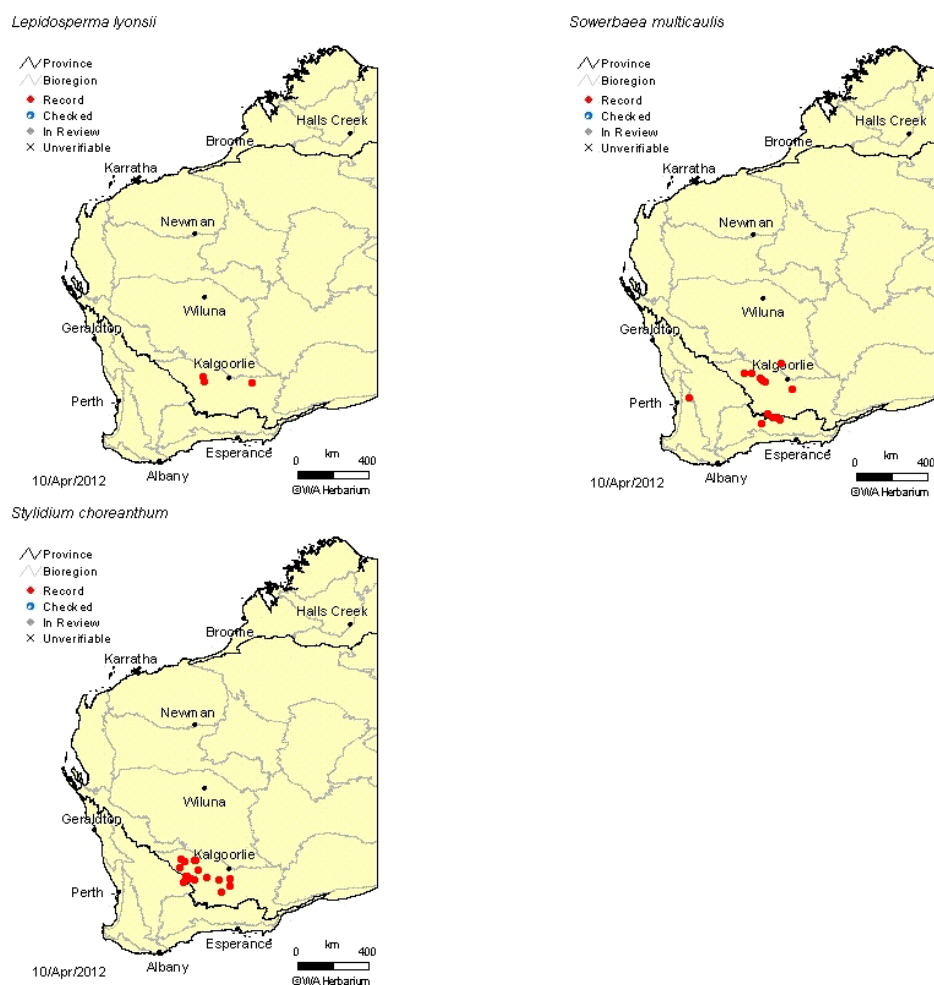


Figure 10: Distributions maps for *Lepidosperma lyonsii* (P3), *Stylidium choreanthum* and *Sowerbaea multicaulis* (P4) (Department of Environment and Conservation 2012g).

6.5 *Lepidosperma* Taxa

A number of *Lepidosperma* taxa have been recorded, both during the survey of the four areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011), as well as during previous surveys undertaken by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation (Mattiske Consulting Pty Ltd 2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d).

6.5.1 *Lepidosperma* sp. Aurora Sandplain (R.L. Barrett 2809B)

This taxon is currently not listed on Florabase (Department of Environment and Conservation 2012g). This taxon was known from a single population in sandy soils located to the north of the Helena and Aurora Ranges (R. Barrett pers comm). The locations and populations of *Lepidosperma* sp. Aurora Sandplain (R.L. Barrett 2809B) recorded during past surveys of the yellow sandplain vegetation by Mattiske Consulting Pty Ltd are set out in Table 17.

Table 17: Location and population of *Lepidosperma* sp. Aurora Sandplain (R.L. Barrett 2809B) recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
Carina: haul road	237816	6593416	1
Carina: haul road	237920	6593411	1
Carina: haul road	238324	6592710	1
Carina: haul road	238421	6592714	1
Carina: haul road	238617	6592310	1
Carina: haul road	239272	6591520	1
Carina: haul road	239587	6591084	1

6.5.2 Un-named *Lepidosperma* taxa

Populations of *Lepidosperma* species, whose current taxonomic status is un-named, were recorded at several locations, both within the survey areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011), as well as during previous surveys undertaken by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation (Mattiske Consulting Pty Ltd 2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d).. The locations and populations of each taxon recorded are set out in Table 18.

6.6 Photographic Record of Survey Sites

A photograph of each of the 16 quadrats established in the four areas delineated in Schedule 3 of Ministerial Statement 852 (Government of Western Australia 2011) was made. Each photograph was taken from the north-west corner towards the south-east corner of the quadrat. The photographic record is presented in Appendix E.

Table 18: Location and population of un-named *Lepidosperma* species recorded in the yellow sandplain vegetation

Survey area: MS852 – areas delineated in Ministerial Statement 852; Carina – past surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation.

Survey Area	Location (GDA, Zone 51)		Population Count
	Easting (mE)	Northing (mN)	
<i>Lepidosperma</i> sp. DA075			
Carina: monitoring plots	239683	6590759	1
Carina: monitoring plots	239683	6590759	1
Carina: monitoring plots	241044	6591473	1
Carina: monitoring plots	241204	6592140	1
Carina: monitoring plots	241393	6591376	1
Carina: accommodation village	240389	6591219	1
Carina: accommodation village	241131	6591711	1
Carina: accommodation village	241339	6591706	1
Carina: accommodation village	241134	6591514	1
Carina: accommodation village	241218	6591612	1
Carina: accommodation village	241016	6591606	1
Carina: accommodation village	241008	6591643	1
Carina: accommodation village	240975	6591665	1
Carina: accommodation village	240793	6591511	1
Carina: accommodation village	240704	6591501	1
Carina: accommodation village	240645	6591411	1
<i>Lepidosperma</i> sp. CBL095			
Carina: monitoring plots	239683	6590759	1
Carina: monitoring plots	240390	6591399	1
Carina: monitoring plots	241506	6591413	1
<i>Lepidosperma</i> undesc. (DA093)			
MS852: Area 1	241319	6590700	1
MS852: Area 1	241282	6590382	1
MS852: Area 1	241712	6590298	1
MS852: Area 1	241707	6590789	1
MS852: Area 2	239701	6589699	1
MS852: Area 2	239210	6589738	1
MS852: Area 2	239297	6589267	1
MS852: Area 3	239222	6594213	1
MS852: Area 3	239255	6594745	1
MS852: Area 3	239697	6594226	1
MS852: Area 4	238088	6600395	1
<i>Lepidosperma</i> undesc. (DA120)			
MS852: Area 1	241319	6590700	1
MS852: Area 1	241707	6590789	1
MS852: Area 1	239700	6594762	1
MS852: Area 3	238489	6600455	1
MS852: Area 4	238654	6600629	1
MS852: Area 4	238200	6600828	1
<i>Lepidosperma</i> undesc. (DA152)			
MS852: Area 3	239222	6594213	1
MS852: Area 3	239700	6594762	1
<i>Lepidosperma</i> undesc. (DA182)			
MS852: Area 3	239697	6594226	1
<i>Lepidosperma</i> undesc. (DA191)			
MS852: Area 1	241319	6590700	1
MS852: Area 1	241707	6590789	1
<i>Lepidosperma</i> undesc. (DA191)			
MS852: Area 1	241282	6590382	3

7. DISCUSSION

The survey of the yellow sandplain vegetation areas for threatened and priority taxa targeted four areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). Two of these areas (Areas 1 and 2) were located in relative close proximity to infrastructure associated with Polaris Metals Pty Ltd Carina mine operations, on the western side of Mt Walton Rd. The other two areas (Areas 3 and 4) were located more distant to the Carina mine infrastructure, and on the eastern side of Mt Walton Rd (Figures 1, 3 and 4). The purpose for this distribution of search areas was to determine if the flora, in general, and threatened and priority taxa specifically, recorded in areas associated with the mine infrastructure development, are more widespread in the yellow sandplain vegetation. In addition the survey represented an opportunity to conduct a flora survey in a relatively poorly explored area. The results of the survey demonstrate that the both the general flora, and the priority taxa previously recorded are distributed through the region of the yellow sandplain both near to, and distant from the Polaris metals Pty Ltd operations.

Sixteen quadrats, together with opportunistic collections, were established during the present survey. The data collected was subsequently merged with data from previous surveys in the yellow sandplain vegetation (Mattiske Consulting Pty Ltd. 2009, 2010a, 2010b, 2011a, 2011b, 2011c and 2011d). The data from these previous surveys was related to flora and vegetation associated with the Carina mine infrastructure. In total, the data from 151 survey quadrats has been used to evaluate the presence of the flora of the yellow sandplain vegetation.

7.1 Flora and Vegetation

Within the 16 quadrats established for the present survey, 124 flora taxa were recorded. When the data from the additional 135 survey quadrats is incorporated into the dataset, the result is that to date, a total of 331 flora taxa have been recorded in the yellow sandplain vegetation. Based on the species accumulation analysis of Colwell (2006) and the estimation of species richness (Chao 2004), there are potentially 380 species present in the yellow sandplain vegetation (Figure 5). The 331 taxa recorded to date represent approximately 87% of the potential species present. Whilst the potential number of species which may be present in the yellow sandplain vegetation is an estimate, the relatively small area surveyed to date has yielded 331 species. Given that the Eremaean Province (Beard 1990) is estimated to have some 3977 vascular plant taxa (Department of Environment and Conservation 2012a), the number of taxa recorded in the yellow sandplain vegetation, during surveys by Mattiske Consulting Pty Ltd, represents 8.3% of the total known species. When the estimate for the potential number of species is taken into account, the proportion of potential flora is close to 10% of known species. This demonstrates that the yellow sandplain vegetation is a species rich vegetation type, despite the relatively low annual precipitation.

The dominant plant families in the yellow sandplain vegetation were the Myrtaceae, Fabaceae, Proteaceae, Cyperaceae and Ericaceae. This result was reflected not only by analysis of all 151 survey quadrat data, but also from the 16 quadrats established in the present survey. Other significant plant families present were the Goodeniaceae, Lamiaceae and Rutaceae. In total 38 vascular plant families have been recorded in the yellow sandplain vegetation during flora surveys undertaken by Mattiske Consulting Pty Ltd. The relative dominance of these plants families, more generally within the Coolgardie bioregion has been recognised (Beard 1990). The more historical surveys by both Spencer (1899) and Diels (1906) also noted the relative abundance of the Myrtaceae and Fabaceae, and to a lesser extent, the Goodeniaceae and Ericaceae.

In terms of the vegetation communities present within the 16 quadrats established within the four areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), they were predominantly typical of vegetation communities previously recorded by Mattiske Consulting Pty Ltd (2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d) in the yellow sandplain vegetation. These communities have been summarised in Section 5.4.5 of this report. One vegetation community, Area 2 (Quadrat 4), was atypical of the area and had not been previously encountered. This vegetation community was a thicket of *Melaleuca hamata* and *Melaleuca laxiflora* with occasional *Eucalyptus eremophila* over a very sparse understorey of mixed shrubs, herbs and grasses. The soil consisted of yellow sands, but was located in a very shallow depressed area covering approximately 1 ha. This was the least species rich of the 16 quadrats established during the present survey.

Whilst in general the vegetation recorded by Mattiske Consulting Pty Ltd, both during the present and past surveys (Mattiske Consulting Pty Ltd 2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d) of the yellow sandplain vegetation is in broad agreement with Beard's pre-European vegetation (Figure 3), the broad classifications used by Beard (1990) do not reflect the finer scale variations observed by the recent surveys. There are likely to be a range of localised factors (environmental, topographic and soil-related) which will result in the fine mosaic of plant communities observed in the yellow sandplain vegetation.

7.2 Threatened and Priority Flora

No threatened flora have been recorded by Mattiske Consulting Pty Ltd, either during the present survey or past surveys of the yellow sandplain vegetation (Mattiske Consulting Pty Ltd 2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d). The survey of the 16 quadrats established in the four areas delineated in Ministerial Statement 852 (Government of Western Australia 2011) resulted in five priority taxa being recorded. These were *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1), *Hakea rigida* (P2), *Calytrix creswellii* (P3), *Cryptandra crispula* (P3), and *Homalocalyx grandiflorus* (P3). When the data from the additional 135 survey sites is incorporated, a total of 13 priority taxa have been recorded. The additional taxa are *Acacia formidabilis* (P3), *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3), *Banksia lullfitzii* (P3), *Eutaxia ?nanophylla* (P3), *Mirbelia* sp. Helena & Aurora (B.J. Lepschi 2003) (P3), *Lepidosperma lyonsii* (P3), *Stylidium choreanthum* (P3) and *Sowerbaea multicaulis* (P4).

Cryptandra crispula (P3), *Hakea rigida* (P2) and *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) (P1) were recorded for the first time, by Mattiske Consulting Pty Ltd, during the survey of the 16 quadrats established in the four areas delineated in Ministerial Statement 852 (Government of Western Australia 2011). The other priority flora recorded during the present survey have previously been recorded by Mattiske Consulting Pty Ltd during previous surveys of the yellow sandplain vegetation (Mattiske Consulting Pty Ltd 2009, 2010a, 2010b, 2011a, 2011b, 2011c, 2011d). This result indicates that the priority species recorded to date are generally more widespread in the yellow sandplain vegetation, and not restricted to the areas impacted by infrastructure development associated with the Carina mine development. In addition, the results of the present survey demonstrate that there is potential for additional flora of conservation significance to be found in the yellow sandplain vegetation. From an environmental perspective, this is a positive outcome, as it provides evidence that the priority species present in the yellow sandplain vegetation are less likely to be overly threatened from developments associated with the Carina mine. However, every step must be taken to minimise impacts on the pristine (Keighery 1994) vegetation of the area.

It is noteworthy, that since surveys of the yellow sandplain vegetation commenced in 2009, two of the present priority taxa have seen a reduction in their priority status. Both *Homalocalyx grandiflorus* (P3) and *Calytrix creswellii* (P3) were previously Priority 2 taxa. In addition, two taxa which were previously listed as priority taxa have subsequently now been delisted. These taxa are *Daviesia purpurascens* and *Eutaxia neurocalyx* subsp. *nacta*. Whilst these changes cannot be solely attributed to surveys associated with the Polaris Metals Pty Ltd developments, the increased level of survey effort, which is a consequence of infrastructure development by Polaris Metals Pty Ltd and others, are contributing to the increased knowledge of the distribution and populations of these conservation significant taxa.

Two of the priority taxa recorded to date are of questionable identity, namely *Astartea* ?sp. Bungalbin Hill (K.R. Newbey 8989) (P3) and *Eutaxia ?nanophylla* (P3). The former was identified from a sterile specimen, and the latter from a sterile juvenile specimen. Whilst there is a high level of confidence in the former taxon, there is a possibility that the specimen identified as *Eutaxia ?nanophylla* (P3) may also represent a juvenile of *Eutaxia neurocalyx* subsp. *nacta*, which is currently not a priority listed species. In both cases, both the range and known soils types on which these two priority taxa are known to occur are consistent with the yellow sandplain vegetation, and therefore cannot be discounted on this basis.

Both the present and previous surveys by Mattiske Consulting Pty Ltd have focused on one area of yellow sandplain in the region. These yellow sandplains are present through the Coolgardie bioregion and occur as disjunct areas within the eucalypt woodlands which occur on the deeper red clay soils (Figure 3). It would be of interest to investigate the distribution of these taxa in other sandplain areas.

7.3 *Lepidosperma* species

Although not recorded during the survey of the 16 quadrats established in the four areas delineated in Ministerial Statement 852 (Government of Western Australia 2011), Mattiske Consulting Pty Ltd has recorded the presence of *Lepidosperma* sp. Aurora Sandplain (R.L. Barrett 2809B) during a previous survey (Mattiske Consulting Pty Ltd 2009). The identity of this taxon was confirmed by R. Barrett of the Western Australian Herbarium. Only one specimen of this taxon has previously been known, from a location in sandplains to the north of the Helena and Aurora Ranges (R. Barrett pers. comm.). The recording of this taxon in the yellow sandplain vegetation proximate to the Polaris Metals Pty Ltd operations represents not only a new population of this taxon, but a significant range extension. This taxon is not currently listed on florabase.

A number of specimens of *Lepidosperma* species have been collected and recorded in the yellow sandplain vegetation by Mattiske Consulting Pty Ltd (Appendix B and Table 18). These *Lepidosperma* specimens are believed to represent, on present investigations, three or four separate taxa. However, due to the present status of the *Lepidosperma* in Western Australia, which are being revised at the Western Australian Herbarium, a final identification of these specimens is not possible at present. Preliminary discussions with R. Barrett of the Western Australian Herbarium suggest that they are likely to represent un-named taxa represented from only a few collections. It is not possible at present to state if any represent new taxa.

Mattiske Consulting Pty Ltd believes that due to the poor level of knowledge of *Lepidosperma* in the yellow sandplain vegetation, and the current revision of *Lepidosperma* by the Western Australian Herbarium, all *Lepidosperma* encountered should be treated as being potentially of conservation significance. The exception to this is *Lepidosperma* sp. A2 Inland Flat (G.J. Keighery 7000), a taxon which is not of conservation significance, and is both widespread and common in the yellow sandplain vegetation.

7.4 Novel Taxa

Three specimens of *Leucopogon* collected during previous surveys of the yellow sandplain vegetation by Mattiske Consulting Pty Ltd (2010b, 2011b) represent novel taxa (Appendix B). The collection, *Leucopogon* sp. DA014, originally thought to represent part of the *Leucopogon hamulosus* group has now been identified as a new taxon (M. Hislop pers. comm.). Although sterile, *Leucopogon* sp. AM405 and *Leucopogon* sp. undescribed species (DA095 mel appressed) are probably the same and represent sterile specimens of *Leucopogon* sp. DA014. This taxon is not presently listed on Florabase, nor has it been formally described or named. During a previous survey (Mattiske Consulting Pty Ltd 2009) a search for *Leucopogon* sp. DA014 in the vicinity of the Trans-Australian rail line was made and reported. This taxon was recorded not only within the area of the Polaris Metals Pty Ltd operations, but also in the yellow sandplain vegetation adjacent to the Trans-Australian rail line. Mattiske Consulting Pty Ltd considers that this taxon should be treated as a potentially conservation significant taxon until further survey work demonstrates that it is more common and widely distributed than presently known.

8. CONCLUSIONS

Both the present and past surveys of the yellow sandplain vegetation by Mattiske Consulting Pty Ltd have recorded vegetation consistent with the historical description of Beard (1990) and others (Spencer 1899, Diels 1906, Dell *et al.* 1985). The results of the surveys by Mattiske Consulting Pty Ltd demonstrate a much finer degree of vegetation mosaic in the yellow sandplain vegetation. This was not unremarkable given that the previous investigators were presenting data at a much broader scale. The results of surveys by Mattiske Consulting Pty Ltd also indicate that the yellow sandplain vegetation is a species rich environment notwithstanding the relatively poor soils and low annual level of precipitation (Bureau of Meteorology 2012).

The range and distribution of priority flora taxon recorded during the surveys of the yellow sandplain vegetation by Mattiske Consulting Pty Ltd demonstrated that the priority taxon are reasonably widely distributed and not restricted to the areas of operations of Polaris Metals Pty Ltd. This provides a level of confidence that the mining proponent's operations will have a lesser impact on conservation significant taxa than may have been originally thought. However, all efforts should be made to minimise disturbance to the relatively pristine vegetation present in the area.

Potentially one of the more significant outcomes of the surveys by Mattiske Consulting Pty Ltd in the yellow sandplain vegetation is the recording of novel taxa of *Lepidosperma* and other taxa. Based on discussions with representatives of the Western Australian Herbarium these may represent either new taxa or taxa which are relatively unknown. In either case, these taxa should be treated as being potentially of conservation significance. Unnecessary impacts to populations of these plants should be avoided.

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10. PERSONNEL

The following Mattiske Consulting Pty Ltd personnel were involved in this project:

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Dr E.M. Mattiske	Managing Director & Principal Ecologist	Planning, Management & Reporting	
Mrs B. Koch	Senior Botanist	Plant identification	
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