SUSTAINABILITY PTY LTD

CYCLONE PROJECT

PRELIMINARY FLORA AND VEGETATION SURVEY

September 2012

woodmanenvironmentalconsulting

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Cover Photo: *Eucalyptus gongylocarpa* (Marble Gum) in the Cyclone Project Area (Photo: Woodman Environmental Consulting Pty Ltd)

DISCLAIMER

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EXECUTIVE SUMMARY

Diatreme Resources Limited ('Diatreme'), through its wholly owned subsidiary Lost Sands Pty Ltd ('Lost Sands'), proposes to develop the Cyclone mineral sands deposit. The Cyclone mineral sands deposit is located approximately 50 km south of the Anne Beadell Highway (also known as Serpentine Lakes Road), approximately 25 km west of the South Australian border, and approximately 730 km north-east of Kalgoorlie, near the southern edge of the Great Victoria Desert in Western Australia. The Cyclone Project (the Project) involves the mining and processing of mineral sands from the Cyclone mineral sands deposit into heavy mineral concentrate on-site, transport of heavy mineral concentrate via a proposed private haul road to the Trans Australian Railway line on the Nullarbor Plain, and rail of the heavy mineral concentrate to Esperance Port. Three potential alignment options have been considered for the proposed haul road, with all but one of the options passing through the Great Victoria Desert Nature Reserve. Woodman Environmental were commissioned in 2012 to conduct a preliminary reconnaissance flora and vegetation study of the Cyclone Project area (Project area), including all 3 haul road alignment options, to gain an understanding of the flora and vegetation of the Project area in its entirety. The information collected was then utilised to compare the 3 haul road alignment options in terms of flora and vegetation attributes, to support selection of a preferred haul road alignment option.

The survey was conducted over a single visit, from the 22nd – 27th March 2012. Due to the size of the Project area, and the lack of vehicular access to the majority of the Project area, the majority of the survey was undertaken by helicopter, with personnel dropped at selected detailed recording site locations. However, the mining area, the northern part of the central haul road alignment option and the east-west running section of the western haul road alignment option were accessed by vehicle and on foot. A series of 96 non-permanent detailed recording sites (and 17 additional site inspections) were established throughout the Project area over a total distance of approximately 700 km.

A total of 175 discrete vascular flora taxa and 1 known hybrid were recorded within the Project area in 2012. A total of 2 confirmed and 2 potential conservation significant flora taxa were recorded in the Project area: *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3), *Dampiera* ?*eriantha* (P1), *Eremophila* ?*attenuata* (P1) and *Eucalyptus pimpiniana* (P3). *D.* ?*eriantha* (P1) and *E.* ?*attenuata* (P1) could not be positively identified because of poor material. Two further conservation significant flora taxa, *Lepidium fasciculatum* (P3) and *Ptilotus blackii* (P3), have historically been collected in the Project area, however were not collected during this survey. Additionally, a collection of a *Eucalyptus* could not be matched to material of any known taxon, and may represent an undescribed taxon, or a taxon not previously recorded in Western Australia. Three collections made during the survey also appear to represent taxa that have not been collected in Western Australia before, however are known from nearby areas in South Australia (*Eucalyptus canescens* subsp. *canescens*, *Eucalyptus canescens* subsp. *beadellii* and *Austrostipa nullanulla*). Two introduced (weed) taxa were also recorded (?*Carrichtera annua* and *Malvastrum americanum*).

A total of 16 broad structural Vegetation Types (VTs) were mapped over the mining area and 3 haul road alignment option corridors of the Project area. Two VTs were further divided into sub-types (2 sub-types for VT 5 and 9 sub-types for VT 10), VTs 1 to 9 occur in the northern half of the Project area, relating to sandy dunal and clay-loam areas, while VTs 10 to 16 occur over the southern half and relate to the clayey soils of the Nullarbor Plain. The VTs in the northern half of the Project area were broadly represented by *Eucalyptus* mallee woodlands on sandy soils on plains and dunes, and *Casuarina pauper* and mulga woodlands on clay soils on plains. Several VTs were also associated with small claypans and associated gypsum lunettes. The VTs in the southern half of the Project area were broadly represented by *Acacia papyrocarpa* woodland over *Maireana sedifolia* (bluebush) and grasses on the northern edge of the Nullarbor Plain, with shrublands of bluebush and *Atriplex* spp. over grasses on the central part of the Nullarbor Plain. The 9 sub-types of VT 10 were vegetation in dongas on the Nullarbor Plain, often dominated by *Senna artemisioides* subsp. *petiolaris* with occasional mulga and *Grevillea nematophylla* subsp. *supraplana*. Several VTs were either highly locally restricted in their distribution, including some that were only mapped in 1 of the haul road alignment options, or were mapped in a limited number of small areas across 2 or all of the haul road alignment options, often associated with uncommon land forms.

Following comparison of the 3 haul road alignment options, it is considered that the central and eastern haul road alignment option corridors are similar in terms of flora and vegetation issues, and therefore 1 of these routes should be selected as the preferred route. The western haul road alignment option corridor is significantly longer than both the eastern and central haul road alignment option corridors, which are of similar length; it is therefore a less favourable option when the overall impact to flora and vegetation is considered. All 3 haul road alignment option corridors contain landforms such as claypans and depressions that may require localised drainage to support vegetation, however the largest chain of lakes is present in the western haul road alignment option corridor, with smaller lake chains, as well claypans and dongas, present in the eastern, and to a lesser extent the central, haul road alignment option corridors. All 3 haul road alignment option corridors contain taxa of conservation significance, however the western haul road alignment option corridor appears to contain greater flora-related constraints than the central or eastern corridors, as it contains *Eremophila* ?*attenuata* (P1), a species only known from a single other collection in Western Australia. The eastern and central haul road alignment option corridors appear similar with the central having 1 more taxon of conservation significance confirmed at present. All 3 haul road alignment option corridors also contain VTs considered to be of local significance, however, the western haul road alignment option corridor appears to contain greater VT-related constraints than the central or eastern corridors, as it contains a donga community dominated by *Eremophila* ?*attenuata* (P1 which may be of regional significance.

1. INTRODUCTION

1.1 Description of Project and Project Area

Diatreme Resources Limited ('Diatreme'), through its wholly owned subsidiary Lost Sands Pty Ltd ('Lost Sands'), proposes to develop the Cyclone mineral sands deposit. The Cyclone mineral sands deposit is located approximately 50 km south of the Anne Beadell Highway (also known as Serpentine Lakes Road), approximately 25 km west of the South Australian border, and approximately 730 km north-east of Kalgoorlie, near the southern edge of the Great Victoria Desert in Western Australia (Figure 1). The Cyclone Project (the Project) involves the mining and processing of mineral sands from the Cyclone mineral sands deposit into heavy mineral concentrate on-site, transport of heavy mineral concentrate via a proposed private haul road to the Trans Australian Railway line on the Nullarbor Plain, and rail of the heavy mineral concentrate to Esperance Port. The Cyclone mineral sands deposit (hereafter referred to as 'mining area') itself is located on Puapiyala Tjarutja Aboriginal Corporation tribal lands owned by the Pila Nguru (Spinifex) People. The mining area is located just north of the Great Victoria Desert Nature Reserve, within exploration tenement E 69/1920. Three potential alignment options have been considered for the proposed haul road (Figure 1), with all but one of the options passing through the Great Victoria Desert Nature Reserve.

As part of the Environmental Impact Assessment (EIA) process for the Cyclone Project, Sustainability Pty Ltd, on behalf of Diatreme, initially commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) in 2011 to conduct a desktop study of known flora and vegetation values of the Cyclone Project area ('Project area'). This involved a review of all existing literature relating to flora, vegetation and other environmental factors relevant to the Project area, including relevant state and federal databases. The Project area consisted of the Cyclone mineral sands deposit itself, as well as 2 potential haul road alignment options (the central and eastern options). Woodman Environmental were then commissioned in 2012 to conduct a preliminary reconnaissance flora and vegetation study of the Project area (including all 3 haul road alignment options), to gain an understanding of the flora and vegetation of the Project area in its entirety. The results of this survey are proposed to be utilised as supporting information to aid in the selection of a preferred haul road alignment, and aid in the design of a detailed flora and vegetation survey of the preferred haul road alignment and the mining area to support environmental impact assessment under the Western Australian *Environmental Protection Act 1986* and the Commonwealth *Environment Protection Biodiversity Conservation Act 1999*. Figure 2 displays an overview of the Project area.

1.2 Aims

The overall aims of the study were to:

- Compile a preliminary inventory of vascular plant taxa present within the Project area;

- Conduct preliminary survey for conservation significant and introduced flora taxa within the Project area;
- Define and map structural Vegetation Types (VTs) and other communities present within the Project area;
- Determine a preferred haul road alignment based on an assessment of the flora and vegetation values of the Project area; and
- Design a detailed survey plan of the preferred haul road alignment and the Cyclone mining area.

The tasks undertaken to meet this aim were:

- Interpret aerial photography of the project area to identify visible vegetation types for sampling;
- Establish flora survey sites throughout all discernible vegetation types within the Project area;
- Define structural VTs within the Project area;
- Map the distribution of structural VTs within the Project area using a combination of aerial photograph interpretation and field observations;
- Record locations and abundance of conservation significant flora taxa, including Threatened (Declared Rare Flora – Extant) (T (DRF)), Priority Flora and introduced taxa that were identified during sampling within the Project area;
- Provide a report and map detailing structural VTs, conservation significant flora and introduced flora within the Project area;
- Provide an assessment of the flora and vegetation values of the 3 proposed haul road alignments, and recommend a preferred haul road alignment based on this assessment.

This report presents a description of the methods employed during the preliminary flora and vegetation survey and the results of the survey. It also briefly compares the flora and vegetation values of each haul road corridor in order to provide supporting information for selection of a preferred option. This report does not provide a design for a comprehensive flora and vegetation survey of the project area as this has been provided separately.

1.3 Level of Survey

This study forms the reconnaissance survey component, and supplements the background research/desktop study component, of a Level 2 survey as defined by the Environmental Protection Authority's (EPA) Guidance Statement No. 51 (EPA 2004). This level of survey has been determined from Table 2 of Guidance Statement No. 51 (EPA 2004), where the Bioregion Groups are defined as Groups 2 and 4 (Nullarbor and Great Victoria Desert respectively), and the nature of impacts of the Cyclone Project are considered to be 'Moderate to High'. A Level 2 survey consists of a background research/desktop study and a reconnaissance survey, followed by a detailed or comprehensive survey. The purpose of the background research/desktop study is to review known information on the target area through all sources of literature available (EPA 2004). A background research/desktop study component has previously been undertaken by Woodman Environmental (2011) for the central and eastern corridor haul road alignment options, as displayed on Figure 1; however

the western option was not investigated, and is therefore investigated as part of this study. The purpose of a reconnaissance survey is to verify the accuracy of the background research/desktop study, delineate and characterise the flora and range of vegetation units present, and identify potential impacts (EPA 2004). As noted in Woodman Environmental (2011), a comprehensive survey is considered appropriate for the proposed Level 2 survey. This is discussed further in Woodman Environmental (2011).

2. BACKGROUND

2.1 Previous Desktop Study

Woodman Environmental (2011) previously conducted a desktop study of the Project area, however this did not include the western haul road alignment option. The majority of the information contained in that desktop study is also relevant to the western haul road alignment option. Therefore, only background information specific to the western haul road alignment option is contained in this report; all other information relevant to all 3 haul road alignment options is contained in Woodman Environmental (2011), which is presented as Appendix A of this report.

2.2 Climate

Information relating to climate is contained in Appendix A (Woodman Environmental 2011).

2.3 Geology, Soils and Landforms

Information relating to geology, soils and landforms is contained in Appendix A (Woodman Environmental 2011).

2.4 Regional Flora and Vegetation

The majority of information relating to regional flora and vegetation is contained in Appendix A (Woodman Environmental 2011).

In addition to the information contained in Appendix A, (Woodman Environmental 2011) regarding Interim Biogeographic Regionalisation for Australia (IBRA) Regions (Government of Australia 2005), a small part the western haul road alignment option is also located within the GVD2 – Great Victoria Desert Central IBRA subregion. GVD2 is an arid active sand-ridge desert characterised by extensive dune fields of deep Quaternary aeolian sands, with salt lakes, major valley floors with lake-derived dunes, sand plains with extensive seif dunes and occasional outcropping also present (Barton & Cowan 2001). The Vegetation is primarily a tree steppe of *Eucalyptus gongylocarpa*, Mulga (*Acacia aneura*) and *E. youngiana* over hummock grassland dominated by *Triodia basedowii* (Barton & Cowan 2001) on the aeolian sands. Mulga dominates colluvial soils with *Eremophila* and *Santalum* spp., with halophytes confined to the edges of salt lakes and saline drainage systems (Barton & Cowan 2001). The remaining western haul road alignment option, and the rest of the Project area, is located within the GVD3, NUL1 and NUL2 subregion (see Appendix A).

Shepherd *et al.* (2002) mapped and described vegetation system associations related to physiognomy, expanding on mapping undertaken by Beard (1974; 1975). Vegetation associations were described at a scale of 1:250,000. With the addition of the western haul road alignment option, the Project area now traverses 17 vegetation system associations which are summarised in Table 1 below, and shown on Figure 3 of Appendix A. Table 1 also presents the current extent of each vegetation system association in relation to the pre-European extent, and the extent in lands protected for conservation. Lands protected for conservation are defined as being listed in the Department of Environment and Conservation (DEC) Tenure dataset as Crown Reserves having an IUCN Category of I - IV (Government of Western Australia 2011). All vegetation system associations remain at or just below their pre-European extents. Some are also well-reserved in lands protected for conservation, however others have very little reserved, including Carlisle Plain 1239 and Great Victoria Desert 46, which have none reserved (Table 1).

Table 1: Extent of Vegetation Associations within the Project Area (Shepherd *et al.* 2002; Government of Western Australia 2011)

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent in Lands Protected for Conservation
Bunda Plateau 448	Succulent steppe; bluebush (in dongas)	892,832	100.0	28.8
Bunda Plateau 449	Succulent steppe; bluebush with grassy depressions	2,556,698	99.9	4.3
Bunda Plateau 460	Succulent steppe; bluebush with saltbush in depressions	2,543,971	99.9	0.5
Carlisle Plain 20	Low woodland; mulga mixed with Allocasuarina cristata & Eucalyptus sp. (e6?)	103,452	100	65.6
Carlisle Plain 120	Succulent steppe with open low woodland; mulga & sheoak	342,959	99.8	100
Carlisle Plain 122	Succulent steppe with open low woodland; Acacia papyrocarpa over saltbush & bluebush,	53,803	100	3.0
Carlisle Plain 251	Low woodland; mulga & Allocasuarina cristata	101,551	100	100
Carlisle Plain 441	Succulent steppe with open low woodland; mulga & sheoak over bluebush	1,991,805	100	19.7
Carlisle Plain 461	Succulent steppe with open low woodland; Acacia papyrocarpa over bluebush	656,801	99.6	97.4
Carlisle Plain 676	Succulent steppe; samphire	159,931	99.9	19.2

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent in Lands Protected for Conservation
Carlisle Plain 1239	Hummock grasslands, open medium tree & mallee steppe; marble gum & mallee (E. youngiana) over hard spinifex Triodia basedowii on sandplain	25,554	100	0.0
Carlisle Plain 4623	Succulent steppe with low woodland; Acacia papyrocarpa over bluebush	146,064	100	91.5
Nyanga Plain 461	Succulent steppe with open low woodland; Acacia papyrocarpa over bluebush	1,958,598	100	0.6
Great Victoria Desert 46	Shrublands; mallee scrub (e=?)	578,256	100	0.0
Great Victoria Desert 84	Hummock grasslands, open low tree & mallee steppe; marble gum & mallee (Eucalyptus youngiana) over hard spinifex Triodia basedowii between sandhills	1,781,739	100	9.3
Great Victoria Desert 85	Hummock grasslands, open low tree & mallee steppe; marble gum & mallee (Eucalyptus youngiana) over hard spinifex on sandplain	6,355,354	99.9	14.3
Great Victoria Desert 676	Succulent steppe; samphire	205,159	99.7	13.5

In addition to the information contained in Appendix A, (Woodman Environmental 2011) regarding land systems described by the Department of Agriculture (Mitchell *et al.* 1988), the western haul road alignment option also intersects 2 additional land systems, as described in Table 2 below.

Table 2: Land Systems Located within the Project Area (Mitchell *et al.* 1988)

Land System	Mapped Extent (km^2)	Description of Land System
Carlisle	2,556	Gently undulating stony plains with *Acacia papyrocarpa* on the crests, *Maireana sedifolia* on the lower plains and slopes. Large to small dongas support *Acacia aneura*, *Pittosporum angustifolium* and *Grevillea* spp. Small depressions covered with *Atriplex vesicaria* characterise this land system.
Kyarra	950	Very gently undulating plain carrying *Acacia papyrocarpa* on the higher rises, *Maireana sedifolia* on the lower plains and slopes and *Pittosporum angustifolium* and *Grevillea* spp. in the dongas.

2.5 Local Flora and Vegetation

2.5.1 Local Flora

The majority of information relating to local flora is contained in Appendix A (Woodman Environmental 2011).

A search of the western haul road alignment option and surrounds for records of vascular flora taxa was conducted using the online tool *NatureMap* (DEC 2012a). Five search areas were created, each consisting of a rectangular polygon approximately 25 km either side of the western haul road alignment option. A total of 151 vascular flora taxa have been recorded within these search areas. Given the large size of the total search area, this is a strong indication of the paucity of flora and vegetation surveys in the vicinity of the western haul road alignment option; however this is a significant increase on the number of taxa recorded in the vicinity of the remainder of the Project area (Appendix A).

The DEC threatened flora databases, including the Western Australian Herbarium (WAHerb) specimen database and the Threatened and Priority Flora database (TPFL) were interrogated for information regarding conservation significant taxa known from the western haul road alignment option (DEC 2012b). The Threatened and Priority Flora list (TP List) was also interrogated, which provides information on taxa known to occur in the general region of the western haul road alignment option. A total of 13 flora taxa of conservation significance were returned; of these, only 3 taxa are known to occur within the search area: *Acacia* eremophila numerous-nerved variant (A.S. George 11924), *Eucalyptus pimpiniana* and *Ptilotus blackii* (all P3). A full list of these taxa is presented in Table 3. Appendix B presents conservation codes for Western Australian flora (DEC 2012b).

Table 3: Conservation Significant Flora Taxa Returned from Interrogation of DEC Databases Potentially Occurring within Project area (DEC 2012b)

*Note: TP List = Threatened and Priority Flora List
WAHerb = Western Australian Herbarium Specimen Database

Taxon	Code	Description	Known Localities	Source*
Acacia eremophila numerous-nerved variant (A.S. George 11924)	P3	Dense, spreading shrub, 1–2 m high. Fl. yellow, Sep. Sandy soils. Flats.	Norseman, Neale Junction, Great Victoria Desert, Balladonia, Plumridge Lakes.	WAHerb, TP List
Baeckea sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)	P3	Upright shrub, ca 1 m high. Fl. white, Oct. Orange sand. Flats.	Wiluna, Sandstone, Agnew, Great Victoria Desert	TP List
Comesperma viscidulum	P4	Shrub, to ca 0.7 m high with viscid stems. Fl. Yellow, purple, blue, white, May-Sep. Orange or yellow sand, red gritty sand with pebbles, sandstone, Flats, plains, dunes, breakaways,	Queen Victoria Spring, Little Sandy Desert, Carnarvon Range, Great Victoria Desert	TP List
Conospermum toddii	P4	Spreading shrub, 1.2–2 m high. Fl. white, yellow, Jul–Oct. Yellow sand. Sand dunes.	N of Queen Victoria Spring in Great Victoria Desert	TP List
Dampiera eriantha	P1	Erect perennial, herb, to 0.6 m high. Yellow, brown or orange sand. Dunes.	Great Victoria Desert	TP List
Eremophila sp. Great Victoria Desert (R. Davis 10621)	P2	Compact, perennial shrub 1.8 m high x 1.5 m wide. Fl. pale pink, Sep. Brown clayey sand. Plain	Plumridge Lakes N.R., Great Victoria Desert	TP List
Eucalyptus pimpiniana	P3	Straggly shrubby mallee, 0.7–2 m high, bark smooth. Fl. white, May–Oct. Red sand. Sand dunes & plains.	46 km SW of Wanna Lakes ca 3km N of North Boundary of Queen Victoria Nature Reserve; Lake Minigwal, Great Victoria Desert	WAHerb, TP List
Hibbertia crispula	P1	Erect to procumbent shrub, to 1 m high. Fl. yellow, Apr/Sep/Dec. Yellow sand. Dunes.	Great Victoria Desert, South Australia	TP List
Labichea deserticola	P1	Shrub, to 1 m high. Fl. yellow. Sandstone ridges.	Great Victoria Desert	TP List

Taxon	Code	Description	Known Localities	Source*
Melaleuca nanophylla	P3	Tree or shrub, to 5 m high. Fl. yellow. Gypsum soils. Ridges.	Great Victoria Desert	TP List
Olearia arida	P4	Erect shrub, to 0.4 m high. Fl. white, Jul–Sep. Red or yellow sand. Undulating low rises.	Neale Junction, Plumridge Lakes, Great Victoria Desert	TP List
Ptilotus blackii	P3	Erect perennial herb to 0.35 m high. Sand and sandy loam. Plains	Ilukurlka	WAHerb
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2	Erect shrub to 0.6 m high. Yellow and orange sand. Dunes	Great Victoria Desert, Cundeelee, Queen Victoria Spring N.R.	TP List

A search of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) database with regard to environmental matters of national significance as listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), was performed over the western haul road alignment option within a radius of approximately 50 km of the western haul road alignment option (DSEWPC 2012). The results of this search indicate that no federally-listed threatened flora taxa occur within or in the vicinity of the western haul road alignment option.

The search of the western haul road alignment option and surrounds for records of vascular flora taxa using the online tool *NatureMap* (DEC 2012a) returned 2 introduced (weed) flora taxa: *Cucumis myriocarpus* (Prickly Pademelon) and *Lythrum hyssopifolia* (Lesser Loosestrife). Neither are considered to be particularly serious environmental weeds, however *L. hyssopifolia* was ranked 'Moderate' under the then-Department of Conservation and Land Management's (CALM) (now DEC) Environmental Weed Strategy for Western Australia (CALM 1999). This strategy assessed and rated environmental weeds in terms of their environmental impact on biodiversity. Each weed species was rated according to 3 criteria, namely invasiveness, distribution and environmental impact, and was assigned a score of 'High', 'Moderate', 'Mild' or 'Low'. These ratings were then used to determine an order of priority for control and/funding. The DSEWPC database with regard to environmental matters of national significance as listed under the EPBC Act indicates that 2 taxa or habitat for such taxa may occur in or in the vicinity of the western haul road alignment option: *Carrichtera annua* (Ward's Weed) and *Lycium ferrocissimum* (African Boxthorn) (DSEWPC 2012). These taxa are discussed in Appendix A.

2.5.2 Local Vegetation

The majority of information relating to local vegetation is contained in Appendix A (Woodman Environmental 2011).

The DEC's Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) database was interrogated for information regarding any occurrences of TECs or PECs within 50 kilometres of the western haul road alignment option (DEC 2012d). There were no known occurrences of TECs and PECs within the search area. The search of the DSEWPC database with regard to environmental matters of national significance as listed under the EPBC Act also did not return any federally-listed threatened ecological communities (DSEWPC 2012). However, one Priority 3 PEC, 'Yellow sandplain communities of the Great Victoria Desert', is known to occur within the Great Victoria Desert region (DEC 2010a), and therefore could potentially occur in the Project area. Appendix C presents definitions, categories and criteria for TECs and PECs (DEC 2010b).

3. METHODS

3.1 PERSONNEL AND LICENSING

Table 4 lists the personnel involved in both fieldwork and plant identifications for the study. All personnel are experienced in conducting flora and vegetation surveys. All plant material was collected under the scientific licences (pursuant to *Wildlife Conservation Act* 1950 Section 23C and Section 23F) as listed in Table 4.

Table 4: Personnel and Licensing Information

Personnel	Role	Flora Collecting Permit / Permit to take DRF
David Coultas	Fieldwork, Plant Identifications	SL009960 148-1112
Lisa McFarlane	Fieldwork	SL009958
Bethea Loudon	Fieldwork	SL009953 150-1112
John Grantham	Fieldwork	SL009955
Frank Obbens	Plant Identifications	-

3.2 INITIAL AERIAL PHOTOGRAPHY INTERPRETATION

Initial interpretation of vegetation type boundaries was conducted with the use of orthorectified aerial photography at a scale of 1:10,000, supplied to Woodman Environmental by Sustainability. Preliminary vegetation type boundaries were transcribed onto the aerial photography, to allow for ground-truthing of these boundaries to be conducted in the field, via detailed recording site establishment and mapping notes (see Section 3.3). Preliminary detailed recording site locations were also allocated based on these vegetation type boundaries.

3.3 FIELD SURVEY METHODS

The survey was conducted over a single visit, from the 22nd – 27th March 2012. Due to the size of the Project area, and the lack of vehicular access to the majority of the Project area, the majority of the survey was undertaken by helicopter, with personnel dropped at selected detailed recording site locations. However, the mining area, the northern part of the central haul road alignment option and the east-west running section of the western haul road alignment option were accessed by vehicle and on foot.

A series of 96 non-permanent detailed recording sites (and 17 additional site inspections) were established throughout the Project area over a total distance of approximately 700 km (Figures 3 to 5). Detailed recording sites were established in the majority of vegetation types identified following interpretation of aerial photography. However, some vegetation types could not be accessed because of cultural heritage restrictions. The number of detailed recording sites within each identified vegetation type was determined based on the size of the area covered by the vegetation type, and the potential species richness of each vegetation type. The majority of sites were established in the northern half of the Project area, corresponding to areas of more complex vegetation types associated with sand dunes, sand plains and loamy plains.

Fewer sites were established in the southern half of each corridor option, as the southern half corresponded with the relatively homogenous Nullarbor Plain, where large areas of similar vegetation types occurred.

The survey of the western haul road alignment option was less comprehensive than the other haul road alignment options. Limited set-downs, time and fuel constraints with the helicopter meant significantly less detailed recording sites were able to be established. Consequently the majority of the vegetation mapping was undertaken from the air, along with interpretation and extrapolation of aerial photography, without any ground-truthing. A large proportion of the alignment (in comparison to the other two alignments) was also unable to be surveyed due to cultural heritage restrictions.

The detailed recording sites measured approximately 25 m in radius from a central point. All vascular taxa that were visually identifiable at each site were recorded, and at least one reference collection for each taxon identified was made. However, collections could not be made in the portion of the Project area located on tribal lands owned by the Pila Nguru people outside of the Great Victoria Desert Nature Reserve, as permission to collect had not been granted to collect specimens at the time of survey (see also Section 3.6). At detailed recording sites located in this portion of the Project area, vascular taxa were matched to collections made in the Great Victoria Desert Nature Reserve where possible; if this could not be achieved, photographs of the taxa that could not be matched were taken for later identification.

The following information was recorded at each detailed recording site:

- Personnel
- Unique site number
- Date of survey
- GPS coordinates (GDA94)
- Site photograph
- Topography (including landform type and aspect)
- Soil colour and type (including the presence of any rock outcropping and surface stones)
- Vegetation condition (adapted from Keighery (1994))
- Approximate time since fire
- Presence of disturbance (if any)
- Percentage foliage cover (for each species)
- Height (m) (for each species, excluding climbers/aerial shrubs)

Additional flora taxa were also recorded opportunistically via a search around the general vicinity of each detailed recording site, and during traverses on foot between detailed recording sites.

Mapping notes of vegetation type distribution were also taken while traversing the Project area on foot, by vehicle, and by helicopter (while in the air). In addition to the 96 detailed recording sites established in the Project area, a further 17 recording points were made, whereby personnel were dropped into a location by helicopter, and made brief mapping notes on species composition that could not be discerned from the air. These points are also shown on Figures 3 to 5. The mapping notes are used to aid in

mapping polygons of vegetation types that were not allocated detailed recording sites, as time constraints prevented detailed recording sites being allocated to all vegetation type polygons.

No specific targeted searching for conservation significant flora species was undertaken as part of this survey. However, conservation significant flora and introduced flora were searched for while undertaking survey of detailed recording sites, and while traversing between recording sites. If populations of known conservation significant flora taxa were identified, particularly those ranked as T (DRF), a representative collection of material was made, and the abundance and spatial distribution (using GPS coordinates) of individuals within each population was recorded where possible. Any populations of introduced flora identified were treated as for populations of conservation significant flora.

Vegetation condition was recorded at all recording sites and opportunistically within the Project area. Any occurrences of weed species were also noted if observed. Vegetation condition was described using the vegetation condition scale used for the Northern and Eremaean Botanical Province, adapted from Keighery (1994). This scale is presented in Appendix D. The vegetation condition of the Project area is discussed briefly in Section 4.2.2 but has not been mapped for this Project.

3.4 PLANT COLLECTION AND IDENTIFICATION

As previously mentioned, at least one reference specimen for each discreet vascular taxon identified was collected. Specimens were then pressed for later identification at the WAHerb. Photos of taxa that could not be collected (see Section 3.3) were also identified at the WAHerb. Identifications were undertaken by experienced taxonomist Frank Obbens, with assistance from David Coultas. Experts of particular plant families or genera were consulted for any specimens considered to be of taxonomic interest. Species nomenclature follows *Florabase* (DEC 2012c) with all names checked against the current DEC Max database to ensure their validity. The conservation status of each species was checked against *Florabase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest (T (DRF) and Priority Flora taxa, range extensions of taxa and potential new taxa) will be vouchered at the WAHerb at the conclusion of the Project. Threatened and Priority Flora Report Forms (TPRFs) will be submitted to the DEC for all locations of T (DRF) and Priority Flora taxa at the conclusion of the Project.

3.5 VEGETATION MAPPING AND DESCRIPTION

As this survey of the Project area is preliminary, and primarily serves to gain a general understanding of the flora and vegetation of the Project area in preparation for a comprehensive survey of the mining area and a preferred haul road alignment, broad structural VTs have been developed. The data collected at the detailed recording sites was used to determine these broad structural units. The structural VTs were defined using a combination of landforms, and the habit and foliage cover of dominant species within each discernible height stratum. It is considered that more detailed floristic data is required to be collected and statistically analysed to delineate more detailed floristic

vegetation types; this is proposed to be conducted as part of the comprehensive survey mentioned above. For example, this level of data is required to delineate different *Eucalyptus*-dominated woodlands dune crests and inter-dunal swales; in the absence of this data, broad structural VTs have been defined to include vegetation on both dune crests and inter-dunal swales.

VT descriptions have been broadly adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data is produced nation-wide. For the purposes of this report, it is considered that a VT is equivalent to a NVIS association as described in ESCAVI (2003).

Following the definition of VTs, VT mapping polygon boundaries over the Project area were then developed, utilising the detailed recording site locations, as well as mapping notes recorded during the survey. These polygon boundaries were then digitised using Geographic Information System (GIS) software, and are displayed on Figures 3 to 5. Areas that could not be surveyed because of cultural heritage restrictions were not mapped (indicated by 'NS').

3.6 LIMITATIONS OF SURVEYS

Table 5 presents the limitations of the flora and vegetation survey of the Project area in accordance with EPA Guidance Statement No. 51 (EPA 2004).

Table 5: Limitations of the Flora and Vegetation Survey of the Project Area

Limitation	Comment
Level of survey.	Level 1 Reconnaissance Survey: A desktop survey was undertaken prior to the commencement of field survey, with field survey undertaken in March 2012. Detailed recording sites were established in all discernible vegetation types, with opportunistic recording of flora taxa conducted while traversing to and between detailed recording sites.
Competency/experience of the consultant(s) carrying out the survey.	Senior personnel are experienced in conducting similar assessments in Western Australia, with mentoring given to less experienced botanists throughout the survey. Personnel have not had specific experience in the Great Victoria Desert region, however this is not expected to have influenced the results.
Scope (floral groups that were sampled; some sampling methods not able to be employed because of constraints?)	All vascular groups that were present during the survey were sampled. However, permission was not obtained to collect specimens of taxa within Pila Nguru tribal lands outside of the Great Victoria Desert Nature Reserve. Therefore, only photographs of taxa were taken in these areas, which has resulted in incomplete identification of some taxa. No survey could be conducted in several areas because of cultural heritage restrictions. Foot transecting very limited because of time constraints, and because most access was by helicopter only with personnel were dropped at specific locations.

Limitation	Comment
Proportion of flora identified, recorded and/or collected.	Relatively high proportion of perennial vascular taxa (approx. 60 %) collected and recorded based on intensity and method of survey. Very low proportion of expected ephemeral vascular taxa collected (less than 10 %) and recorded based on intensity and method of survey and lack of any significant rainfall prior to commencement of survey. All vascular taxa recorded had at least 1 reference specimen collected, with specimens identified at the WAHerb.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include government databases (DEC, EPBC), broad-scale vegetation reports (e.g. Beard 1974; 1975) and a limited number of unpublished reports located in the general region of the Project area. However, no specific historical information available for the Project area, and very limited information available for the vicinity of the Project area.
The proportion of the task achieved and further work which might be needed.	Level 1 survey complete, however comprehensive survey required for the purposes of EIA.
Timing/weather/season/cycle.	Field survey conducted in March; this coincides with a period where significant rainfall associated with cyclonic activity in the north of the country occasionally occurs (e.g. in 2011 – 209 mm recorded at Forrest for February (Bureau of Meteorology 2012)). However apparently very little rain prior to survey (no rain in February, 24.8 mm in January (Bureau of Meteorology 2012), which likely affected proportion of ephemeral taxa recorded, and quality of perennial material collected, with limited flowering material observed and collected.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey.	Previous fire history of parts of the Project area influenced patterns discernible from aerial photography, and also existing structure and composition of the vegetation in parts of the Project area as observed during survey, however this did not significantly affect survey results.
Intensity of survey.	Survey intensity adequate to identify broad structural groupings of terrestrial flora as required by a Level 1 survey, with replication of detailed recording sites through most discernible plant community types. Relatively Low intensity of survey over much of Project area, because of large size of Project area, and large size of most vegetation types. No specific searching for significant flora undertaken, however some opportunistic recording undertaken.
Completeness and mapping reliability.	Survey of Project area considered complete in terms of Level 1 survey. Mapping of VTs considered reliable for the purposes of a Level 1 survey, as high resolution aerial photography was used, and detailed recording sites were replicated throughout most VTs. However, fire history affected vegetation patterns discernible on aerial photography. Western haul road alignment option was less comprehensively surveyed and mapped than the other haul road alignment options due to constraints with the helicopter and cultural heritage restrictions; a greater emphasis was placed on aerial photography interpretation and extrapolation.
Resources and experience of personnel.	Adequate resources including experienced field personnel and taxonomists with appropriate expertise were utilised, with relevant experts consulted during plant identifications.
Remoteness and/or access problems.	Project area extremely remote and very large, and therefore majority of access by helicopter. This meant that all areas were accessible, but limited foot transecting was employed, as personnel were generally dropped at specific locations.

4. RESULTS

4.1 FLORA OF THE PROJECT AREA

A total of 175 discrete vascular flora taxa and 1 known hybrid were recorded within the Project area in 2012. These taxa represent 28 families, 82 genera and 168 species. The most well-represented families were Fabaceae (25 taxa and 1 known hybrid), Chenopodiaceae (25 taxa), Poaceae (21 taxa) and Myrtaceae (18 taxa). The majority of the vascular plant taxa recorded during the survey were collected at least once and positively identified at the WAHerb. A full list of taxa is presented in Appendix E.

4.1.1 Conservation Significant Flora Taxa

A total of 2 confirmed and 2 potential conservation significant flora taxa were recorded in the Project area: *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3), *Dampiera* ?*eriantha* (P1), *Eremophila* ?*attenuata* (P1) and *Eucalyptus pimpiniana* (P3). These taxa are discussed in detail below.

Acacia eremophila numerous-nerved variant (A.S. George 11924) (P3) is a dense, spreading shrub to 2 m high (DEC 2012c). It is found on sandy soils on flats and plains (DEC 2012c) in the Great Victoria Desert over a range in Western Australia of approximately 550 km, from near Yarri Station north-east of Kalgoorlie to the northern edge of the Great Victoria Desert Nature Reserve, with disjunct records east of Norseman (DEC 2012a). There are 18 DEC records of this species, representing approximately 9 populations (DEC 2012a). This taxon was recorded at 5 locations in the Project area in 2012: 1 each in the eastern and central haul road alignment option corridors, and 3 in the western haul road alignment option corridor (Figures 3 to 5). Abundances were not noted at any locations, however it was noted as being relatively common at each location.

Eucalyptus pimpiniana (P3) is a straggly, shrubby mallee to 2 m high (DEC 2012c). It is found on sandy soils on plains and dunes (DEC 2012c) in the Great Victoria Desert over a range in Western Australia of approximately 600 km, from near Queen Victoria Springs Nature Reserve east of Kalgoorlie to the centre of the Great Victoria Desert Nature Reserve (DEC 2012a). There are also numerous records of this species in the Great Victoria Desert in the eastern part of South Australia (The Council of Heads of Australasian Herbaria 2012). There are 26 DEC records of this species, representing approximately 12 populations (DEC 2012a). This taxon was recorded at 3 locations in the Project area in 2012: 1 in the eastern haul road alignment option corridor, and 2 in the central haul road alignment option corridor (Figures 3 and 4). In excess of 250 individuals were recorded across the 2 locations in the central haul road alignment option corridor, with in excess of 50 individuals recorded at the location in the eastern haul road alignment option corridor. Additionally, it was recorded at 2 locations outside the Project area in the vicinity of the central haul road alignment option corridor, with in excess of 50 individuals noted at both locations. It is also known to occur at 2 locations in the western haul road alignment option corridor (Figure 5), however these locations could not be accessed because of cultural heritage restrictions

Eremophila ?*attenuata* may represent only the second collection of *E. attenuata* (P1) ever made. Although the collection made during this survey superficially differs from the single collection of *E. attenuata* in some minor aspects, it is considered likely that these differences are the result of relatively poor material and/or natural variations in the anatomy of the species. As there is only one other collection it may mean that any natural variation has not been seen before. Further investigation by an expert in the genus is required to determine whether this collection represents *E. attenuata*; if it is not this species, the collection is highly likely to represent a new taxon. *E. attenuata* is a very distinct species, and is a much-branched, intricate shrub to 1 m with branch tips becoming spinescent (Chinnock 2007). The sole existing collection was made in 1970 from a swampy area in Myall (*Acacia papyrocarpa*) country, approximately 130 km north of Rawlinna on the Nullarbor Plain (DEC 2012c). Despite several searches of what was believed to be the location of the collection between 2003 and 2010, it has not been relocated (Brown & Buirchell 2011). The collection of *E.* ?*attenuata* was from the western haul road alignment option corridor (Figure 5), from an open depression, where it was growing with *Atriplex nummularia* subsp. *spathulata*. This collection will be submitted to the WAHerb.

Dampiera ?*eriantha* may represent *D. eriantha* (P1), a species that has been collected in the Great Victoria Desert approximately 300 km west of the Project area (DEC 2012a). These collections were sterile, and therefore it could not be confirmed that the collection from the Project area, which had old floral material, was the same taxon. However, the old floral material collected does not appear to match the description of *D. eriantha* in Flora of Australia (Australian Biological Resources Study 1992), and therefore the collection may represent a new taxon. Further material, including fresh floral material, is required to confirm the taxonomic status of this entity, however it is likely to be of conservation significance regardless. *D.* ?*eriantha* was recorded at 2 locations in the Project area in 2012: 1 in the central haul road alignment option corridor, where a single plant was noted, and 1 in the western haul road alignment option corridor, where several plants were noted (Figures 4 and 5).

Two further conservation significant flora taxa, *Lepidium fasciculatum* (P3) and *Ptilotus blackii* (P3), have historically been collected in the Project area, however were not collected during this survey. *Lepidium fasciculatum* has been recorded at the very southern end of the central haul road alignment option corridor near Forrest (Figure 4), while *Ptilotus blackii* has been recorded in the northern part of the western haul road alignment option (Figure 5). *Lepidium fasciculatum* is an annual species, and it is likely that this species was not present at the time of survey because of lack of rainfall prior to the survey. *Ptilotus blackii* is a perennial species, however is unlikely to have been flowering at the time of survey, and therefore may not have been easily visible. Limited survey was also conducted in the western haul road alignment option corridor, which may have also contributed to this species not being collected during this survey.

4.1.2 Other Flora of Interest

A collection of a *Eucalyptus* could not be matched to material of any taxon held at the WAHerb, and may represent an undescribed taxon, or a taxon not previously recorded in Western Australia. The collection of this entity appears to be most similar to *E. leptophylla*, a species also recorded in the Project area, however has slightly different-shaped buds, and has rough bark extending over the trunk and much of the branches (*E. leptophylla* almost always has entirely smooth bark). This entity also grew in relatively

unusual and specific habitat: it was recorded on a single gypsum lunette dune on the edge of a small salt pan, in the central haul road alignment option corridor (Figure 4), and nowhere else in the Project area. Further material, including fruits, as well as an assessment by an expert in the genus, is required to determine the taxonomic and conservation status of this entity. This specimen will be submitted to the WAHerb for further investigation.

Two separate collections of *Eucalyptus* from the Project area have been tentatively identified as *Eucalyptus canescens* subsp. *canescens* and *E. canescens* subsp. *beadellii*. Neither of these taxa have previously been recorded in Western Australia, however both are known from the Great Victoria Desert in South Australia, just east of the border with Western Australia. As the WAHerb does not hold any material of these taxa, the collections could not be matched to any existing collections, and the identification is based on information contained in Nicolle (1997). These specimens will be submitted to the WAHerb for investigation by an expert in the genus. They will be treated as being *E. canescens* subsp. *canescens* and *E. canescens* subsp. *beadellii* for the present time; as these taxa have not been collected before in Western Australia, their conservation status in Western Australia is unknown, however they appear to be relatively widely distributed in South Australia (The Council of Heads of Australasian Herbaria 2012). These specimens will be submitted to the WAHerb for further investigation and determination of their conservation status within W.A.. *E. canescens* subsp. *canescens* was recorded at 1 location in the central haul road alignment option corridor, with *E. canescens* subsp. *beadellii* recorded at 1 location in the eastern haul road alignment option corridor, and 3 locations in the central haul road alignment option corridor (Figures 3 and 4).

Two separate collections of a grass were identified by a Poaceae expert at the WAHerb as *Austrostipa nullnulla*. This taxon is common and relatively widely distributed in South Australia (The Council of Heads of Australasian Herbaria 2012), however it has not previously been recorded in W.A.. *A. nullanulla* was recorded from the western and central haul road alignment option corridors in the Project area (Figures 4 and 5), growing in clayey soils on gypsum lunette/calcrete breakaways on the edge of claypans. As *Austrostipa nullnulla* has not been collected before in Western Australia, the conservation status of this taxon in Western Australia is unknown. These specimens will be submitted to the WAHerb for further investigation and determination of its conservation status within W.A..

4.1.3 Distribution Extensions and Distribution Gaps

Because of the paucity of collections and previous surveys in the vicinity of the Project area, many of the collections made during this survey represent significant extensions to the known distribution of the collected taxa, or fill large gaps in their known distributions. Table 6 below presents a list of such collections made during this survey.

Table 6: Taxa Where Collections Represent Extensions to the Known Distributions of these Taxa, or Fill Distribution Gaps

Taxon	Description
Abutilon otocarpum	Collection fills a distribution gap within the known distribution of this taxon
?Anthobolus leptomerioides	Extension of known distribution – need additional material to confirm identification
Amyema miquelii	Collection fills a distribution gap within the known distribution of this taxon
Amyema nestor	Extension of known distribution
Aristida holathera var. *holathera*	Extension of known distribution
Austrostipa nullnulla	Extension of known distribution – first record for Western Australia
Bossiaea walkeri	Extension of known distribution
Chenopodium desertorum subsp. *desertorum*	Collection fills a distribution gap within the known distribution of this taxon
Chenopodium desertorum subsp. *rectum*	Collection fills a distribution gap within the known distribution of this taxon
Chenopodium nitrariaceum	Large extension of known distribution
Dampiera ?eriantha	Extension of known distribution– need additional material to confirm identification
Dicrastylis beveridgei	Extension of known distribution
Dodonaea stenozyga	Collection fills a distribution gap within the known distribution of this taxon
Enteropogon ramosus	Large extension of known distribution
Eragrostis xerophila	Collection fills a distribution gap within the known distribution of this taxon
Eriachne helmsii	Extension of known distribution
Eucalyptus canescens subsp. *beadellii*	Extension of known distribution – first record for Western Australia
Eucalyptus canescens subsp. *canescens*	Extension of known distribution – first record for Western Australia
Goodenia gypsicola	Extension of known distribution
Hakea leucoptera subsp. *sericipes*	Collection fills a distribution gap within the known distribution of this taxon
Hemichroa diandra	Extension of known distribution
Melaleuca zeteticorum	Extension of known distribution
Monachather paradoxus	Extension of known distribution
Olearia exiguifolia	Collection fills a distribution gap within the known distribution of this taxon
Olearia muelleri	Extension of known distribution
Paspalidium basicladum	Extension of known distribution
Paspalidium reflexum	Extension of known distribution
Prostanthera althoferi subsp. *althoferi*	Extension of known distribution
Psydrax ammophila	Extension of known distribution
Rytidosperma ?acerosa	Large extension of known distribution
Santalum acuminatum	Collection fills a distribution gap within the known distribution of this taxon
Sclerolaena deserticola	Extension of known distribution
Sclerolaena diachantha	Extension of known distribution

Taxon	Description
Senna artemisioides subsp. *filifolia*	Extension of known distribution
Sida ammophila	Extension of known distribution
Streptoglossa ?adscendens	Extension of known distribution – need additional material to confirm identification
Thryptomene biseriata	Extension of known distribution
Westringia rigida	Collection fills a distribution gap within the known distribution of this taxon
Xerochrysum bracteatum	Extension of known distribution

4.1.4 Introduced Taxa

A total of 2 introduced flora taxa were recorded in the Project area: ?*Carrichtera annua* and *Malvastrum americanum.*

?*Carrichtera annua* could not be confirmed as *C. annua* as all individuals were senescent at the time of survey, however it is highly likely that it represents *C. annua. C. annua* (Ward's Weed) is an annual herb to 0.4 m high, and is a widespread weed of shrublands in the Goldfields and Nullarbor shrublands in Western Australia (Hussey *et al.* 2007). This taxon was rated as High under the Environmental Weed Strategy for Western Australia, due to its high level of invasiveness, wide current and potential distribution and impact on native biodiversity (CALM 1999). This taxon was recorded at 4 locations in the Project area in 2012; with 2 locations each in the central and eastern haul road alignment option corridors (Figures 3 and 4). It is expected that this taxon would be prevalent on the Nullarbor Plain within all 3 haul road alignment option corridors following significant rainfall.

Malvastrum americanum (Spiked Malvastrum) is an erect, perennial herb or shrub to 1.5 m high, that is widespread throughout the northern half of Western Australia, particularly the Pilbara and Kimberley regions (Hussey *et al.* 2007). It is usually found near creeks, rivers, and on floodplains, particularly in disturbed areas such as areas frequented by cattle. It was noted for its high level of invasiveness and wide current distribution, and was rated as Moderate under the Environmental Weed Strategy for Western Australia (CALM 1999). It was recorded at a single location within the eastern haul road alignment option corridor (Figure 3).

4.2 VEGETATION OF THE PROJECT AREA

4.2.1 Vegetation Type Mapping

A total of 16 broad structural VTs were mapped over the 3 haul road alignment option corridors of the Project area. Two VTs were further divided into sub-types (2 sub-types for VT 5 and 9 sub-types for VT 10), VTs 1 to 9 occur in the northern half of the Project area, relating to sandy dunal and clay-loam areas, while VTs 10 to 16 occur over the southern half and relate to the clayey soils of the Nullarbor Plain. Figure 2 provides an overview of the VTs mapped across the entire Project area, with Figures 3, 4 and 5 displaying VTs in the eastern, central and western haul road alignment option corridors respectively. As the mining area represents the origin of all 3 haul road alignment options, the VTs mapped in the mining area are displayed on the first sheet of each of the haul road alignment option corridor figures (Figures 3.1, 4.1 and 5.1).

None of the vegetation types recorded represent the Priority 3 PEC, 'Yellow sandplain communities of the Great Victoria Desert'.

The VTs of the Project area, including a representative photograph or photographs, are described below:

VT 1 - Mid Woodland to Mid Isolated Trees of *Eucalyptus gongylocarpa* over Mid Mallee Woodland to Mid Isolated Mallee Trees of mixed *Eucalyptus* species dominated by *E. socialis* subsp. *victoriensis* and *E. gypsophila* over Tall Open Shrubland to Mid Open Shrubland of mixed species including *Acacia ligulata, A. ramulosa* var. *linophylla, A. gilesiana, Eremophila latrobei* subsp. *glabra* and *Thryptomene elliottii* with Isolated Trees of *Acacia aneura* and *A. aptaneura* (Mulga) and/or *Casuarina pauper* over Low Hummock Grassland dominated by *Triodia basedowii* or *T. scariosa* on red sandy dunes and swales (Plates 1 to 4).

VT 1 was mapped over large areas in the northern half of all 3 haul road alignment option corridors, as well as over the majority of the mining area (Figures 3 to 5). It is possible that a number of VTs occur on dunes and in swales in the Project area, however a floristic analysis is required to delineate these VTs, and for the purposes of this report, VT 1 has been mapped on all dunes and swales. The conservation significant flora taxa *Dampiera* ?*eriantha* (P1), *Eucalyptus pimpiniana* (P3) and *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3) were recorded in VT 1, as well as the taxon of interest *Eucalyptus canescens* subsp. *beadellii*. The conservation significant taxon *Ptilotus blackii* (P3) has also been recorded in this VT. No introduced taxa were recorded in VT 1.

Plate 1 – Vegetation Type 1, Sand Dunes with *Eucalyptus gongylocarpa*, Mixed Shrub Species and Mallee (Site C1-52)

Plate 2 – Vegetation Type 1, Sand Dunes with Mixed Shrub Species and Mallee (Site C1-V)

Plate 3 – Vegetation Type 1, Sandy Swales with Mixed Shrub Species and Mallee (Site C2-108)

Plate 4 – Vegetation Type 1, Sandy Swales with Scattered Mulga/Casuarina and Mixed Shrub Species (Site C1-Z)

VT 2 - Low Open Woodland of *Acacia aneura* (Mulga) over Mid Sparse Shrubland of *Eremophila latrobei* subsp. *glabra* and *Senna artemisiodes* subsp. *petiolaris* over Mid Hummock Grassland of *Triodia basedowii* on plains of red clayey sand or sandy loam (Plate 5).

VT 2 was relatively restricted in occurrence, being mapped in a few relatively small areas in the mining area and the very northern part of the central and western haul road alignment option corridors (where these corridors overlap) (Figures 4 and 5). No conservation significant flora taxa or introduced taxa were recorded in VT 2.

Plate 5 – Vegetation Type 2 (Site M-01-A)

VT 3 - Mid Woodland to Mid Open Woodland of *Casuarina pauper* and Low Isolated Clumps of Trees of *Acacia caesaneura, A. aptaneura* and *A. aneura* (Mulga) over Tall to Mid Shrubland of mixed species dominated by *Alectryon oleifolius* subsp. *canescens, Eremophila latrobei* subsp. *glabra, E. scoparia, Senna artemesioides* subsp. *petiolaris, Acacia kempeana* and *Acacia oswaldii* over Low Sparse Shrubland of mixed species dominated by *Ptilotus obovatus, Maireana* spp. and *Sclerolaena* spp. over Low Sparse Tussock Grassland to Isolated Clumps of Tussock Grasses dominated by *Aristida* ?*inaequiglumis* on undulating plains of red sand, sandy-clay loam or clayey sand (Plate 6).

VT 3 was mapped over large areas in the northern half of all 3 haul road alignment option corridors (Figures 3 to 5). The conservation significant flora taxon *Dampiera* ?*eriantha* (P1) was recorded in VT 3. No introduced taxa were recorded in VT 3.

Plate 6 – Vegetation Type 3 (Site C1-53)

VT 4 - Low Woodland to Low Open Woodland of *Acacia caesaneura, A. aptaneura* and *A. aneura* (Mulga) with Low Isolated Clumps of Trees of *Casuarina pauper* and/or *Myoporum playtycarpum* subsp. *playtcarpum* over Mid Isolated to Low Isolated Clumps of Shrubs of mixed species including *Senna artemesioides* subsp. *petiolaris* over Low Open Chenopod Shrubland dominated by *Atriplex vesicaria, Rhagodia spinescens* and *Sclerolaena diacantha* over Low Closed Tussock Grassland of *Aristida* spp., *Enneapogon avenaceus* and *Eragrostis laniflora* on flats and depressions of red clay loam (Plate 7).

VT 4 was mapped in small areas in the northern half of all 3 haul road alignment option corridors, usually in association with depressions (Figures 3 to 5). No conservation significant flora taxa or introduced taxa were recorded in VT 4.

Plate 7 – Vegetation Type 4 (Site C2-110)

VT 5 – Chenopod vegetation in claypans in the northern part of the Project area, in the Great Victoria Desert.

Several small claypans containing vegetation dominated by chenopod species in the Project area, were mapped as VT 5, however the species composition varied between claypans in the western, central and eastern haul road alignments. Therefore, 2 sub-types of VT 5 were described:

VT 5a - Low Open Samphire Shrubland of *Tecticornia indica* subsp. *bidens* and *T. pruinosa* over Low Isolated Clumps of Chenopod Shrubs of mixed species including *Hemichroa diandra* over Low Isolated Clumps of Tussock Grasses of *Eragrostis ?pergracilis* in claypans of red-brown light silty clay (Plate 8).

VT 5a was restricted in occurrence, being mapped in several small areas in the very north-eastern part of the western and central haul road alignment option corridors (Figures 4 and 5). It was similar to VT 5b in occurring in claypans, however 5b was dominated by *Atriplex vesicaria* rather than *Tecticornia* spp. No conservation significant flora taxa or introduced taxa were recorded in VT 5a.

Plate 8 – Vegetation Type 5a (Site C3-T)

VT 5b - Low Chenopod Shrubland of *Atriplex vesicaria* over Low Open Tussock Grassland dominated by *Enneapogon avenaceus* with Low Isolated Trees of *Casuarina pauper* and *Myoporum playtycarpum* subsp. *playtcarpum* in claypans of red clay loam (Plate 9).

VT 5b was restricted in occurrence, being mapped in 2 small areas in the northern part of the eastern haul road alignment option corridor (Figure 3). No conservation significant flora taxa or introduced taxa were recorded in VT 5b.

Plate 9 – Vegetation Type 5b (Site C1-62)

VT 6 - Low Open to Low Sparse Forbland *of Scaevola collaris* and *Goodenia gypsicola* over Low Open Tussock Grassland of *Austrostipa nullnulla* and Low Isolated Chenopod Shrubs including *Rhagodia spinescens* and *Sclerolaena symoniana* with Low Isolated Clumps of Trees of *Casuarina pauper* or *Myoporum playtycarpum* subsp. *playtcarpum* and *Alectryon oleifolius* subsp. *canescens* on gypsum lunettes or calcrete breakaways of pale brown clay or red sandy clay (Plate 10).

VT 6 was restricted in occurrence, being mapped in several small areas in the very north-eastern part of the western and central haul road alignment option corridors, on gypsum or calcrete lunettes or breakaways associated with claypans (Figures 4 and 5). No conservation significant flora taxa were recorded in VT 6, however the taxa of interest *Austrostipa nullanulla* and *Eucalyptus* sp. were recorded in this VT. No introduced taxa were recorded in VT 6.

Plate 10 – Vegetation Type 6 (Site C3-U)

VT 7 - Low Mallee Woodland of mixed *Eucalyptus* spp. dominated by *E. gypsophila* and *E. socialis* subsp. *victoriensis* over Tall Isolated Clumps of Shrubs of mixed species dominated by *Acacia ligulata, A. gilesiana* and *E. paisleyi* subsp. *paisleyi* over Mid Open Shrubland to Mid Isolated Clumps of Shrubs of mixed species including *Eremophila latrobei* subsp. *glabra, Senna artemisioides* subsp. *petiolaris* and *Scaevola spinescens* over Low Closed to Low Open Hummock and Tussock Grassland of *Triodia basedowii* or *T. scariosa* on broad sandplains of red clayey sand or sand (Plate 11).

VT 7 was mapped over large areas in the northern half of all 3 haul road alignment option corridors, as well as over the majority of the mining area (Figures 3 to 5). It is possible that a number of VTs occur on sandplains in the Project area, however a floristic analysis is required to delineate these VTs, and for the purposes of this report, VT 7 has been mapped on all dunes and swales. The conservation significant flora taxa *Eucalyptus pimpiniana* (P3) and *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3) were recorded in VT 7, as well as the taxa of interest *Eucalyptus canescens* subsp. *beadellii* and *Eucalyptus canescens* subsp. *canescens*. No introduced taxa were recorded in VT 7.

Plate 11 – Vegetation Type 7 (Site C3-M)

VT 8 - Bare claypan (no perennial vegetation present) (Plate 12).

VT 8 was mapped in 2 small areas in the central haul road alignment option corridor, in small claypans with no perennial vegetation. It is possible that they may contain ephemeral vegetation following significant rainfall events, and hence they have been mapped as a VT.

Plate 12 – Vegetation Type 8

VT 9 - Low Open Forest of *Acacia aptaneura* (Mulga) over Tall Isolated Clumps of *Acacia tetragonophylla* over Mid Isolated Clumps of *Eremophila latrobei* subsp. *glabra* over Low Open Chenopod Shrubland dominated by *Maireana* spp. over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Open Tussock Grassland of mixed species dominated by *Aristida contorta* on gently undulating plains of red clay loam (Plate 13).

VT 9 was restricted in occurrence, being mapped in several small areas in the central part of the central haul road alignment option corridor, near the top of the Nullarbor Plain (Figure 4). No conservation significant flora taxa or introduced taxa were recorded in VT 9.

Plate 13 – Vegetation Type 9 (Site C2-25)

VT 10 – Vegetation in dongas (shallow saucer-shaped depressions (Beard 1990)) or drainage depressions in the southern part of the Project area on the Nullarbor Plain.

Dongas and depressions were common on the Nullarbor Plain in the Project area, however frequently differed from each other in their species composition. Therefore, 9 sub-types of VT 10 were described:

VT 10a - Mid Isolated Clumps of *Muehlenbeckia florulenta, Senna artemisioides* subsp. *petiolaris* and/or *Eremophila longifolia* over Low Tussock Grassland of *Eragrostis xerophila* or Poaceae species (dead) in dongas of red light clay (Plate 14 and 15).

VT 10a was relatively restricted in occurrence, being mapped in several small areas in the southern part of the western haul road alignment option corridor, on the Nullarbor Plain (Figure 5). No conservation significant flora taxa or introduced taxa were recorded in VT 10a.

Plate 14 – Vegetation Type 10a, *Muehlenbeckia florulenta* Over Grasses (Site C3-B)

Plate 15 – Vegetation Type 10a, *Muehlenbeckia florulenta* with *Eremophila longifolia* (Site C3-F)

VT 10b - Mid Isolated Clumps of *Senna artemisioides* subsp. *petiolaris* and Low Isolated Clumps of Shrubs of *Rhagodia spinescens* with Low Isolated Trees of *Acacia aptaneura* (Mulga), *Alectryon oleifolius* subsp. *canescens* and *Pittosporum angustifolium* in dongas of red light clay. No photograph available.

VT 10b was mapped in numerous small areas in the southern part of the central haul road alignment option corridor, on the Nullarbor Plain (Figure 4). No conservation significant flora taxa or introduced taxa were recorded in VT 10b.

VT 10c - Mid Woodland of *Acacia aptaneura* (Mulga) and *Grevillea nematophylla* subsp. *supraplana* over Tall Sparse Shrubland to Tall Isolated Shrubs of *Eremophila longifolia, Pittosporum angustifolium, Senna artemisioides* subsp. *x artemisiodes* and/or *Senna artemisioides* subsp. *petiolaris* over Mid Sparse Chenopod Shrubland of *Rhagodia spinescens* or Low Isolated Clumps of Chenopod Shrubs of mixed species over Low Open Forbland of **?Carrichtera annua* or Low Isolated Clumps of Tussock Grass of *Eragrostis xerophila* in dongas of red to pale brown clay loam (Plate 16).

VT 10c was mapped in numerous small areas in the southern part of the central and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 and 4). No conservation significant flora taxa, were recorded in VT 10c, however the potential introduced taxon ?*Carrichtera annua* was recorded in VT 10c.

Plate 16 – Vegetation Type 10c (Site C2-38)

VT 10d - Low Isolated Clumps of Trees of *Alectryon oleifolius* subsp. *canescens* over Mid Isolated Chenopod Shrubs of *Rhagodia spinescens* over Low Isolated Chenopod Shrubs of mixed species in dongas of red light clay (Plate 17).

VT 10d was restricted in occurrence, being mapped in several small areas in the southern part of the central and western haul road alignment option corridors, on the Nullarbor Plain (Figures 4 and 5). No conservation significant flora taxa or introduced taxa were recorded in VT 10d.

Plate 17 – Vegetation Type 10d (Site MS-06)

VT 10e - Low Tussock Grassland of *Rytidosperma ?acerosum* and *Enneapogon avenaceus* or *Eragrostis xerophila* with Low Isolated Chenopod Shrubs of *Atriplex acutibractea* subsp. *acutibractea*, *A. vesicaria* and *Rhagodia spinescens* in drainage channels of red light clay (Plate 18).

VT 10e was restricted in occurrence, being mapped in several small areas in the southern part of the central and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 and 4). No conservation significant flora taxa, were recorded in VT 10e, however the potential introduced taxon ?*Carrichtera annua* was recorded in VT 10e.

Plate 18 – Vegetation Type 10e (Site MS-05)

VT 10f - Mid Isolated Clumps of Trees of *Casuarina pauper* over Low Open Woodland of *Alectryon oleifolius* subsp. *canescens* over Tall Isolated Clumps of *Acacia kempeana* over Mid Open Shrubland of *Senna artemisioides* subsp. *petiolaris* and *Senna artemisioides* subsp. *petiolaris* (broad petiole form) over Low Sparse Chenopod Shrubland of *Chenopodium desertorum* subsp. *desertorum* and *Maireana pentatropis* in dongas of red sand (Plate 19).

VT 10f was restricted in occurrence, being mapped in several small areas in the southern part of the eastern haul road alignment option corridor, on the Nullarbor Plain (Figure 3). No conservation significant flora taxa or introduced taxa were recorded in VT 10f.

Plate 19 – Vegetation Type 10f (Site C1-54)

VT 10g - Low Open Woodland to Low Isolated Clumps of Trees of *Acacia aptaneura* (Mulga) over Tall Open Shrubland of *Acacia tetragonophylla* and *Eremophila longifolia* over Mid Sparse Shrubland to Mid Isolated Clumps of Chenopod Shrubs of *Rhagodia spinescens* and Mid Isolated Clumps of Shrubs of *Senna artemisioides* subsp. *petiolaris* over Low Isolated Clumps of Tussock Grasses of *Enneapogon* spp. in dongas of red clay loam (Plate 20).

VT 10g was mapped in numerous small areas in the southern part of the western and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 and 5). No conservation significant flora taxa, were recorded in VT 10g, however the potential introduced taxon *Malvastrum americanum* was recorded in VT 10g.

Plate 20 – Vegetation Type 10g (Site C1-23)

VT 10h - Low Shrubland of *Eremophila ?attenuata* and Low Open Chenopod Shrubland of *Atriplex nummularia* subsp. *spathulata* in claypans of red light clay (Plate 21).

VT 10h was restricted in occurrence, being mapped in several small areas in the southern part of the western haul road alignment option corridor, on the Nullarbor Plain (Figure 5). The conservation significant flora taxon *Eremophila* ?*attenuata* (P1) was recorded in VT 10h, with no introduced taxa recorded in VT 10h.

Plate 21 – Vegetation Type 10h (Site C3-A)

VT 10i - Low Isolated Chenopod Shrubs of *Maireana sedifolia* (Bluebush) and *Sclerolaena obliqicuspis* over Low Tussock Grassland of *Enneapogon avenaceus* and *Eragrostis xerophila* with Low Isolated Clumps of Forbs of *Streptoglossa ?adscendens* in dongas of red sandy clay (Plate 22).

VT 10i was restricted in occurrence, being mapped in several small areas in the central part of the central haul road alignment option corridor, near the top of the Nullarbor Plain (Figure 4). No conservation significant flora taxa or introduced taxa were recorded in VT 10i.

Plate 22 – Vegetation Type 10i (Site C2-26a)

VT 11 - Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush) over Low Tussock Grassland of *Enneapogon cylindricus* on plains of red clay loam (Plate 23).

VT 11 was mapped over large areas as a mosaic with VT 12 in the southern part of the western, central and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 to 5). It is possible that VTs 11 and 12 represent a single VT, however a floristic analysis is required to determine whether this is the case, and therefore they are considered separate for the purposes of this report. No conservation significant flora taxa or introduced taxa were recorded in VT 11.

Plate 23 – Vegetation Type 11 (Site C1-56)

VT 12 - Low Woodland of *Acacia papyrocarpa* over Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush), *Sclerolaena uniflora* and *Atriplex vesicaria* over Low Open Tussock Grassland of *Enneapogon cylindricus* and *E. avenaceus* on plains of red clay loam or white/red sandy clay (Plate 24).

VT 12 was mapped over large areas as a mosaic with VT 11 in the southern part of the western, central and eastern haul road alignment option corridors, on the Nullarbor Plain. It was also mapped as a mosaic with VT 15 (Figures 3 to 5), as it was often difficult to differentiate these VTs on aerial photography. No conservation significant flora taxa or introduced taxa were recorded in VT 11.

Plate 24 – Vegetation Type 12 (Site C2-41)

VT 13 - Low Sparse Chenopod Shrubland of *Atriplex acutibractea* subsp. *acutibractea*, *Maireana sedifolia* (Bluebush) and *Sclerolaena patenticuspis* over Low Tussock Grassland of *Enneapogon cylindricus* and Poaceae sp. (dead) with Mid Isolated Shrubs of *Eremophila longifolia* or *Pittosporum angustifolium* on plains of brown clay loam (Plate 25 and 26).

VT 13 was mapped over large areas in the southern part of the western, central and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 to 5). It was frequently mapped as a mosaic with VT 14, as it was often difficult to differentiate these VTs on aerial photography. No conservation significant flora taxa were recorded in VT 13, however the potential introduced taxon ?*Carrichtera annua* was recorded in an area mapped as a mosaic of VTs 13/14; it is likely to occur in both of these VTs.

Plate 25 – Vegetation Type 13, Sparse Chenopod Shrubland and Grasses (Site C1-57)

Plate 26 – Vegetation Type 13, Sparse Chenopod Shrubland and Grasses with Mid Isolated Shrubs (Site C3-E)

VT 14 - Low Closed to Low Sparse Chenopod Shrubland of *Atriplex acutibractea* subsp. *acutibractea* and/or *A. vesicaria* and *Maireana ?trichoptera* over Low Sparse Tussock Grassland of Poaceae sp. (dead) with Mid Isolated Shrubs of *Pittosporum angustifolium* on plains of red silty loam or clay loam (Plate 27).

VT 14 was mapped over large areas in the southern part of the western, central and eastern haul road alignment option corridors, on the Nullarbor Plain (Figures 3 to 5). It was frequently mapped as a mosaic with VT 13, as it was often difficult to differentiate these VTs on aerial photography. No conservation significant flora taxa were recorded in VT 14, however the potential introduced taxon ?*Carrichtera annua* was recorded in an area mapped as a mosaic of VTs 13 and 14; it is likely to occur in both of these VTs.

Plate 27 – Vegetation Type 14 (Site MS-03)

VT 15 - Low Woodland of *Acacia caesaneura* and *A. pteraneura* (Mulga) to Low Isolated Clumps of Trees of *Acacia aptaneura* (Mulga) and *Casuarina pauper* over Tall Isolated Clumps of Shrubs of *Acacia kempeana* and *A. tetragonophylla* over Mid Isolated Clumps of Shrubs of *Eremophila latrobei* subsp. *glabra* over Low Shrubland of *Ptilotus obovatus* and Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush) over Low Open Tussock Grassland of *Eriachne helmsii* and *Enneapogon caerulescens* or *E. cylindricus* on undulating plains of red clay loam (Plate 28).

VT 15 was mapped over large areas in the central part of the central and eastern haul road alignment option corridors, at the top of the Nullarbor Plain (Figures 3 and 4). It was frequently mapped as a mosaic with VT 12, as it was often difficult to differentiate these VTs on aerial photography. No conservation significant flora taxa or introduced flora taxa were recorded in VT 15.

Plate 28 – Vegetation Type 15 (Site C2-32)

VT 16 - Low Woodland of *Acacia aneura, A. pteraneura* (Mulga) and *Casuarina pauper* over Tall Isolated Clumps of Shrubs of *Acacia kempeana* over Mid Isolated Clumps of Shrubs of *Eremophila latrobei* subsp. *glabra, E. longifolia, Senna artemisioides* subsp. x *artemisioides* and *Senna artemisioides* subsp. *petiolaris* over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Closed to Low Tussock Grassland of *Aristida contorta, A. ?inaequiglumis* and *Eragrostis laniflora* on plains of red clayey sand (Plate 29).

VT 16 was relatively restricted, being mapped in several areas, some of which were large, in the north-western part of the western haul road alignment option corridor, near the top of the Nullarbor Plain (Figure 5). No conservation significant flora taxa or introduced flora taxa were recorded in VT 15.

Plate 29 – Vegetation Type 16 (Site C3-G)

4.2.2 Other Areas Mapped

Areas that could not be surveyed because of cultural heritage restrictions were mapped as Not Surveyed ('NS'). These were the Carlisle Lakes chain in the western haul road alignment option corridor, and the Forrest Lakes chain in the eastern haul road alignment option corridor.

Several areas near the Trans Australia Railway Line were mapped as 'Disturbed' (D), with the vegetation in these areas either partially or completely cleared. These included areas near Forrest in the central haul road alignment option corridor, and near Loongana in the western haul road alignment option corridor. The conservation significant flora taxon *Lepidium fasciculatum* (P3) has previously been recorded in an area mapped as 'Disturbed', however this area is surrounded by a mosaic of VTs 13 and 14.

4.2.3 Vegetation Condition

The vegetation in the northern half of the Project area (VTs 1 to 9) was mostly in Excellent condition, with little to no disturbance or weeds.

The southern half of the Project area (relating to the Nullarbor Plain and VTs 10 to 16) ranged from Excellent to Good. Very recent fire, a high density of rabbit warrens and

high rabbit numbers, the presence of weed species and heavy grazing by rabbits resulted in lower condition scores in approximately half of the sites recorded in the Nullarbor area.

4.2.4 Potential Conservation Significance of Vegetation Types

A number of VTs were mapped widely and over large areas, including over 2 or more of the haul road alignment option corridors. Table 7 below outlines the distributions of VTs mapped in the Project area. However, several VTs were either highly locally restricted in their distribution, including some that were only mapped in 1 of the haul road alignment options, or were mapped in a limited number of small areas across 2 or all of the haul road alignment options, often associated with uncommon land forms. These VTs are currently considered to be of local conservation significance; however, it is likely that these VTs occur outside the Project area. This is particularly relevant for the sub-types of VT 10 (vegetation in dongas and other depressions on the Nullarbor Plain), as dongas were seen to be prevalent from the air outside the haul road alignment option corridors. It is also worthy of note that VTs identified during this survey as habitat for conservation significant flora taxa are potentially of increased local conservation significance and should be viewed as such until further study has been conducted to quantify both the floristic VTs of the area and their respective conservation status'. Table 8 outlines the VTs in the Project area considered to be of local conservation significance, and the factors determining their significance.

Table 7: Distribution of Vegetation Types in the Project Area

Vegetation Type	Eastern Corridor	Central Corridor	Western Corridor	Mining Area
1	Present	Present	Present	Present
2		Present		Present
3	Present	Present	Present	
4	Present	Present	Present	
5a		Present	Present	
5b	Present			
6		Present	Present	
7	Present	Present	Present	
8		Present		
9		Present		
10a			Present	
10b		Present	Present	
10c	Present	Present		
10d		Present	Present	
10e	Present	Present		
10f	Present			
10g	Present		Present	
10h			Present	
10i		Present		
11	Present	Present	Present	
12	Present	Present	Present	
13	Present	Present	Present	
14	Present	Present	Present	
15	Present	Present		
16			Present	

Table 8: Potentially Locally Conservation Significant Vegetation Types in the Project Area

Vegetation Type	Description	Comments
1	Mid Woodland to Mid Isolated Trees of *Eucalyptus gongylocarpa* over Mid Mallee Woodland to Mid Isolated Mallee Trees of mixed *Eucalyptus* spp. over Tall Open Shrubland to Mid Open Shrubland of mixed species with Isolated Trees of *Acacia aneura/aptaneura* (Mulga) and/or *Casuarina pauper* over Low Isolated Clumps of Tussock Grasses and/or Hummock Grasses on red sandy dunes and swales	• Habitat for conservation significant flora taxa
2	Low Open Woodland of *Acacia aneura* (Mulga) over Mid Sparse Shrubland of *Eremophila latrobei* subsp. *glabra* and *Senna artemisiodes* subsp. *petiolaris* over Mid Hummock Grassland of *Triodia basedowii* on plains of red clayey sand or sandy loam	• Mapped over a limited range in the Project area (mining area and adjacent central haul road corridor option) • Area mapped relatively small
3	Mid Woodland to Mid Open Woodland of *Casuarina pauper* and Low Isolated Clumps of Trees of *Acacia caesaneura/aptaneura/aneura* (Mulga) over Tall to Mid Shrubland of mixed species over Low Sparse Shrubland of mixed species and/or Chenopods over Low Sparse Tussock Grassland to Isolated Clumps of *Aristida* spp. and *Eragrostis laniflora* on undulating plains of red sand/sandy-clayey loam/clayey sand	• Habitat for conservation significant flora taxon
5a	Low Open Samphire Shrubland of *Tecticornia* spp. and Low Isolated Clumps of Chenopod Shrubs of mixed species over Low Isolated Clumps of Tussock Grasses of *Eragrostis ?pergracilis* in claypans of red-brown light silty clay	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (central haul road corridor option and immediately adjacent western haul road corridor option) • Occurred on unusual landform
5b	Low Chenopod Shrubland of *Atriplex vesicaria* over Low Open Tussock Grassland of predominantly *Enneapogon avenaceus* with Low Isolated Trees of *Casuarina pauper* and *Myoporum playtycarpum* subsp. *playtcarpum* in claypans of red clay loam	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (eastern road corridor option) • Occurred on unusual landform

Vegetation Type	Description	Comments
6	Low Open to Low Sparse Forbland *of Scaevola collaris* and *Goodenia gypsicola* over Low Open Tussock Grassland of *Austrostipa nullnulla* and Low Isolated Chenopod Shrubs with Low Isolated Clumps of Trees of *Casuarina pauper* or *Myoporum playtycarpum* subsp. *playtcarpum* and *Alectryon oleifolius* subsp. *canescens* on gypsum lunettes/calcrete breakaways of pale brown clay or red sandy clay	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (central haul road corridor option and immediately adjacent western haul road corridor option) • Habitat for potentially conservation significant flora taxon • Occurred on unusual landform
7	Low Mallee Woodland of mixed *Eucalyptus* spp. over Tall Isolated Clumps of Shrubs of mixed species over Mid Open Shrubland to Mid Isolated Clumps of Shrubs of mixed species over Low Closed to Low Open Hummock Grassland of *Triodia* spp. and over Low Open to Low Isolated Clumps of Tussock Grasses of *Eragrostis laniflora* on broad sandplains of red clayey sand or sand	• Habitat for conservation significant flora taxa
8	Bare claypan (no perennial vegetation present)	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (central haul road corridor option and immediately adjacent western haul road corridor option) • Occurred on unusual landform
9	Low Open Forest of *Acacia aptaneura* (Mulga) over Tall Isolated Clumps of *Acacia tetragonophylla* over Mid Isolated Clumps of *Eremophila latrobei* subsp. *glabra* over Low Open Chenopod Shrubland (Bluebush) of mixed species over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Open Tussock Grassland of mixed species (predominantly *Aristida contorta*) on gently undulating plains of red clay loam	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (central road corridor option)
10a	Mid Isolated Clumps of *Muehlenbeckia florulenta, Senna artemisioides* subsp. aff. *petiolaris* and/or *Eremophila longifolia* over Low Tussock Grassland of *Eragrostis xerophila* or Poaceae species (dead) in dongas of light clay (red)	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (western haul road corridor option)
10d	Low Isolated Clumps of Trees of *Alectryon oleifolius* subsp. *canescens* over Mid Isolated Chenopod Shrubs of *Rhagodia spinescens* over Low Isolated Chenopod Shrubs of mixed species in dongas of light clay (red)	• Mapped in a few very small areas; • Mapped over a wide range in the Project area (central and western haul road corridor options)

Vegetation Type	Description	Comments
10e	Low Tussock Grassland of *Rytidosperma ?acerosum* and *Enneapogon avenaceus* or *Eragrostis xerophila* with Low Isolated Chenopod Shrubs of *Atriplex acutibractea* subsp. *acutibractea*, *A. vesicaria* and *Rhagodia spinescens* in drainage channels of light clay (red)	• Mapped in a few very small areas; • Mapped over a wide range in the Project area (central and eastern haul road corridor options)
10f	Mid Isolated Clumps of Trees of *Casuarina pauper* over Low Open Woodland of *Alectryon oleifolius* subsp. *canescens* over Tall Isolated Clumps of *Acacia kempeana* over Mid Open Shrubland of *Senna artemisioides* subsp. aff. *petiolaris* and *Senna artemisioides* subsp. *petiolaris* over Low Sparse Chenopod Shrubland of *Chenopodium desertorum* subsp. *desertorum* and *Maireana pentatropis* on plains of red sand	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (eastern haul road corridor option)
10h	Low Shrubland of *Eremophila ?attenuata* and Low Open Chenopod Shrubland of *Atriplex nummularia* subsp. *nummularia* in claypans of light clay	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (western haul road corridor option) • Habitat for conservation significant flora taxon
10i	Low Isolated Chenopod Shrubs of *Maireana sedifolia* (Bluebush) and *Sclerolaena obliqicuspis* over Low Tussock Grassland of *Enneapogon avenaceus* and *Eragrostis xerophila* with Low Isolated Clumps of Forbs of *Streptoglossa ?adscendens* in dongas of red sandy clay	• Mapped in a few very small areas; • Mapped over a limited range in the Project area (central haul road corridor option)
16	Low Woodland of *Acacia aneura, A. pteraneura* (Mulga) and *Casuarina pauper* over Tall Isolated Clumps of Shrubs of Acacia kempeana over Mid Isolated Clumps of Shrubs of *Eremophila latrobei* subsp. *glabra/E. longifolia* and *Senna artemisioides* subsp. x *artemisioides/*aff. *petiolaris* over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Closed to Low Tussock Grassland of *Aristida contorta, A. ?inaequiglumis* and *Eragrostis laniflora* on plains of red clayey sand	• Mapped over a limited range in the Project area (western haul road corridor option) • Area mapped relatively large

Because of the lack of regional information regarding VTs, it is impossible to determine the regional conservation significance of VTs in the Project area with any certainty. However, given that the majority of VTs mapped in the Project area were recorded across multiple haul road corridor alignment options, and the large unsurveyed areas between the haul road corridor alignment options, it is unlikely that the majority of VTs will be of regional conservation significance. VT 10h is the only VT considered to be of potential regional conservation significance at this stage; this VT is dominated by *Eremophila* ?*attenuata* (P1) a species that (if the tentative identification proves correct) is currently only known from one other location in Western Australia. However, as it occurs in an area that has received little survey effort, this species may prove to be more common, albeit in small localised depressions and dongas.

5. DISCUSSION

5.1 FLORA AND VEGETATION OF THE PROJECT AREA

A total of 175 discrete vascular flora taxa and 1 known hybrid were recorded within the Project area in 2012. This total is considered relatively low given the large size of the Project area. It is considered that this total would have been far higher had the survey been conducted following a significant rainfall event, as it is likely that large numbers of ephemeral taxa would be present following such an event. Sampling was also relatively limited over the Project area because of time constraints, which may also have contributed to the relatively low total. It is therefore considered desirable that future surveys be conducted following such a rainfall event, to allow for ephemeral taxa to be sampled.

Two confirmed conservation significant flora taxa were recorded in the Project area during this survey: *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3) and *Eucalyptus pimpiniana* (P3). Both taxa are relatively widespread in W.A., and are likely to occur in the vicinity of the Project area, with *Eucalyptus pimpiniana* observed adjacent to the central corridor. As previously mentioned, 2 additional taxa of conservation significance, *Lepidium fasciculatum* (P3) and *Ptilotus blackii* (P3), have historically been recorded in the Project area, but were not collected during this survey, likely because of a combination of lack of rainfall prior to survey and relatively low sampling intensity. Both taxa are also relatively widespread in W.A., and are also likely to occur in the vicinity of the Project area. The potentially conservation significant taxa *Dampiera* ?*eriantha* (P1) and *Eremophila* ?*attenuata* (P1) were also recorded; both require further investigation, including collection of good flowering material, to confirm their identification. Both taxa are known from few collections, with *Eremophila attenuata* only known from 1 other collection, and therefore the collections in the Project area are of high significance. If they do not represent these taxa, they are both likely to be undescribed taxa, and therefore also of high significance.

A collection of a *Eucalyptus* may also represent a new taxon, however collection of further material, as well as an assessment by an expert in the genus, is required to determine the taxonomic and conservation status of this entity. However, it is considered appropriate to treat this taxon as being of conservation significance at this time.

Additionally, 3 taxa were apparently collected in W.A. for the first time: *Eucalyptus canescens* subsp. c*anescens*, *E. canescens* subsp. *beadellii* and *Austrostipa nullanulla.*

All 3 taxa are known to be widely distributed in South Australia, however there is the potential that they may be considered of conservation significance in Western Australia once the collections of these taxa have been lodged at the WAHerb.

A total of 16 VTs were described in the Project area, with 2 VTs divided into 2 and 9 sub-types respectively. This is also considered to be relatively low given the size of the Project area. However, it is expected that, with more detailed survey followed by floristic analysis, further VTs would be delineated, particularly within current VTs 1 and 7. These VTs currently encompass broad structural formations that may contain several floristic VTs; however this cannot be confirmed with any certainty at this time.

None of the VTs described were equivalent to any listed TECs or PECs, however 1 VT (VT 10h), is considered to be of potential regional significance, as it is dominated by the apparently rare *Eremophila* ?*attenuata* (P1) (see above). None of the other VTs described in the Project area are likely to be of regional significance, however based on current data, a number are considered to be of local conservation significance, as they generally occur on restricted landforms, or provide habitat for conservation significant flora taxa. These should be further investigated during future more detailed surveys, as some may prove to be more common following floristic analysis, and other VTs may be identified following floristic analysis that could also be locally conservation significant.

As previously mentioned, large areas of the western and eastern haul road alignment option corridors could not be accessed because of cultural heritage restrictions. These areas are associated with the Carlisle and Forrest Lakes, both of which are significant features in an otherwise relatively uniform landscape. It is likely that further VTs and taxa occur in these areas, however as access to these areas was not possible, and similar habitat was not encountered in the Project area, it is not possible to infer the VTs that occur in these areas. It is necessary for these areas to be surveyed in the future if either the western or the eastern haul road alignment option corridors is selected as the preferred option.

5.2 COMPARISON OF HAUL ROAD ALIGNMENT OPTION CORRIDORS

This report seeks to provide information that will support selection of a preferred haul road alignment option. Table 9 presents the identified flora and vegetation issues and values present on each proposed corridor option.

Table 9: Comparison of Corridor Options by Potential Issues

Criteria	Eastern Corridor	Central Corridor	Western Corridor
Length of Corridor	230 km	252 km	405 km
Species Composition Species Not Previously Recorded in WA	*Austrostipa nullanulla* **not present**, VT 6 in which species occurs does not occur in this corridor	*Austrostipa nullanulla* **present**	*Austrostipa nullanulla* **not recorded but possibly present**, VT 6 present in which species occurs
	Eucalyptus canescens subsp. *beadellii* **present**	*Eucalyptus canescens* subsp. *beadellii* **present**	*Eucalyptus canescens* subsp. *beadellii* **not recorded but possibly present**, VT 1 and 7 present in which species occurs

Criteria	Eastern Corridor	Central Corridor	Western Corridor
	Eucalyptus canescens subsp. *canescens* **not recorded but possibly present**, VT 7 present in which species occurs	*Eucalyptus canescens* subsp. *canescens* **present**	*Eucalyptus canescens* subsp. *canescens* **not recorded but possibly present**, VT 7 present in which species occurs
Species Composition Listed conservation significant taxa	*Dampiera ?eriantha* (P1) **not recorded but possibly present,** recorded to west of corridor and VT 1 present in which species occurs	*Dampiera ?eriantha* (P1) **present**	*Dampiera ?eriantha* (P1) **present**
	Eremophila ?attenuata (P1) **not present**, VT 10h in which species occurs is not present	*Eremophila ?attenuata* (P1) **not present**, VT 10h in which species occurs is not present	*Eremophila ?attenuata* (P1) **present**
	Acacia eremophila numerous-nerved variant (A.S. George 11924) (P3) **present**	*Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3) **present**	*Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3) **present**
	Eucalyptus pimpiniana (P3) **present**	*Eucalyptus pimpiniana* (P3) **present**	*Eucalyptus pimpiniana* (P3) **not recorded but probably present**, historical locations known from this corridor
	Ptilotus blackii (P3) **not recorded but possibly present**, VT 1 present in which species occurs	*Ptilotus blackii* (P3) **not recorded but possibly present**, VT 1 present in which species occurs	*Ptilotus blackii* (P3) **not recorded but probably present**, historical locations known from this corridor
	Lepidium fasciculatum (P3) **not recorded but possibly present**, VT 13/14 present in which species occurs (associated with disturbance)	*Lepidium fasciculatum* (P3) **not recorded but probably present**, historical locations known from this corridor	*Lepidium fasciculatum* (P3) **not recorded but possibly present**, VT 13/14 present in which species occurs (associated with disturbance)
Species Composition Potentially Undescribed Taxa	*Eucalyptus* sp. **not present**	*Eucalyptus* sp. **present**	*Eucalyptus* sp. **not recorded but possibly present**, VT 6 present in which species occurs
Rarity of Vegetation Types	Locally conservation significant VTs 1, 3, 5b, 7, 10e, 10f **present,** 5b and 10f **restricted to corridor. No VTs likely to be of regional conservation significance.** Large area associated with lake chain not surveyed.	Locally conservation significant VTs 1, 2*, 3, 5a, 6, 7, 8, 9, 10e, 10d, 10i **present,** 8, 9 and 10i **restricted to corridor. No VTs likely to be of regional conservation significance**	Conservation significant VTs 1, 3, 5a, 6, 7, 10a, 10d, 10h, 10i **present,** 10a, 10h and 16 **restricted to corridor. VT 10h potentially of regional conservation significance.** Large area associated with lake chain not surveyed.
Conservation Risks e.g. Weeds	Both weed species (?*Carrichtera annua, Malvastrum americanum*) **present**	?*Carrichtera annua* **present**; VT10g in which *Malvastrum americanum* occurs **not present**	Weed species **not recorded but possibly present**, VT 10g and 13/14 present in which the two weed species occur
Erosion Risk	Large areas of dune fields prone to erosion **present**	Large areas of dune fields prone to erosion **present**	Large areas of dune fields prone to erosion **present**

Criteria	Eastern Corridor	Central Corridor	Western Corridor
Surface Drainage Risk	Significant lake chain which may represent a significant surface drainage risk **present.** Small claypans and dongas which may represent a low surface drainage risk **present**	Small claypans and dongas which may represent a low surface drainage risk **present.**	Significant lake chain which may represent a significant surface drainage risk **present.** Small claypans and dongas which may represent a low surface drainage risk **present**

* Note: VT 2 occurs within the section of the central haul road alignment option corridor that overlaps the western haul road alignment option corridor, however for the purposes of this table, is considered to only occur in the central haul road alignment option corridor

The western haul road alignment option corridor is significantly longer than both the eastern and central haul road alignment option corridors, which are of similar length; it is therefore a less favourable option when the overall impact to flora and vegetation is considered. All 3 haul road alignment option corridors contained landforms prone to erosion (dune fields), and conservation risks (including weeds); no weeds were recorded in the western haul road alignment option corridor, however it is considered highly likely that ?*Carrichtera annua* would also occur there, as for the other haul road alignment option corridors. However these constraints were widespread and not considered significant in terms of the route selection process. All 3 haul road alignment option corridors also contain landforms such as claypans and depressions that may require localised drainage to support vegetation. In particular, large chains of lakes are present in the western and eastern haul road alignment option corridors, with smaller claypans and dongas present in all haul road alignment option corridors. The central option corridor appears more favourable with regard to localised drainage issues, as it only contains small claypans and dongas, with the western haul road alignment option corridor the least favourable, as it contains an intricate chain of small lakes.

All 3 haul road alignment option corridors contain taxa of conservation significance, however based on the currently available data the western haul road alignment option corridor appears to contain greater flora-related constraints than the central or eastern corridors, as it contains *Eremophila* ?*attenuata* (P1), a species only known from a single other collection in Western Australia. The eastern and central haul road alignment option corridors appear similar with the central having 1 more taxon of conservation significance confirmed at present, however no taxa of conservation significance recorded in either of these corridors was restricted to that corridor. All 3 haul road alignment option corridors also contain VTs considered to be of local significance, however, the western haul road alignment option corridor appears to contain greater VT-related constraints than the central or eastern corridors, as it contains a donga community dominated by *Eremophila* ?*attenuata* (P1 which may be of regional significance. The eastern and central haul road alignment option corridors appear similar, as both contain a number of VTs considered to be of local significance, but no VTs present in these haul road alignment option corridors are considered to be of regional conservation significance.

It is therefore considered that the central and eastern haul road alignment option corridors are similar in terms of flora and vegetation issues, and therefore 1 of these routes should be selected. However, final selection of the preferred route from these two options should take into account other factors not assessed during this survey and also the potential impacts of each corridor on the values of the Great Victoria Desert

Nature Reserve including the introduction of weeds, and also potentially fragmentation of habitat.

6. REFERENCES

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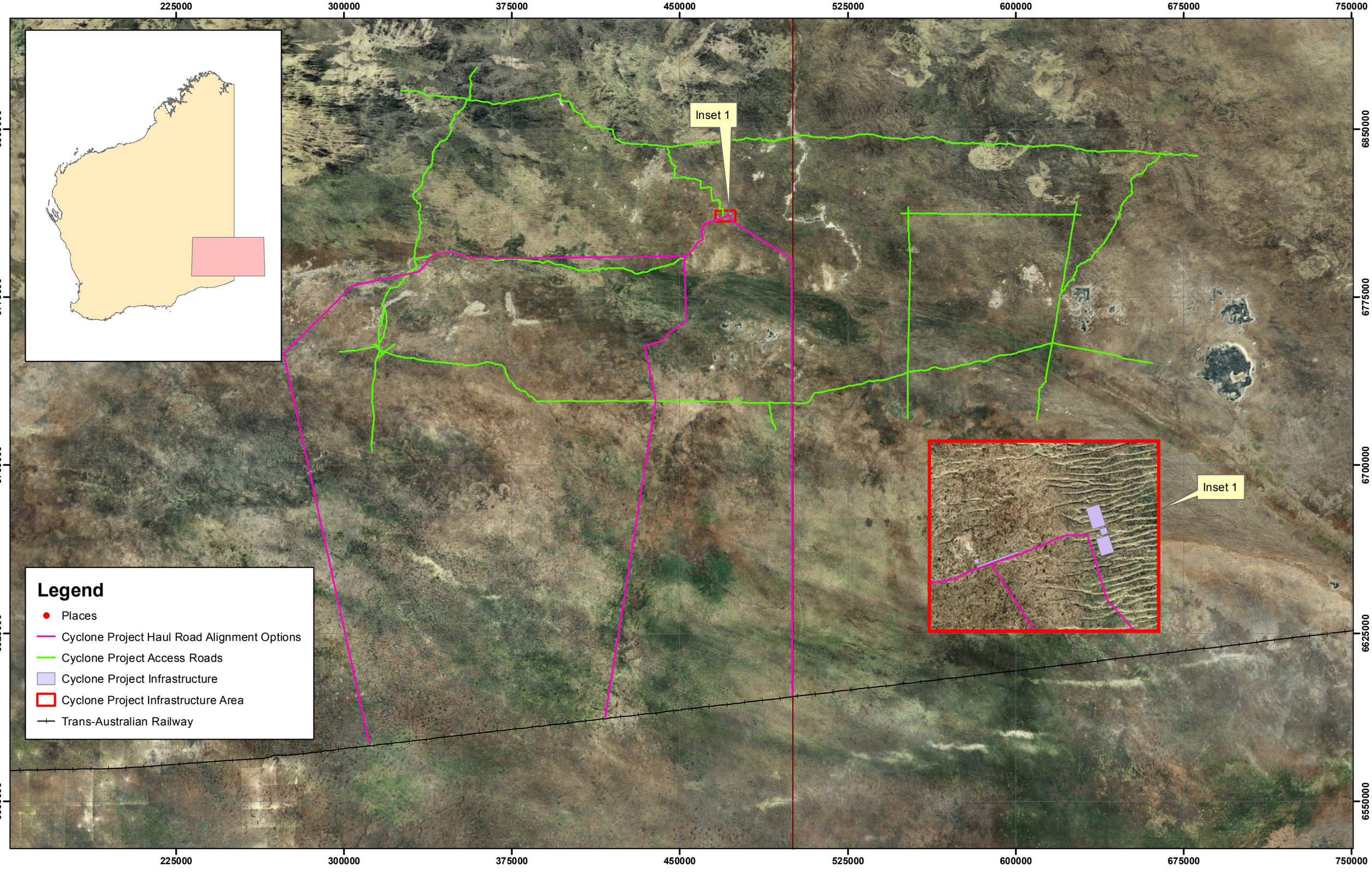

woodmanenvironmentalconsulting	**Cyclone Project Locality Overview** This map should only be used in conjunction with WEC report Sust12-06-01.	Author: David Coultas	Filename:Sust12-06-01-f01.mxd	Scale: 1:1,500,000 (A3)	**Figure** 1
		WEC Ref: Sust12-06-01	Revision: A - July 2012	Grid: GDA94 MGA Zone 52	

400000 450000 500000 550000

6800000 6750000 6700000 6650000 6600000

3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 3.10 3.11 3.12 3.13 3.14

Legend

- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Vegetation Types Overview
Eastern Corridor

Revision: A - July 2012

Author: David Coultas

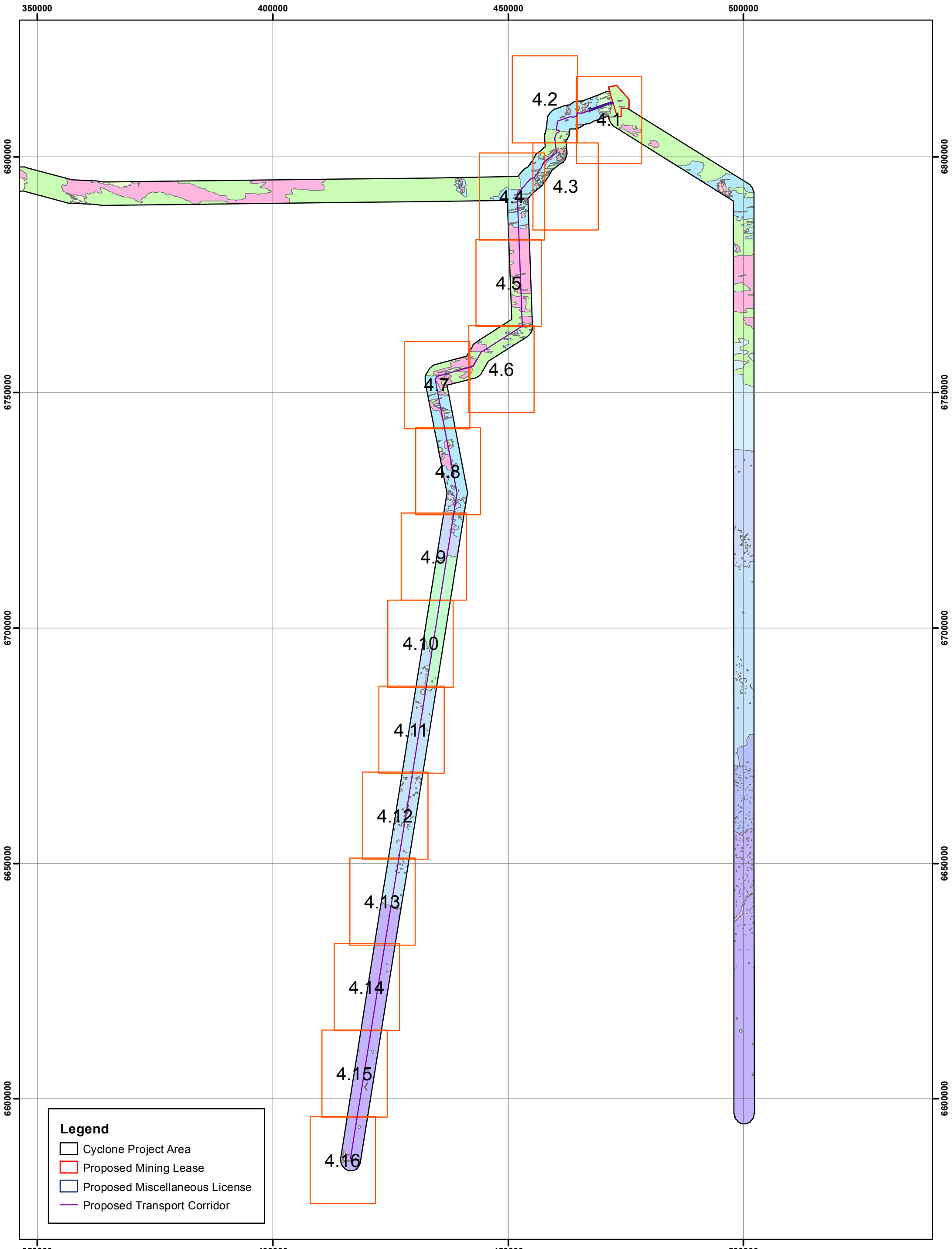
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f02-1.mxd

Scale: 1:700,000 (A3) Grid: MGA Zone 52

Figure

2.1



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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Vegetation Types Overview
Central Corridor

Revision: A - July 2012

Author: David Coultas

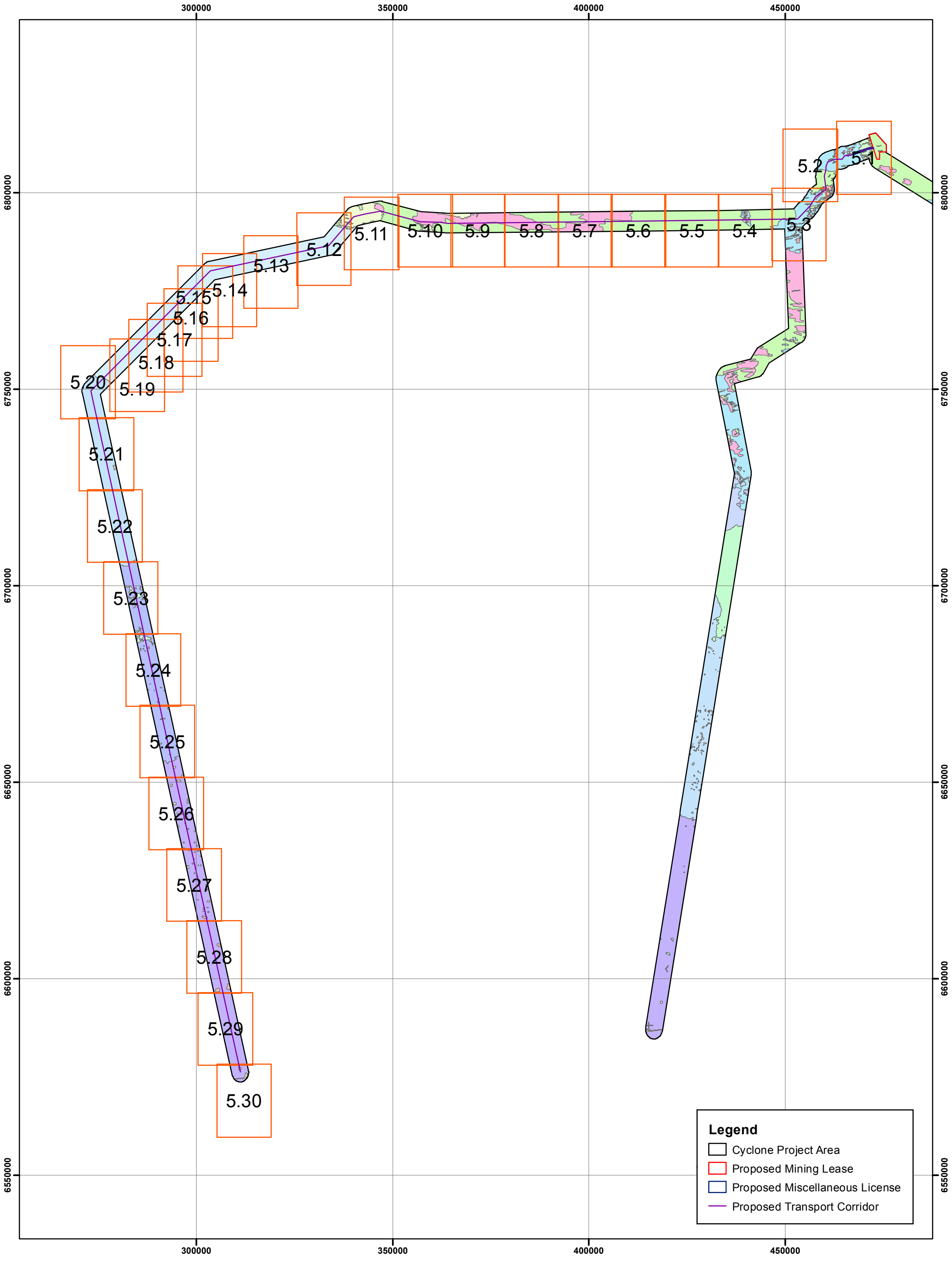
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f02-2.mxd

Scale: 1:700,000 (A3) Grid: MGA Zone 52

Figure

2.2



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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Vegetation Types Overview
Western Corridor

Revision: A - July 2012

Author: David Coultas

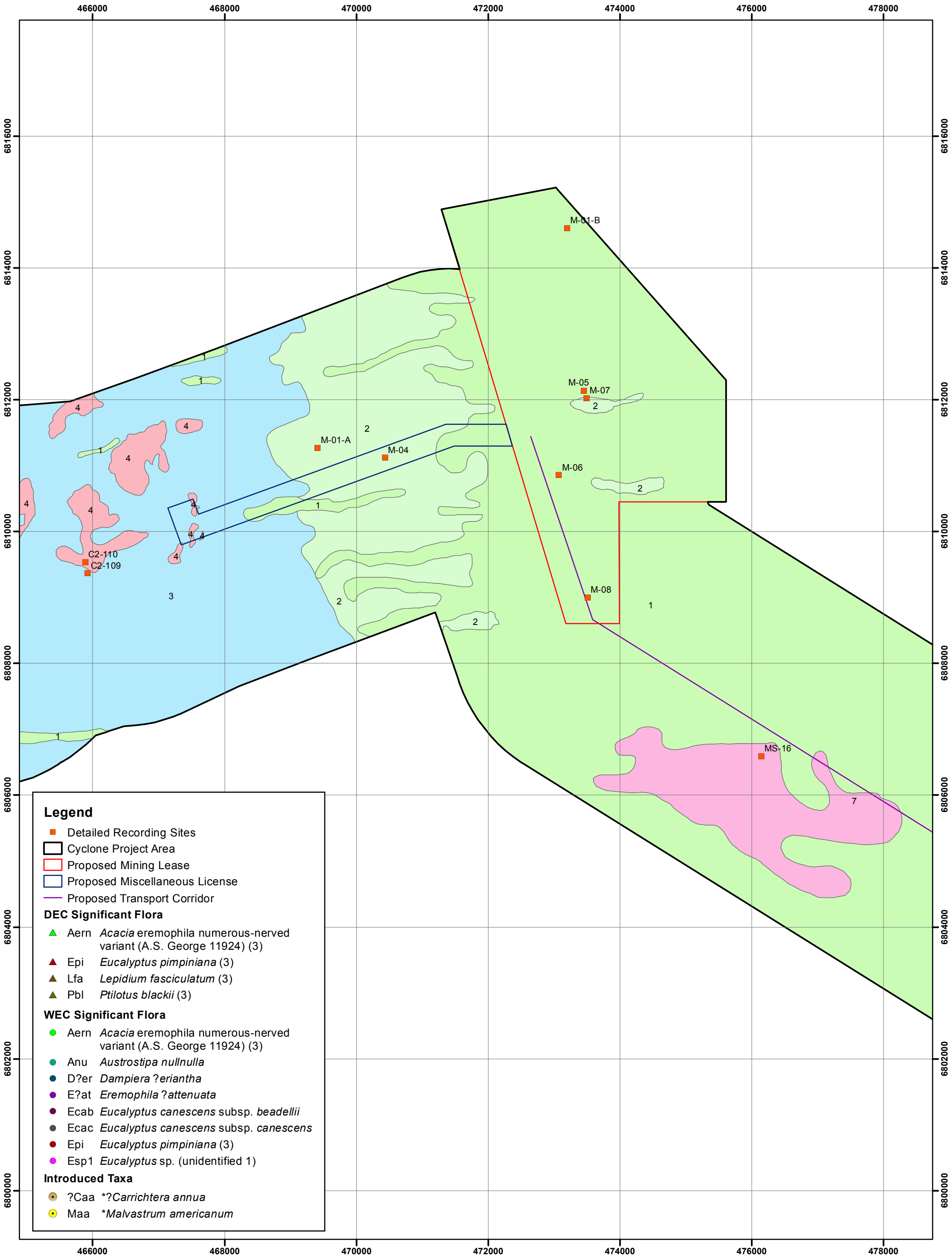
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f02-3.mxd

Scale: 1:1,000,000 (A3) Grid: MGA Zone 52

Figure

2.3



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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.1

480000 482000 484000 486000 488000 490000 492000

6810000 6808000 6806000 6804000 6802000 6800000 6798000 6796000 6794000

MS-15

7

1

MS-14

3

1

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
- Epi *Eucalyptus pimpiniana* (3)
- Lfa *Lepidium fasciculatum* (3)
- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
- Anu *Austrostipa nullnulla*
- D?er *Dampiera ?eriantha*
- E?at *Eremophila ?attenuata*
- Ecab *Eucalyptus canescens* subsp. *beadellii*
- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa **?Carrichtera annua*
- Maa **Malvastrum americanum*

480000 482000 484000 486000 488000 490000 492000

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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Revision: A - July 2012

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.2

494000 496000 498000 500000 502000 504000 506000

6800000 6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000

MS-13
MS-12
C1-62
C1-61
C1-60
C1-07
C1-V
C1-W
C1-53
C1-52

1 3 4 5b

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Ecab *Eucalyptus canescens* subsp. *beadellii*
- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

494000 496000 498000 500000 502000 504000 506000

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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.3

494000 496000 498000 500000 502000 504000 506000

6782000 6780000 6778000 6776000 6774000 6772000 6770000 6768000 6766000

3
1
3
7
C1-51Aern
C1-12
1
7
1
1
Epi
1
7

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

494000 496000 498000 500000 502000 504000 506000

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Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

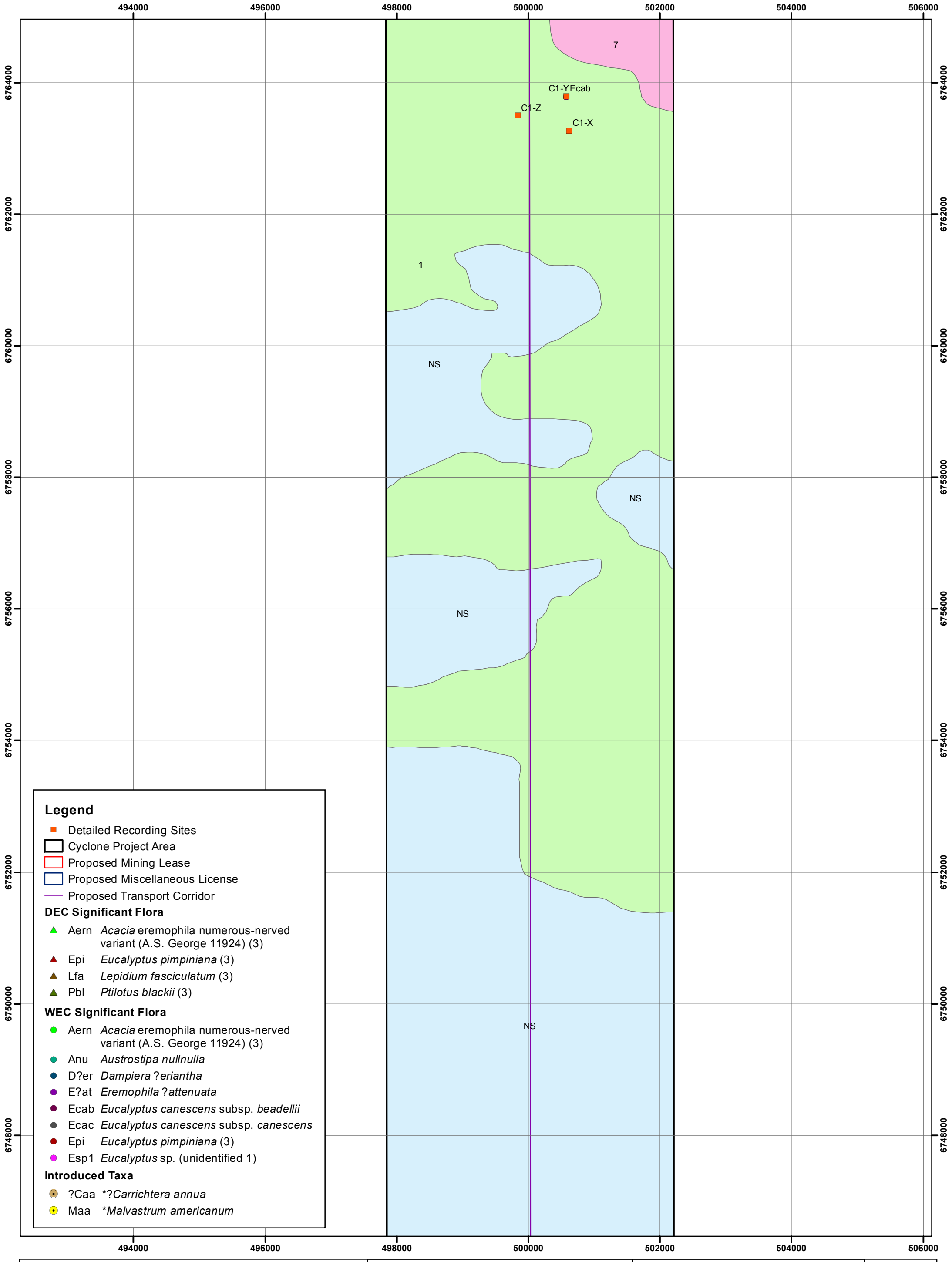
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.4



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Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.5

494000 496000 498000 500000 502000 504000 506000

6746000 6744000 6742000 6740000 6738000 6736000 6734000 6732000 6730000

NS

Maa
10g
C1-50
C1-23
10g
10g
10g
15

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Lfa *Lepidium fasciculatum* (3)
- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

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- E?at *Eremophila ?attenuata*
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- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

494000 496000 498000 500000 502000 504000 506000

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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Author: David Coultas
WEC Ref: Sust12-06-01
Filename: Sust12-06-01-f03.mxd
Revision: A - July 2012
Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure
3.6

494000 496000 498000 500000 502000 504000 506000

6728000 6726000 6724000 6722000 6720000 6718000 6716000 6714000 6712000

15

10f C1-54 11/12

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Lfa *Lepidium fasciculatum* (3)
- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

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- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

494000 496000 498000 500000 502000 504000 506000

woodmanenvironmentalconsulting

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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

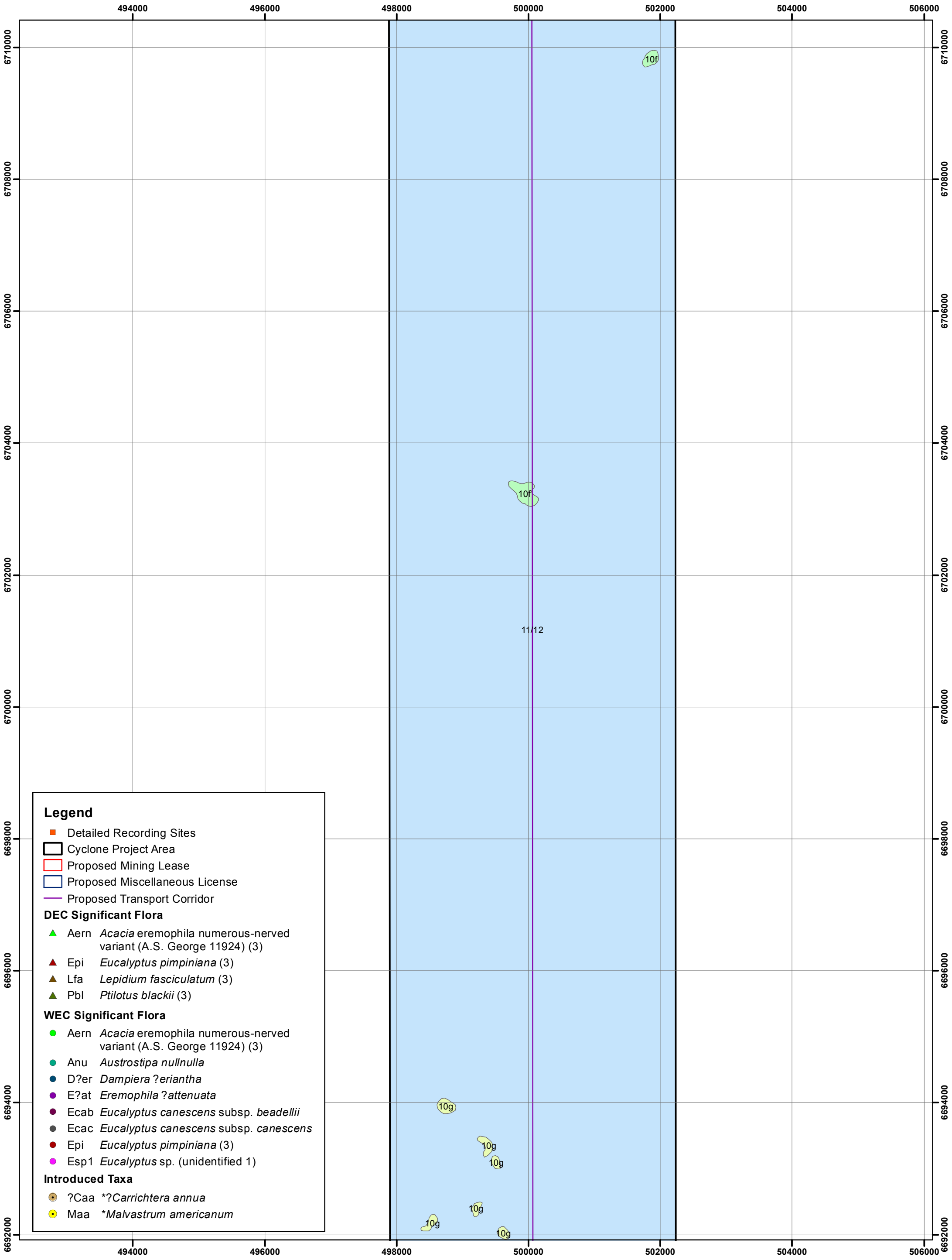
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.7



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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

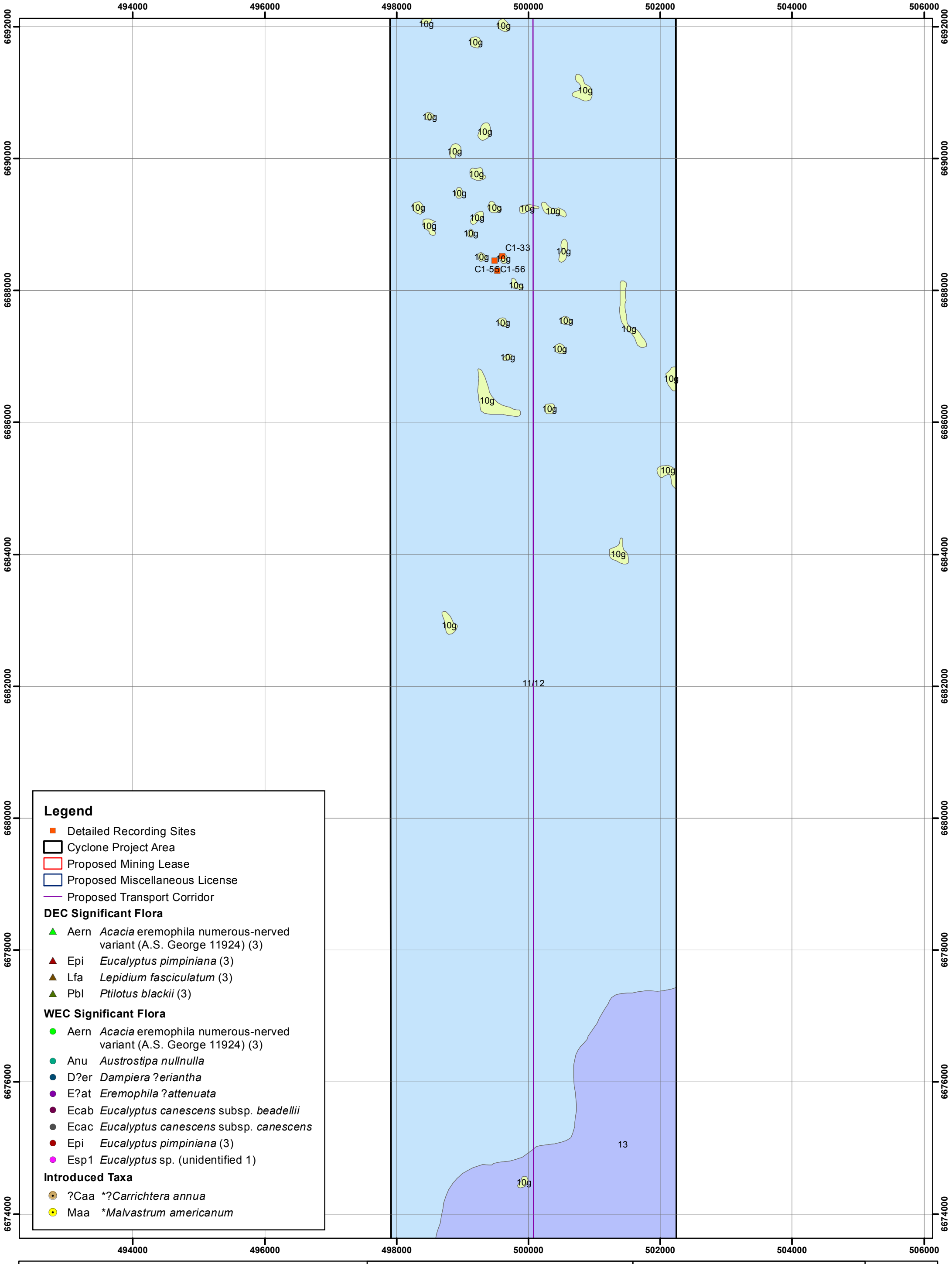
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.8



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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.9

494000 496000 498000 500000 502000 504000 506000

6672000 6670000 6668000 6666000 6664000 6662000 6660000 6658000 6656000

10g 11/12 10c 13 ?Caa C1-40 C1-57

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

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- D?er *Dampiera ?eriantha*
- E?at *Eremophila ?attenuata*
- Ecab *Eucalyptus canescens* subsp. *beadellii*
- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

N

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This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.10

494000 496000 498000 500000 502000 504000 506000

6654000 6652000 6650000 6648000 6646000 6644000 6642000 6640000 6638000

MS-01

C1-41

13/14

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
- Epi *Eucalyptus pimpiniana* (3)
- Lfa *Lepidium fasciculatum* (3)
- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
- Anu *Austrostipa nullnulla*
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Introduced Taxa

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Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Author: David Coultas

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Filename: Sust12-06-01-f03.mxd

Revision: A - July 2012

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.11

494000 496000 498000 500000 502000 504000 506000

6636000 6634000 6632000 6630000 6628000 6626000 6624000 6622000 6620000

10c 13/14

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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Introduced Taxa

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Author: David Coultas

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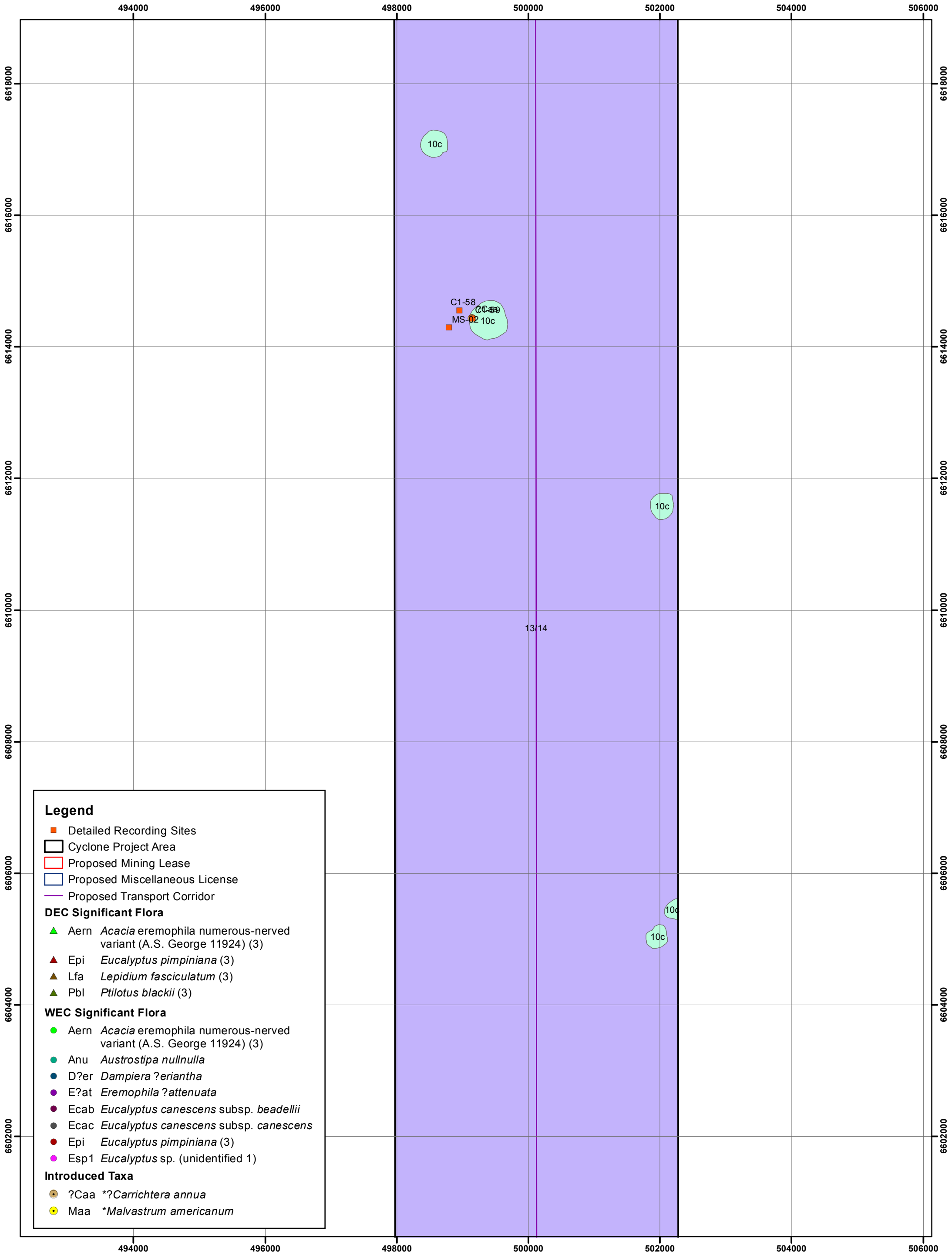
Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.12



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Cyclone Project Area
Eastern Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

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Filename: Sust12-06-01-f03.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.13

494000 496000 498000 500000 502000 504000 506000

6600000 6598000 6596000 6594000 6592000 6590000 6588000 6586000 6584000

13/14

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

3.14

466000 468000 470000 472000 474000 476000 478000

6816000 6814000 6812000 6810000 6808000 6806000 6804000 6802000 6800000

M-01-B
M-05
M-07
M-01-A
M-04
M-06
M-08
C2-110
C2-109
MS-16

1 2 3 4 7

Legend

- Detailed Recording Sites
- Cyclone Project Area
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- Proposed Miscellaneous License
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DEC Significant Flora

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- Epi *Eucalyptus pimpiniana* (3)
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Cyclone Project Area
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Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f04.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.1

452000 454000 456000 458000 460000 462000 464000

6820000 6818000 6816000 6814000 6812000 6810000 6808000 6806000 6804000

Legend

- Detailed Recording Sites
- Cyclone Project Area
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DEC Significant Flora

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Introduced Taxa

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- Maa *Malvastrum americanum*

C3-Z

1 3 4

452000 454000 456000 458000 460000 462000 464000

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Cyclone Project Area
Central Haul Road Alignment Option
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Revision: A - July 2012

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Filename: Sust12-06-01-f04.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.2

456000 458000 460000 462000 464000 466000 468000

6802000 6800000 6798000 6796000 6794000 6792000 6790000 6788000 6786000

C2-108
C3-W
C3-V
C3-X
C3-Y
C2-107
MS-17
C3-T
Anu
C3-U

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

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Cyclone Project Area
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Author: David Coultas
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure
4.3

444000 446000 448000 450000 452000 454000 456000

6800000 6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000

MS-17 C3-T Anu C3-U C3-S3 C3-R C3-Q C2-12 C2-615a Esp1 C2-62 C2-63 C2-106 C2-64 D?er C2-105 C2-13Ecab Epi

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
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DEC Significant Flora

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Figure

4.4

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Central Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

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WEC Ref: Sust12-06-01

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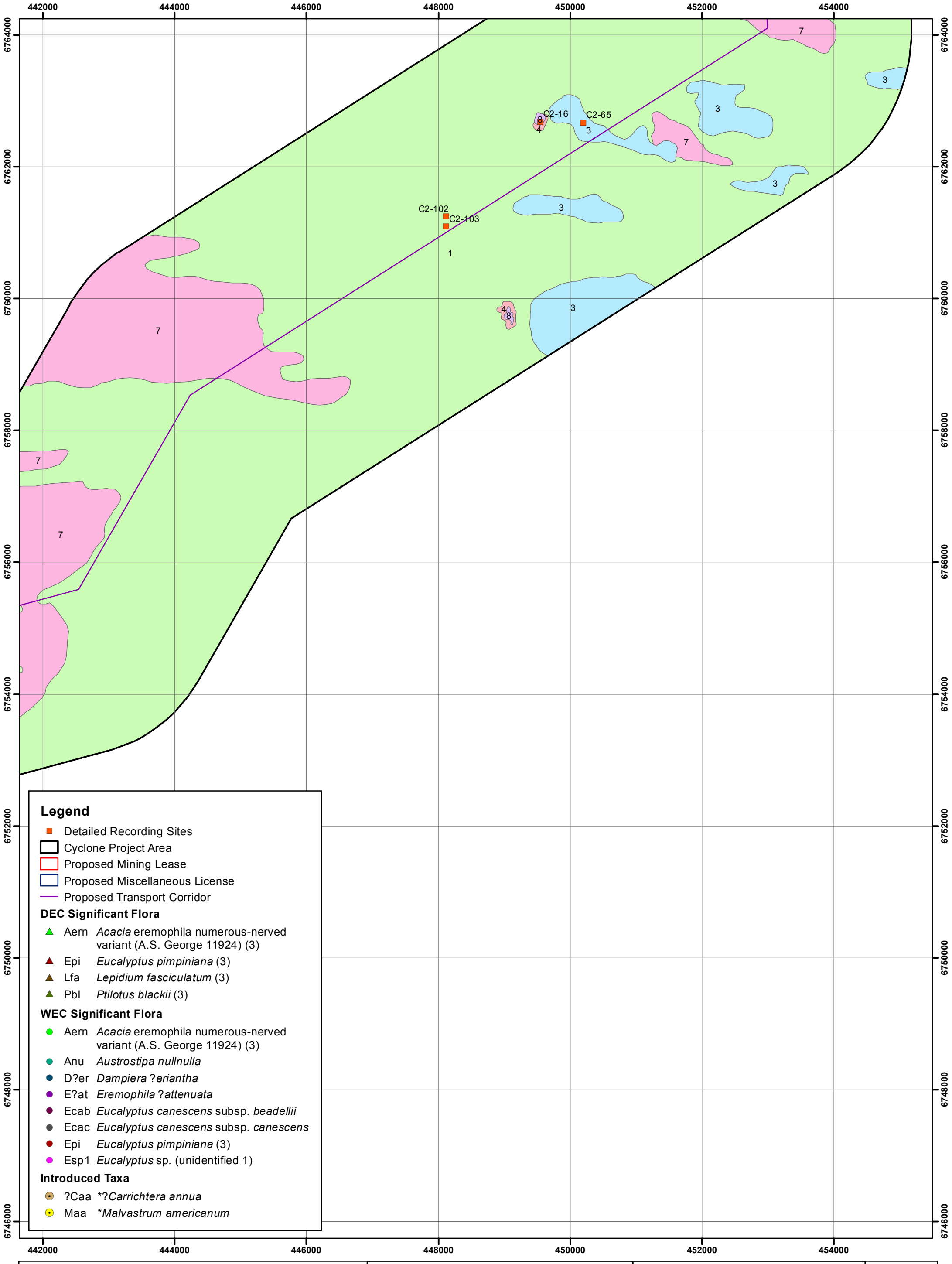
Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.5



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Cyclone Project Area
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Vegetation Types, Conservation Significant Flora and Introduced Flora

Author: David Coultas

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Filename: Sust12-06-01-f04.mxd

Revision: A - July 2012

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.6

428000 430000 432000 434000 436000 438000 440000

6760000 6758000 6756000 6754000 6752000 6750000 6748000 6746000 6744000

1 1 C2-20 C2-20a 3 C2-18 3 1 1 C2-19a C2-19 1 7 1 1 1 1 3 1 7 1 C2-21

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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WEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

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428000 430000 432000 434000 436000 438000 440000

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Cyclone Project Area
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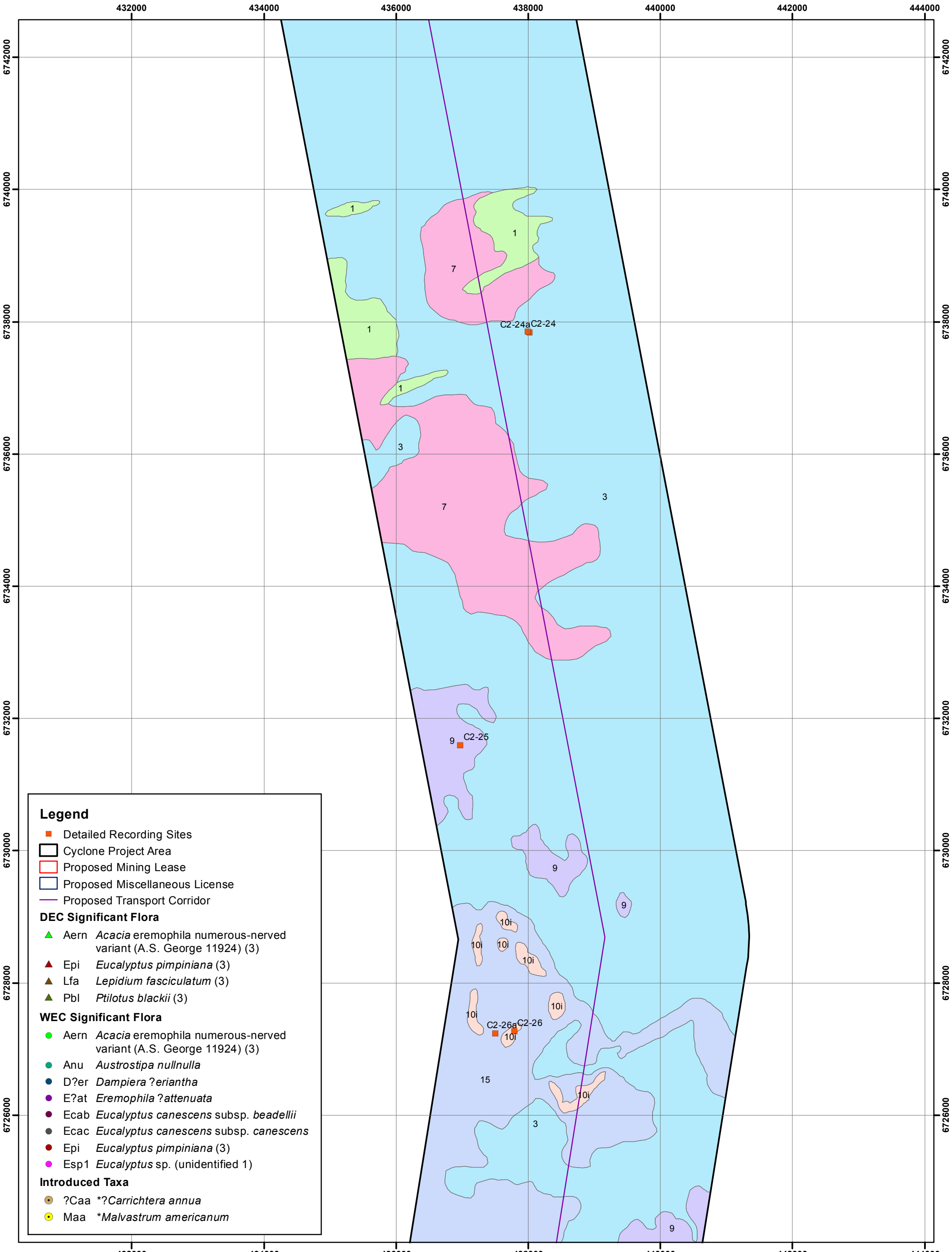
Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.7



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Cyclone Project Area
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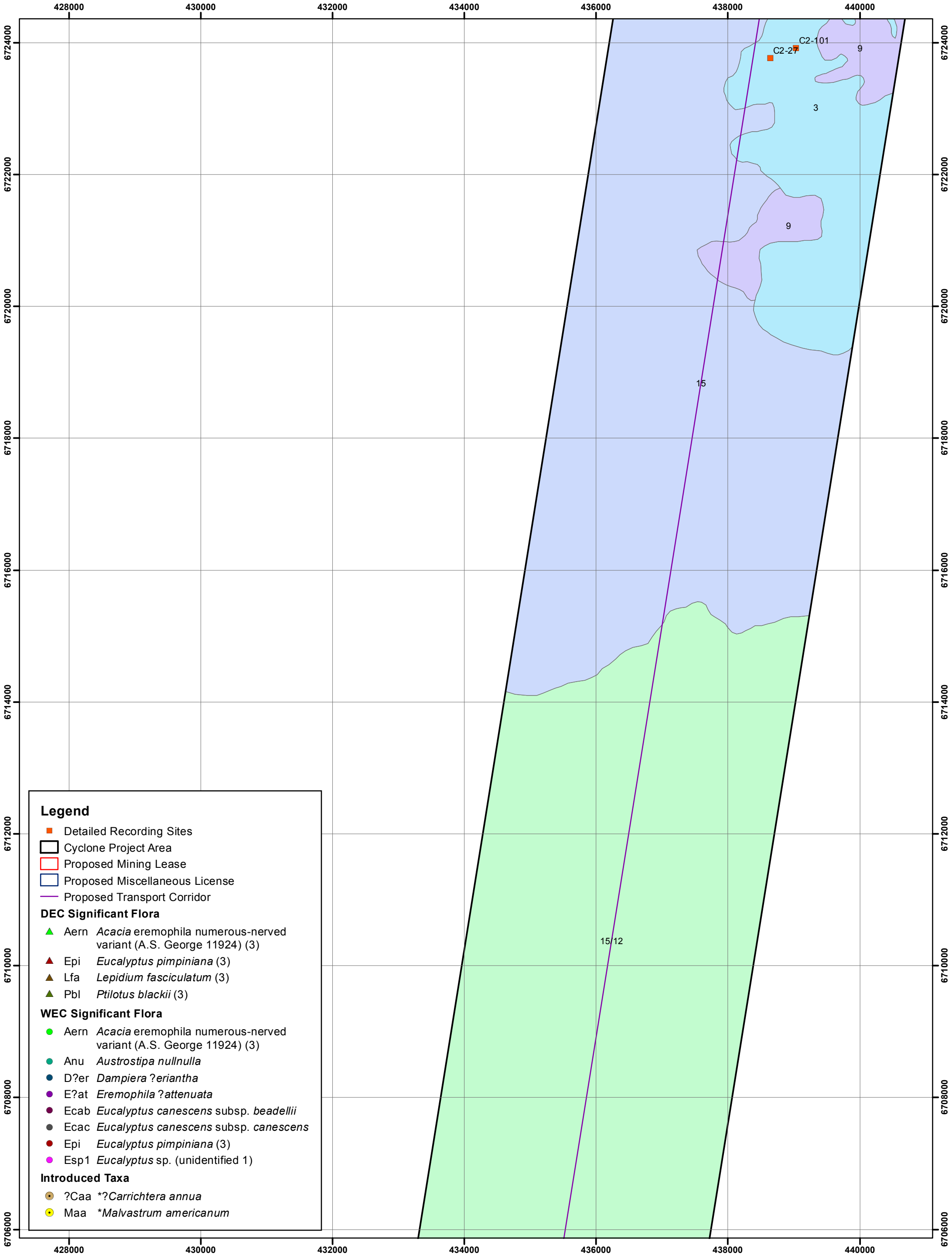
Figure

4.8



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Cyclone Project Area
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.9

426000 428000 430000 432000 434000 436000 438000

6704000 6702000 6700000 6698000 6696000 6694000 6692000 6690000 6688000

15/12

10b

11/12

10b

10b

C2-32

10b

10b

10b

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Miscellaneous License
- Proposed Transport Corridor

DEC Significant Flora

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WEC Significant Flora

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Introduced Taxa

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Filename: Sust12-06-01-f04.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.10

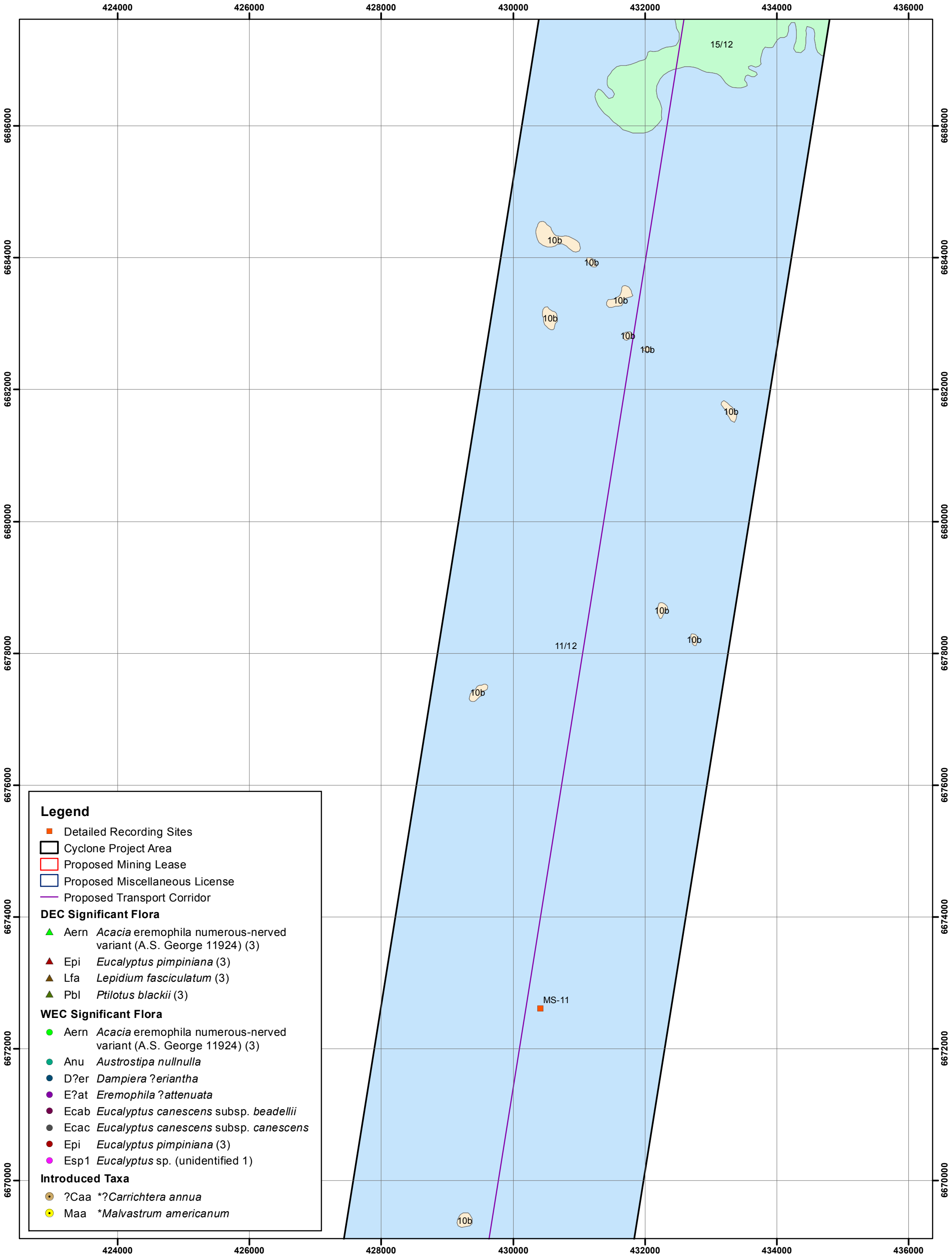

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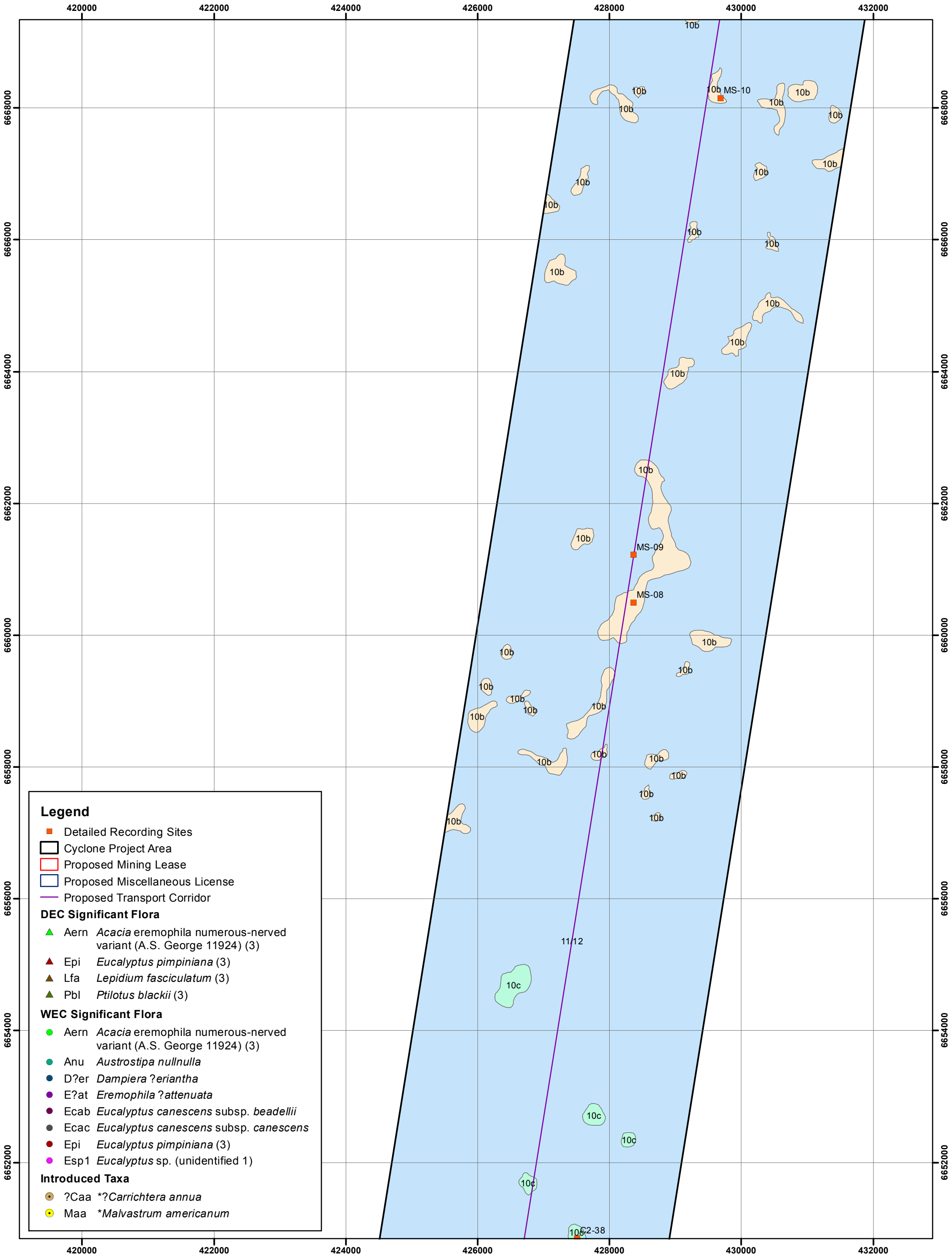
Figure

4.11



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Cyclone Project Area
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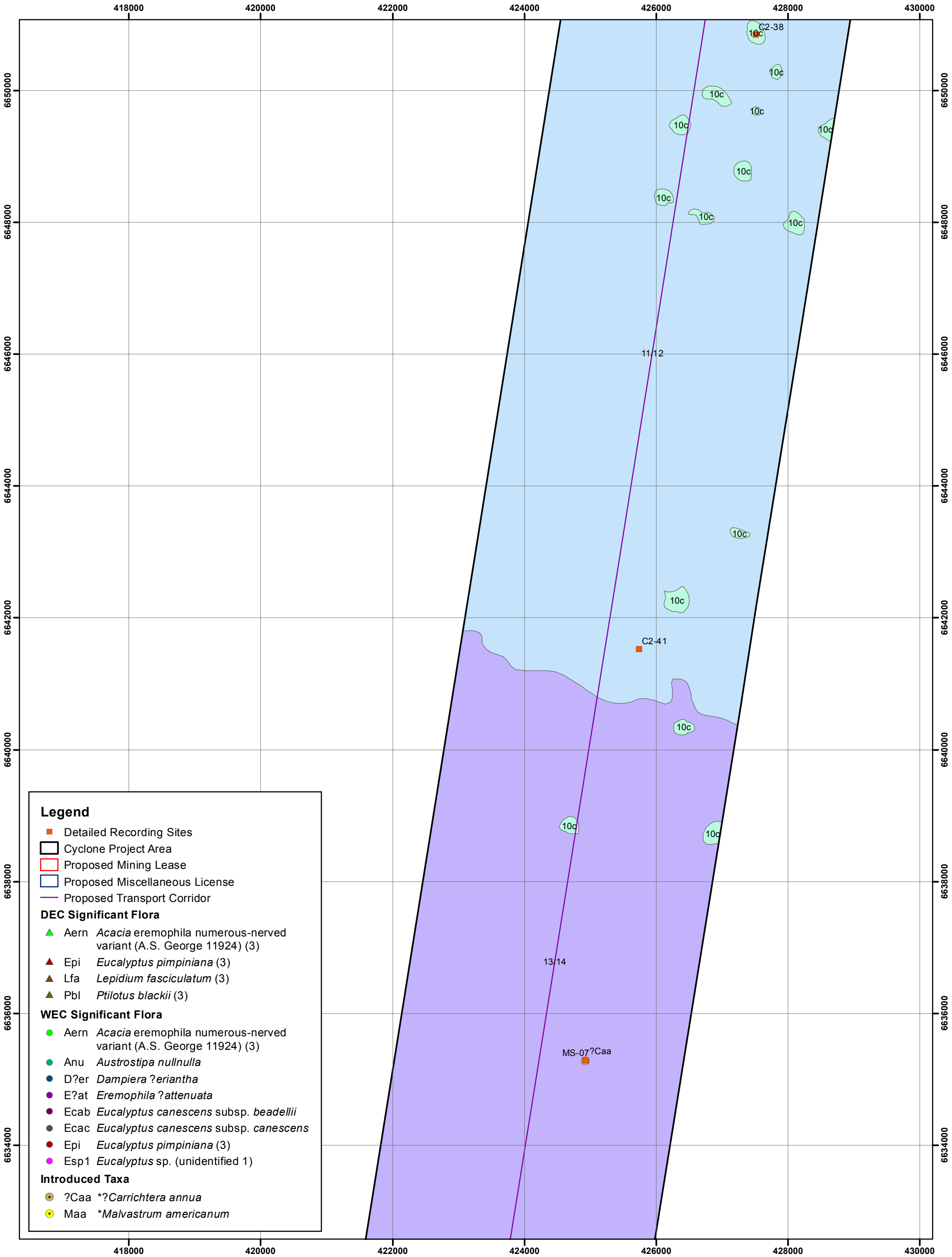
Figure

4.12



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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.13

414000 416000 418000 420000 422000 424000 426000

6632000 6630000 6628000 6626000 6624000 6622000 6620000 6618000 6616000

10d

MS-06

10d

13/14

Legend

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DEC Significant Flora

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WEC Ref: Sust12-06-01

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Figure

4.14

412000 414000 416000 418000 420000 422000 424000

6614000 6612000 6610000 6608000 6606000 6604000 6602000 6600000 6598000

10c
10c
10c
13/14
MS-05 ?Caa
10e

Legend

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DEC Significant Flora

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- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

Introduced Taxa

- ?Caa *?Carrichtera annua*
- Maa *Malvastrum americanum*

412000 414000 416000 418000 420000 422000 424000

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N

This map should only be used in conjunction with WEC report Sust12-06-01.

Cyclone Project Area
Central Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

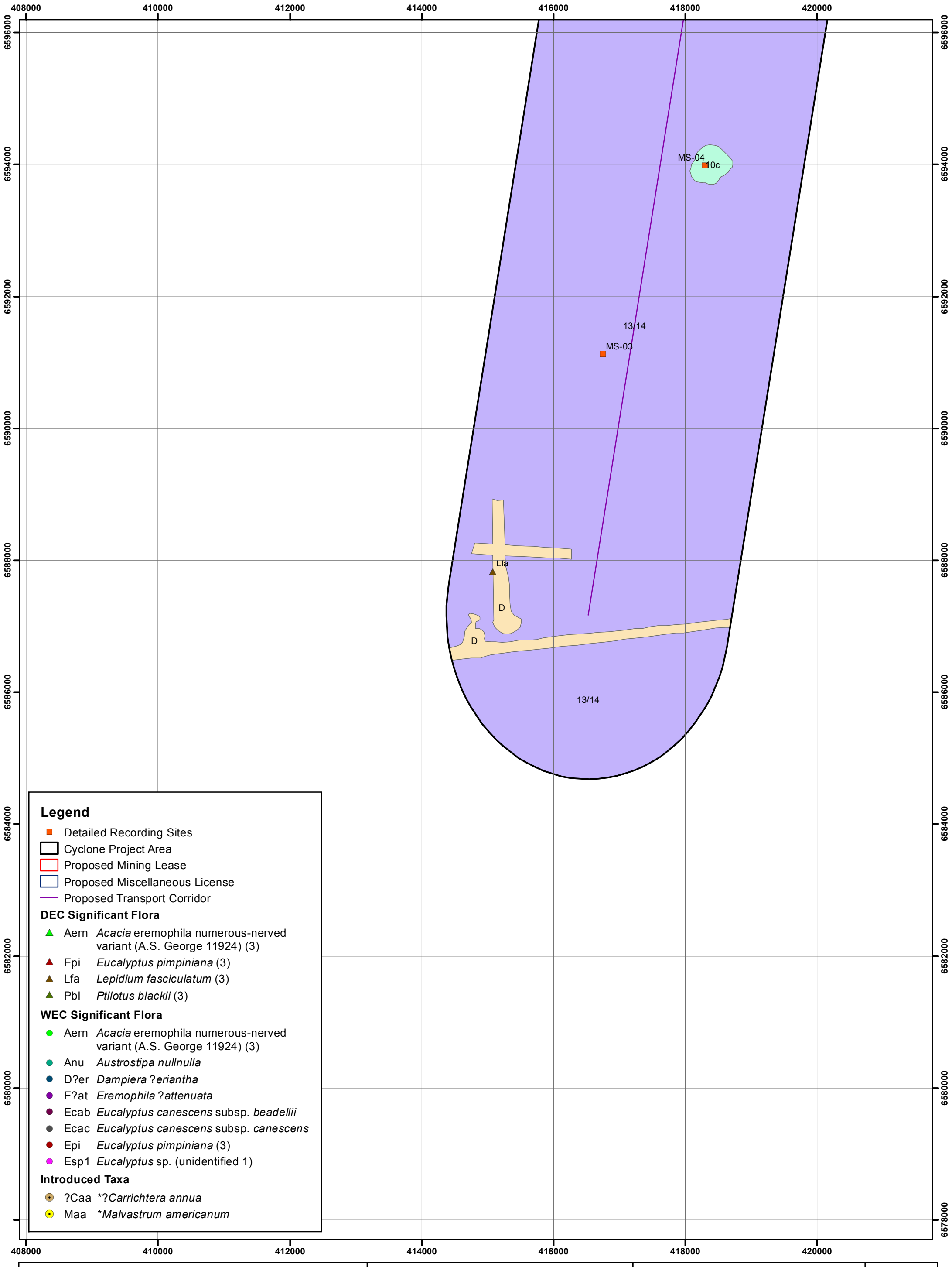
WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f04.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.15



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Cyclone Project Area
Central Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f04.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

4.16

464000 466000 468000 470000 472000 474000 476000

6818000 6816000 6814000 6812000 6810000 6808000 6806000 6804000 6802000 6800000

M-01-B
M-05
M-07
M-01-A
M-04
M-06
M-08
C2-110
C2-109
MS-16

1 2 3 4 7

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
- Epi *Eucalyptus pimpiniana* (3)
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- Pbl *Ptilotus blackii* (3)

WEC Significant Flora

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- E?at *Eremophila ?attenuata*
- Ecab *Eucalyptus canescens* subsp. *beadellii*
- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

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Cyclone Project Area
Western Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f05.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.1

450000 452000 454000 456000 458000 460000 462000

6816000 6814000 6812000 6810000 6808000 6806000 6804000 6802000 6800000 6798000

C3-Z C2-108 C3-W C3-V C3-X4 C3-Y C2-107

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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Cyclone Project Area
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Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.2

448000 450000 452000 454000 456000 458000 460000

6800000 6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000

C3-W C3-V C3-X C3-Y C2-107 MS-17 C3-T C3-S C3-R C3-Q C2-12 C2-615a C2-62 C2-63 C2-106 C2-64 D?er C2-105 Anu C3-U Esp1 Epi

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
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DEC Significant Flora

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.3

434000 436000 438000 440000 442000 444000 446000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

1 3 4 5a 6

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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- Esp1 *Eucalyptus* sp. (unidentified 1)

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Cyclone Project Area
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.4

420000 422000 424000 426000 428000 430000 432000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

1

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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- Epi *Eucalyptus pimpiniana* (3)
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420000 422000 424000 426000 428000 430000 432000

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Cyclone Project Area
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.5

406000 408000 410000 412000 414000 416000 418000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

7

1

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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406000 408000 410000 412000 414000 416000 418000

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Cyclone Project Area
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Revision: A - July 2012

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.6

394000 396000 398000 400000 402000 404000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

Epi
1

7

1

Aern

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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394000 396000 398000 400000 402000 404000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.7

380000 382000 384000 386000 388000 390000 392000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

Epi

1

7

C3-OAern

C3-P

1

Legend

- Detailed Recording Sites
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- Proposed Transport Corridor

DEC Significant Flora

- Aern *Acacia* eremophila numerous-nerved variant (A.S. George 11924) (3)
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380000 382000 384000 386000 388000 390000 392000

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Cyclone Project Area
Western Haul Road Alignment Option
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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.8

366000 368000 370000 372000 374000 376000 378000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

16

16

7

C3-N

1

Pbl

Pbl

Legend

- Detailed Recording Sites
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DEC Significant Flora

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366000 368000 370000 372000 374000 376000 378000

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Cyclone Project Area
Western Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

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Filename: Sust12-06-01-f05.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.9

352000 354000 356000 358000 360000 362000 364000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

C3-L

C3-MAern

1

7

16

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16

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Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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352000 354000 356000 358000 360000 362000 364000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.10

338000 340000 342000 344000 346000 348000 350000

6798000 6796000 6794000 6792000 6790000 6788000 6786000 6784000 6782000

1 7 1 C3-JAern C3-I C3-H C3-KD?er 1 C3-G 16 1 1 1 1 1 NS

Legend

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DEC Significant Flora

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338000 340000 342000 344000 346000 348000 350000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.11

326000 328000 330000 332000 334000 336000 338000

6794000 6792000 6790000 6788000 6786000 6784000 6782000 6780000 6778000

1
1
16
1
1
1
NS

Legend

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326000 328000 330000 332000 334000 336000 338000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure
5.12

314000 316000 318000 320000 322000 324000

6788000 6786000 6784000 6782000 6780000 6778000 6776000 6774000 6772000

NS

Legend

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314000 316000 318000 320000 322000 324000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.13

302000 304000 306000 308000 310000 312000 314000

6784000
6782000
6780000
6778000
6776000
6774000
6772000
6770000
6768000

NS

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
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302000 304000 306000 308000 310000 312000 314000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.14

296000 298000 300000 302000 304000 306000 308000

6780000 6778000 6776000 6774000 6772000 6770000 6768000 6766000 6764000

NS

Legend

- Detailed Recording Sites
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- Proposed Mining Lease
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DEC Significant Flora

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296000 298000 300000 302000 304000 306000 308000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.15

292000 294000 296000 298000 300000 302000 304000

6774000 6772000 6770000 6768000 6766000 6764000 6762000 6760000 6758000

NS

Legend

- Detailed Recording Sites
- Cyclone Project Area
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DEC Significant Flora

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- Epi *Eucalyptus pimpiniana* (3)
- Lfa *Lepidium fasciculatum* (3)
- Pbl *Ptilotus blackii* (3)

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- E?at *Eremophila ?attenuata*
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- Ecac *Eucalyptus canescens* subsp. *canescens*
- Epi *Eucalyptus pimpiniana* (3)
- Esp1 *Eucalyptus* sp. (unidentified 1)

292000 294000 296000 298000 300000 302000 304000

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Cyclone Project Area
Western Haul Road Alignment Option
Vegetation Types, Conservation Significant Flora and Introduced Flora

Revision: A - July 2012

Author: David Coultas

WEC Ref: Sust12-06-01

Filename: Sust12-06-01-f05.mxd

Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.16

288000 290000 292000 294000 296000 298000 300000

6770000
6768000
6766000
6764000
6762000
6760000
6758000
6756000
6754000

NS

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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288000 290000 292000 294000 296000 298000 300000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.17

284000 286000 288000 290000 292000 294000 296000

6766000 6764000 6762000 6760000 6758000 6756000 6754000 6752000 6750000

NS

Legend

- Detailed Recording Sites
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284000 286000 288000 290000 292000 294000 296000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.18

280000 282000 284000 286000 288000 290000

6762000 6760000 6758000 6756000 6754000 6752000 6750000 6748000 6746000

NS

11/12

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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280000 282000 284000 286000 288000 290000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.19

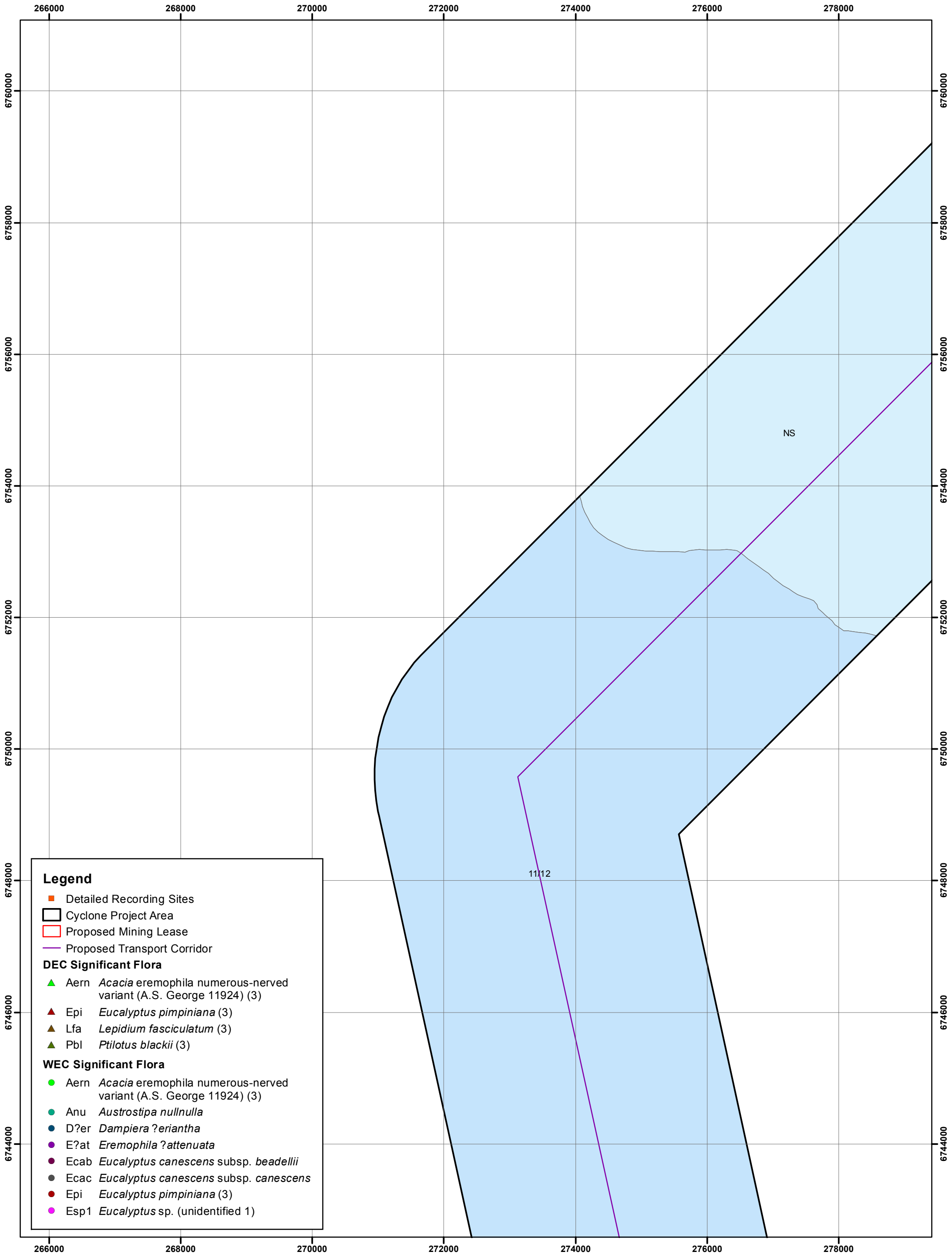

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Figure

5.20

272000 274000 276000 278000 280000 282000 284000

6742000 6740000 6738000 6736000 6734000 6732000 6730000 6728000 6726000

11/12

10b

Legend

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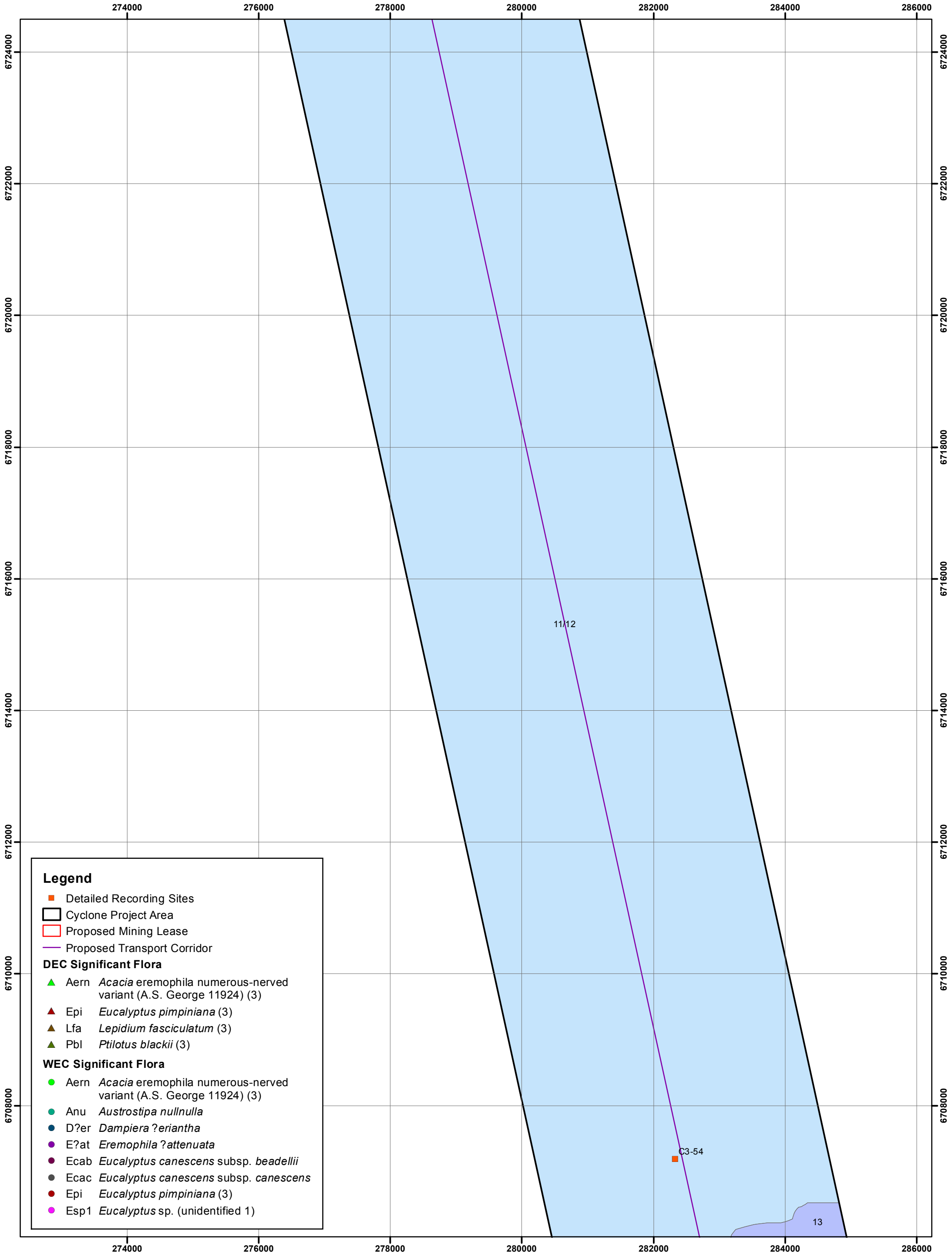
Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.21



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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.22

278000 280000 282000 284000 286000 288000 290000

6706000 6704000 6702000 6700000 6698000 6696000 6694000 6692000 6690000 6688000

11/12
13
11/12
11/12
13
10h
C3-AE?at
10h
10b
10b
10b
10b
10b
10b
13
10h
10h
10h

Legend

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278000 280000 282000 284000 286000 288000 290000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.23

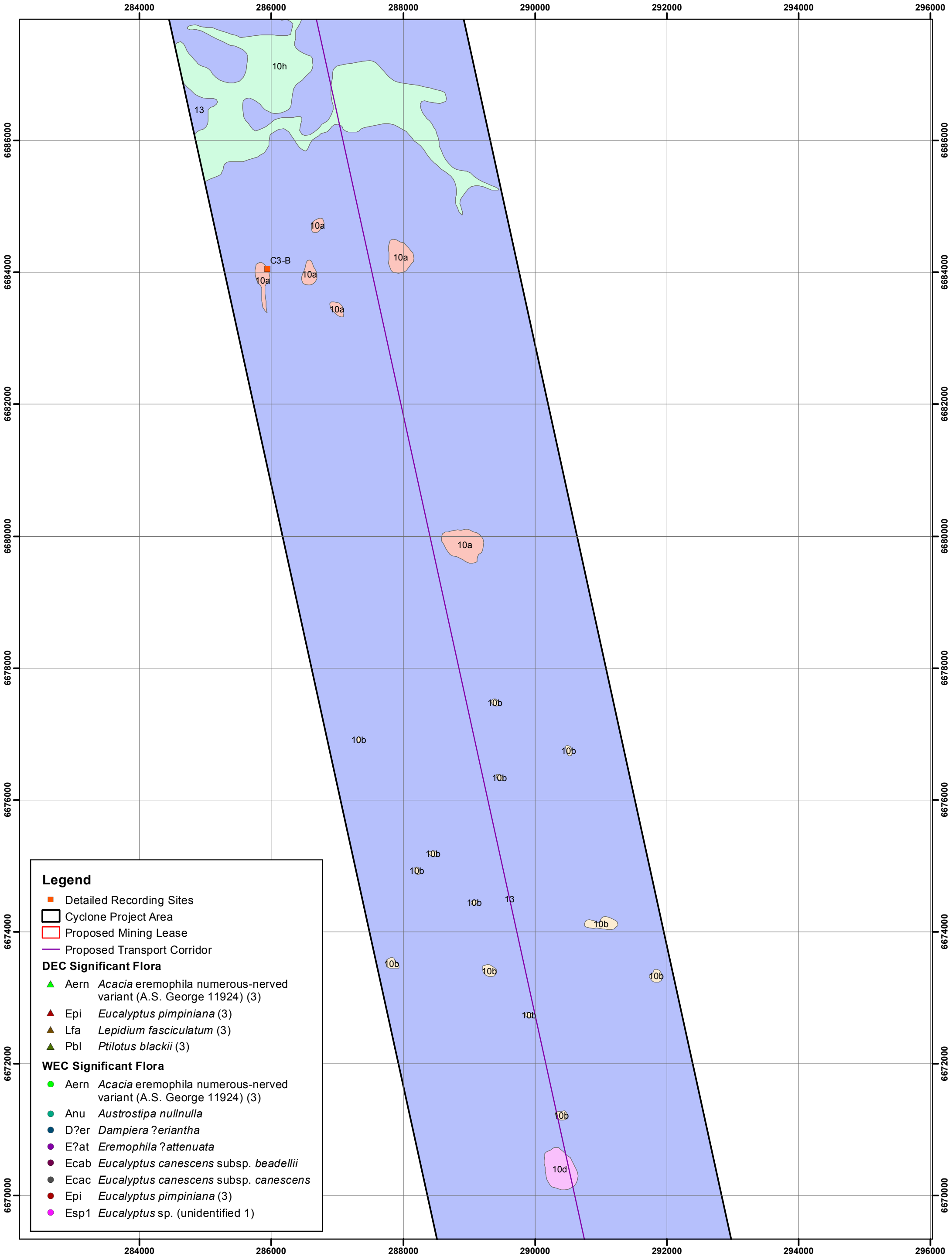

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Figure

5.24

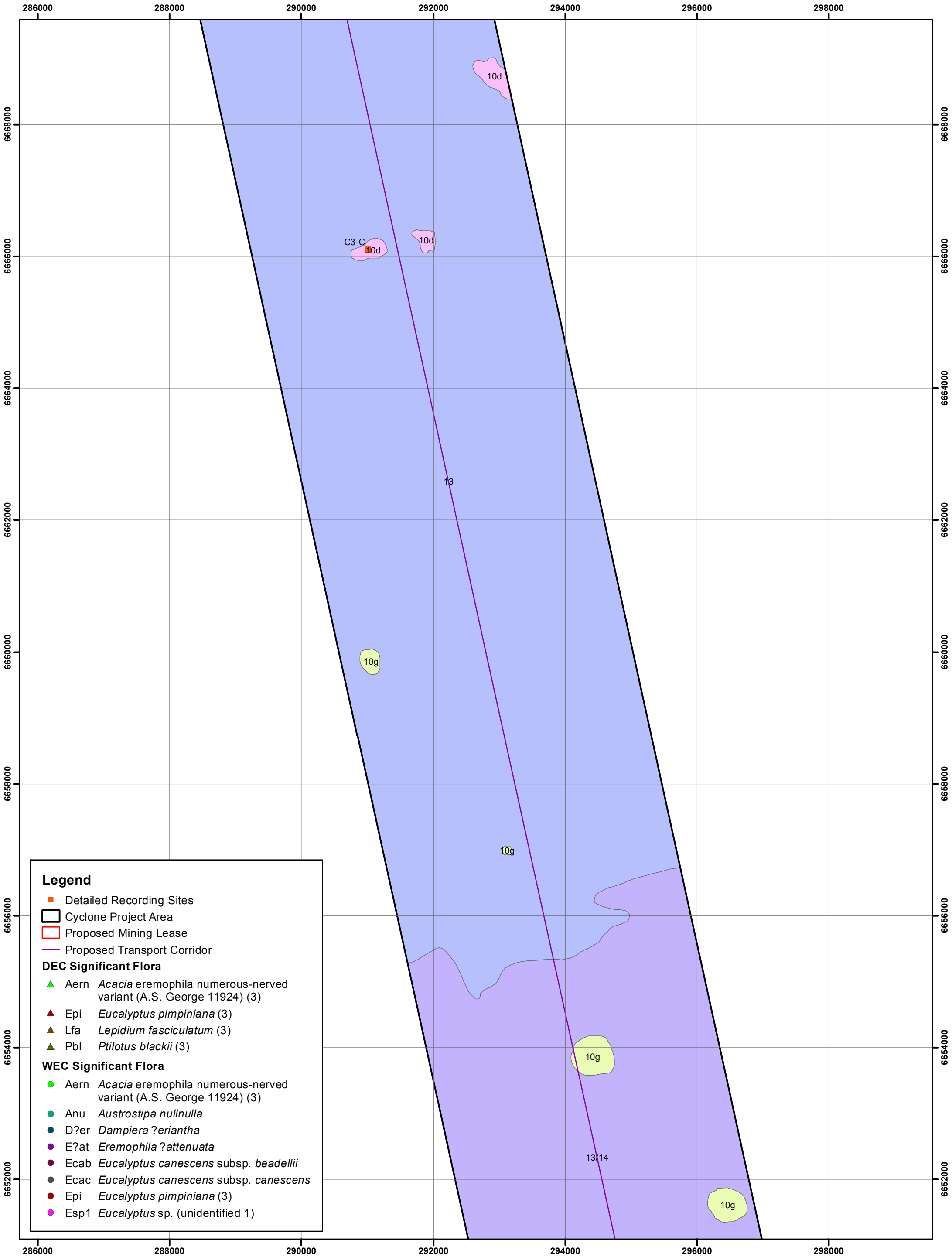

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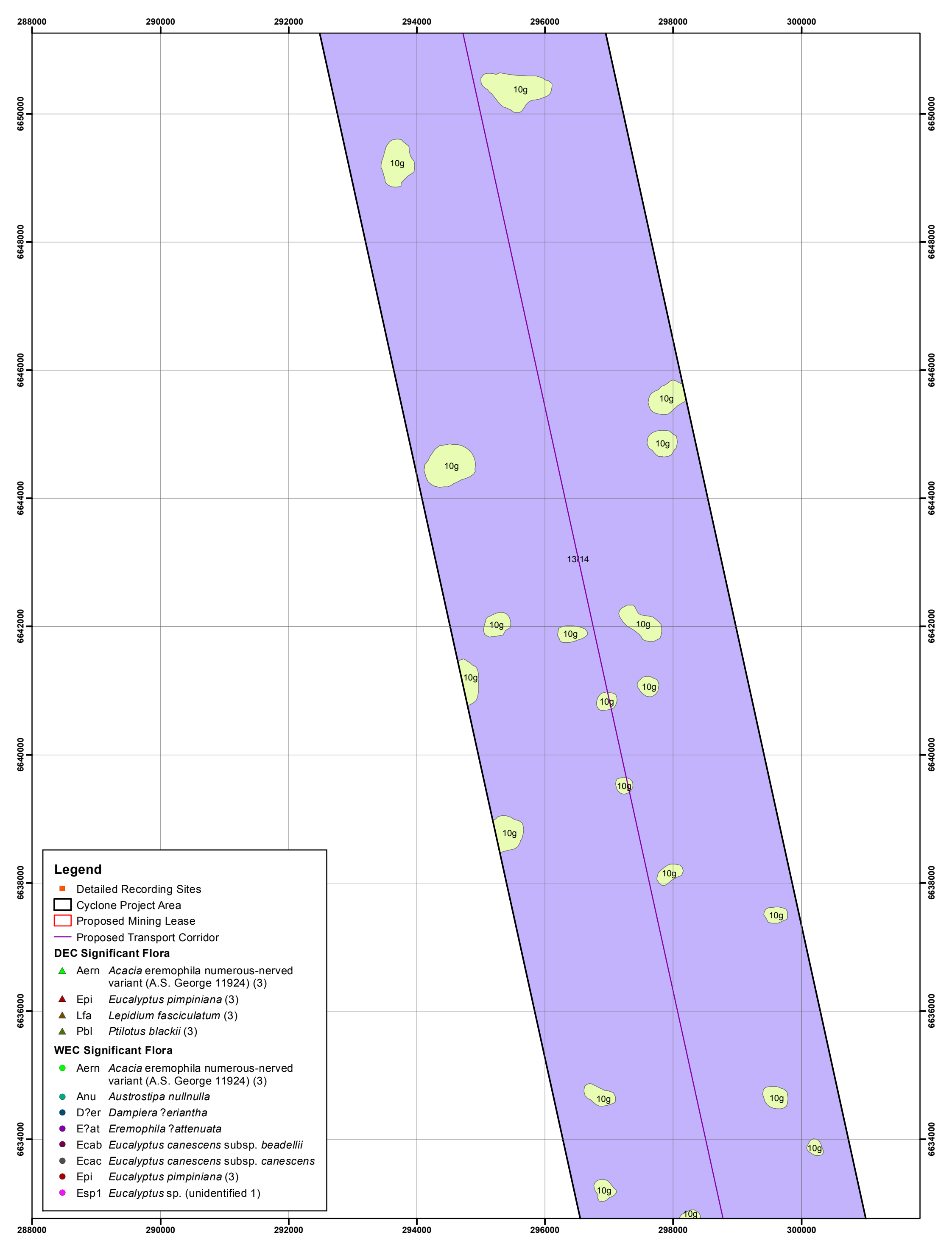
Figure

5.25



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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.26

294000 296000 298000 300000 302000 304000 306000

6632000 6630000 6628000 6626000 6624000 6622000 6620000 6618000 6616000

10g 10g 10g 10g 10g 10g 10g 10g 10g 10g 10g

13/14

10d 10d 10d 10d 10d 10d

C3-D 10a 10a 10a

Legend

- Detailed Recording Sites
- Cyclone Project Area
- Proposed Mining Lease
- Proposed Transport Corridor

DEC Significant Flora

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294000 296000 298000 300000 302000 304000 306000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.27

298000 300000 302000 304000 306000 308000 310000

6614000 6612000 6610000 6608000 6606000 6604000 6602000 6600000 6598000

10a

13/14

10a

10a

Legend

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298000 300000 302000 304000 306000 308000 310000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.28

302000 304000 306000 308000 310000 312000 314000

6596000 6594000 6592000 6590000 6588000 6586000 6584000 6582000 6580000

13/14

C3-E

Legend

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302000 304000 306000 308000 310000 312000 314000

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Scale: 1:50,000 (A3) Grid: MGA Zone 52

Figure

5.29

306000 308000 310000 312000 314000 316000 318000

6578000 6576000 6574000 6572000 6570000 6568000 6566000 6564000 6562000 6560000

10a C3-F

13/14

D

13/14

Legend

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306000 308000 310000 312000 314000 316000 318000

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Figure

5.30

Vegetation Types

1 Mid Woodland to Mid Isolated Trees of *Eucalyptus gongylocarpa* over Mid Mallee Woodland to Mid Isolated Mallee Trees of mixed *Eucalyptus* species dominated by *E. socialis* subsp. *victoriensis* and *E. gypsophila* over Tall Open Shrubland to Mid Open Shrubland of mixed species including *Acacia ligulata, A. ramulosa* var. *linophylla, A. gilesiana, Eremophila latrobei* subsp. *glabra* and *Thryptomene elliottii* with Isolated Trees of *Acacia aneura* and *A. aptaneura* (Mulga) and/or *Casuarina pauper* over Low Hummock Grassland dominated by *Triodia basedowii* or *T. scariosa* on red sandy dunes and swales

2 Low Open Woodland of *Acacia aneura* (Mulga) over Mid Sparse Shrubland of *Eremophila latrobei* subsp. *glabra* and *Senna artemisiodes* subsp. *petiolaris* over Mid Hummock Grassland of *Triodia basedowii* on plains of red clayey sand or sandy loam

3 Mid Woodland to Mid Open Woodland of *Casuarina pauper* and Low Isolated Clumps of Trees of *Acacia caesaneura, A. aptaneura* and *A. aneura* (Mulga) over Tall to Mid Shrubland of mixed species dominated by *Alectryon oleifolius* subsp. *canescens, Eremophila latrobei* subsp. *glabra, E. scoparia, Senna artemesioides* subsp. *petiolaris, Acacia kempeana* and *Acacia oswaldii* over Low Sparse Shrubland of mixed species dominated by *Ptilotus obovatus, Maireana* spp. and *Sclerolaena* spp. over Low Sparse Tussock Grassland to Isolated Clumps of Tussock Grasses dominated by *Aristida ?inaequiglumis* on undulating plains of red sand, sandy-clay loam or clayey sand

4 Low Woodland to Low Open Woodland of *Acacia caesaneura, A. aptaneura* and *A. aneura* (Mulga) with Low Isolated Clumps of Trees of *Casuarina pauper* and/or *Myoporum playtycarpum* subsp. *playtcarpum* over Mid Isolated to Low Isolated Clumps of Shrubs of mixed species including *Senna artemesioides* subsp. *petiolaris* over Low Open Chenopod Shrubland dominated by *Atriplex vesicaria, Rhagodia spinescens* and *Sclerolaena diacantha* over Low Closed Tussock Grassland of *Aristida* spp., *Enneapogon avenaceus* and *Eragrostis laniflora* on flats and depressions of red clay loam

5a Low Open Samphire Shrubland of *Tecticornia indica* subsp. *bidens* and *T. pruinosa* over Low Isolated Clumps of Chenopod Shrubs of mixed species including *Hemichroa diandra* over Low Isolated Clumps of Tussock Grasses of *Eragrostis ?pergracilis* in claypans of red-brown light silty clay

5b Low Chenopod Shrubland of *Atriplex vesicaria* over Low Open Tussock Grassland dominated by *Enneapogon avenaceus* with Low Isolated Trees of *Casuarina pauper* and *Myoporum playtycarpum* subsp. *playtcarpum* in claypans of red clay loam

6 Low Open to Low Sparse Forbland *of Scaevola collaris* and *Goodenia gypsicola* over Low Open Tussock Grassland of *Austrostipa nullnulla* and Low Isolated Chenopod Shrubs including *Rhagodia spinescens* and *Sclerolaena symoniana* with Low Isolated Clumps of Trees of *Casuarina pauper* or *Myoporum playtycarpum* subsp. *playtcarpum* and *Alectryon oleifolius* subsp. *canescens* on gypsum lunettes or calcrete breakaways of pale brown clay or red sandy clay

7 Low Mallee Woodland of mixed *Eucalyptus* spp. dominated by *E. gypsophila* and *E. socialis* subsp. *victoriensis* over Tall Isolated Clumps of Shrubs of mixed species dominated by *Acacia ligulata, A. gilesiana* and *E. paisleyi* subsp. *paisleyi* over Mid Open Shrubland to Mid Isolated Clumps of Shrubs of mixed species including *Eremophila latrobei* subsp. *glabra, Senna artemisioides* subsp. *petiolaris* and *Scaevola spinescens* over Low Closed to Low Open Hummock and Tussock Grassland of *Triodia basedowii* or *T. scariosa* on broad sandplains of red clayey sand or sand

8 Bare claypan (no perennial vegetation present)

9 Low Open Forest of *Acacia aptaneura* (Mulga) over Tall Isolated Clumps of *Acacia tetragonophylla* over Mid Isolated Clumps of *Eremophila latrobei* subsp. *glabra* over Low Open Chenopod Shrubland dominated by *Maireana* spp. over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Open Tussock Grassland of mixed species dominated by *Aristida contorta* on gently undulating plains of red clay loam

10a Mid Isolated Clumps of *Muehlenbeckia florulenta, Senna artemisioides* subsp. *petiolaris* and/or *Eremophila longifolia* over Low Tussock Grassland of *Eragrostis xerophila* or Poaceae species (dead) in dongas of red light clay

10b Mid Isolated Clumps of *Senna artemisioides* subsp. *petiolaris* and Low Isolated Clumps of Shrubs of *Rhagodia spinescens* with Low Isolated Trees of *Acacia aptaneura* (Mulga), *Alectryon oleifolius* subsp. *canescens* and *Pittosporum angustifolium* in dongas of red light clay

10c Mid Woodland of *Acacia aptaneura* (Mulga) and *Grevillea nematophylla* subsp. *supraplana* over Tall Sparse Shrubland to Tall Isolated Shrubs of *Eremophila longifolia, Pittosporum angustifolium, Senna artemisioides* subsp. *x artemisiodes* and/or *Senna artemisioides* subsp. *petiolaris* over Mid Sparse Chenopod Shrubland of *Rhagodia spinescens* or Low Isolated Clumps of Chenopod Shrubs of mixed species over Low Open Forbland of **?Carrichtera annua* or Low Isolated Clumps of Tussock Grass of *Eragrostis xerophila* in dongas of red to pale brown clay loam

10d Low Isolated Clumps of Trees of *Alectryon oleifolius* subsp. *canescens* over Mid Isolated Chenopod Shrubs of *Rhagodia spinescens* over Low Isolated Chenopod Shrubs of mixed species in dongas of red light clay

10e Low Tussock Grassland of *Rytidosperma ?acerosum* and *Enneapogon avenaceus* or *Eragrostis xerophila* with Low Isolated Chenopod Shrubs of *Atriplex acutibractea* subsp. *acutibractea, A. vesicaria* and *Rhagodia spinescens* in drainage channels of red light clay

10f Mid Isolated Clumps of Trees of *Casuarina pauper* over Low Open Woodland of *Alectryon oleifolius* subsp. *canescens* over Tall Isolated Clumps of *Acacia kempeana* over Mid Open Shrubland of *Senna artemisioides* subsp. *petiolaris* and *Senna artemisioides* subsp. *petiolaris* (broad petiole form) over Low Sparse Chenopod Shrubland of *Chenopodium desertorum* subsp. *desertorum* and *Maireana pentatropis* in dongas of red sand

10g Low Open Woodland to Low Isolated Clumps of Trees of *Acacia aptaneura* (Mulga) over Tall Open Shrubland of *Acacia tetragonophylla* and *Eremophila longifolia* over Mid Sparse Shrubland to Mid Isolated Clumps of Chenopod Shrubs of *Rhagodia spinescens* and Mid Isolated Clumps of Shrubs of *Senna artemisioides* subsp. *petiolaris* over Low Isolated Clumps of Tussock Grasses of *Enneapogon* spp. in dongas of red clay loam

10h Low Shrubland of *Eremophila ?attenuata* and Low Open Chenopod Shrubland of *Atriplex nummularia* subsp. *spathulata* in claypans of red light clay

10i Low Isolated Chenopod Shrubs of *Maireana sedifolia* (Bluebush) and *Sclerolaena obliqicuspis* over Low Tussock Grassland of *Enneapogon avenaceus* and *Eragrostis xerophila* with Low Isolated Clumps of Forbs of *Streptoglossa ?adscendens* in dongas of red sandy clay

11 Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush) over Low Tussock Grassland of *Enneapogon cylindricus* on plains of red clay loam

12 Low Woodland of *Acacia papyrocarpa* over Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush), *Sclerolaena uniflora* and *Atriplex vesicaria* over Low Open Tussock Grassland of *Enneapogon cylindricus* and *E. avenaceus* on plains of red clay loam or white/red sandy clay

13 Low Sparse Chenopod Shrubland of *Atriplex acutibractea* subsp. *acutibractea, Maireana sedifolia* (Bluebush) and *Sclerolaena patenticuspis* over Low Tussock Grassland of *Enneapogon cylindricus* and Poaceae sp. (dead) with Mid Isolated Shrubs of *Eremophila longifolia* or *Pittosporum angustifolium* on plains of brown clay loam

14 Low Closed to Low Sparse Chenopod Shrubland of *Atriplex acutibractea* subsp. *acutibractea* and/or *A. vesicaria* and *Maireana ?trichoptera* over Low Sparse Tussock Grassland of Poaceae sp. (dead) with Mid Isolated Shrubs of *Pittosporum angustifolium* on plains of red silty loam or clay loam

15 Low Woodland of *Acacia caesaneura* and *A. pteraneura* (Mulga) to Low Isolated Clumps of Trees of *Acacia aptaneura* (Mulga) and *Casuarina pauper* over Tall Isolated Clumps of Shrubs of *Acacia kempeana* and *A. tetragonophylla* over Mid Isolated Clumps of Shrubs of *Eremophila latrobei* subsp. *glabra* over Low Shrubland of *Ptilotus obovatus* and Low Open Chenopod Shrubland of *Maireana sedifolia* (Bluebush) over Low Open Tussock Grassland of *Eriachne helmsii* and *Enneapogon caerulescens* or *E. cylindricus* on undulating plains of red clay loam

16 Low Woodland of *Acacia aneura, A. pteraneura* (Mulga) and *Casuarina pauper* over Tall Isolated Clumps of Shrubs of *Acacia kempeana* over Mid Isolated Clumps of Shrubs of *Eremophila latrobei* subsp. *glabra, E. longifolia, Senna artemisioides* subsp. x *artemisioides* and *Senna artemisioides* subsp. *petiolaris* over Low Isolated Clumps of Shrubs of *Ptilotus obovatus* over Low Closed to Low Tussock Grassland of *Aristida contorta, A. ?inaequiglumis* and *Eragrostis laniflora* on plains of red clayey sand

Mosaics

11/12 Mosaic of Vegetation Types 11 and 12

13/14 Mosaic of Vegetation Types 13 and 14

15/12 Mosaic of Vegetation Types 15 and 12

Other Mapped Areas

D Disturbed (vegetation partially or completely cleared)

NS Not surveyed (could not be accessed because of cultural heritage restrictions)

woodmanenvironmentalconsulting	**Cyclone Project Area** **Vegetation Types Legend**	Author: David Coultas
		WEC Ref: Sust12-06-01
		Filename: Sust12-06-01-Legend.mxd
This map should only be used in conjunction with WEC report Sust12-06-01.	Revision: A - July 2012	

Appendix A: Cyclone Project Flora and Vegetation Desktop Review (Woodman Environmental 2011)

SUSTAINABILITY PTY LTD

CYCLONE PROJECT

FLORA AND VEGETATION DESKTOP REVIEW

October 2011

woodmanenvironmentalconsulting

A.C.N. 088 055 903

DOCUMENT REVISION HISTORY

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Report Number: Sust11-36

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1. INTRODUCTION

1.1 Description of Project and Project Area

Diatreme Resources Limited ('Diatreme'), through its wholly owned subsidiary Lost Sands Pty Ltd ('Lost Sands'), proposes to develop the Cyclone mineral sands deposit. The Cyclone mineral sands deposit is located approximately 50 km south of Anne Beadell Highway (also known as Serpentine Lakes Road), approximately 25 km west of the South Australian border, near the southern edge of the Great Victoria Desert in Western Australia (Figure 1). The Cyclone Project involves the mining and processing of mineral sands from the Cyclone mineral sands deposit into heavy mineral concentrate on-site, transport of heavy mineral concentrate via a proposed private haul road to the Trans Australian Railway line on the Nullarbor Plain, and rail of the heavy mineral concentrate to Esperance port. The Cyclone mineral sands deposit itself is located on Puapiyala Tjarutja Aboriginal Corporation tribal lands owned by the Pila Nguru (Spinifex) People. The deposit is located just north of the Great Victoria Desert Nature Reserve. Three potential alignment options have been considered for the proposed haul road (Figure 1), with all but one of the options passing through the Great Victoria Desert Nature Reserve.

As part of the Environmental Impact Assessment (EIA) process for the Cyclone Project, Sustainability Pty Ltd, on behalf of Diatreme, commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to conduct a desktop study of known flora and vegetation values of the Cyclone Project area ('Project area').

1.2 Aims

The aims of this report are to provide:

- A desktop review of existing literature (including previous surveys in the vicinity of the Project area) and government databases to develop local and regional context and identify flora and vegetation of significance known from the area; and
- Development of a study design for the flora and vegetation survey of the Project area, in accordance with the requirements of the Environmental Protection Authority (EPA) Guidance Statement No. 51 (EPA 2004) and to the satisfaction of both the Department of Environment and Conservation (DEC) and Diatreme.

1.3 Level of Survey

This desktop study forms the background research/desktop study section of a Level 2 survey as defined by the Environmental Protection Authority's (EPA) Guidance Statement No. 51 (EPA 2004). This level of survey has been determined from Table 2 of Guidance Statement No. 51 (EPA 2004), where the Bioregion Groups are defined as Groups 2 and 4 (Nullarbor and Great Victoria Desert respectively), and the nature of impacts of the Cyclone Project are considered to be 'Moderate to High'. A Level 2 survey consists of a background research/desktop study and a reconnaissance survey, followed by a detailed or comprehensive survey. The purpose of the background

research/desktop study is to review known information on the target area through all sources of literature available (EPA 2004). In the case of the Cyclone Project, it is considered that a comprehensive survey is appropriate. This is discussed further in Section 4. This report addresses the mining area and two eastern haul road options as presented on figure 1. The western haul road option was not included in the current flora and vegetation assessment. However, Diatreme are planning to conduct a full environmental options analysis of all three haul road options in the near future.

2. PHYSICAL ENVIRONMENT

2.1 Climate

The Project area is located within the Great Victoria Desert and Nullarbor Plain regions in the Arid Zone of Western Australia; these regions are classified as desert because of low, erratic rainfall (Beard 1990). The Great Victoria Desert region experiences an arid climate with both summer and winter rainfall, with approximately 200 mm of rainfall annually (Beard 1990). The Nullarbor Plain region experiences an arid non-seasonal climate, with rainfall potentially occurring in any month. It receives approximately 150 – 200 mm of rainfall annually, with the eastern Nullarbor Plain considered to be the driest area in Western Australia, averaging approximately 150 mm of rainfall annually.

Because the Project area is in a largely uninhabited area, there are few meteorological stations in the immediate vicinity. The closest meteorological station is Forrest, near the southern end of the proposed haul road routes. Figure 2 displays average monthly maximum and minimum temperatures, and average monthly rainfall, recorded for Forrest Aerodrome (Bureau of Meteorology 2011a). Temperature data is averaged from data collected from 1946 – 1995, and rainfall data is averaged from data collected from 1930 - 1995. Forrest Aerodrome is now a closed meteorological station; there is an open station at Forrest proper, however data has only been recorded since 1993, and therefore Forrest Aerodrome data is considered more appropriate, as it provides longer-term climatic trends.

The average daily maximum temperatures at Forrest Aerodrome peak in January (32.6 °C), with the lowest average maximum temperatures experienced in July (17.9 °C). Average daily minimum temperatures are also lowest in July, dropping to 5.2 °C. The average annual rainfall for this station is 188.7 mm, with average monthly rainfall totals extremely uniform, varying by only 3.4 mm over the entire year. Interestingly, average annual rainfall recorded at the newer Forrest meteorological station from 1993 – 2011 is much higher, at 251.9 mm (Bureau of Meteorology 2011b).

It is considered that the meteorological station at Warburton, located approximately 300 km north north-west of the Cyclone mineral sands deposit, potentially better reflects climatic patterns of this particular part of the Project area. Warburton average daily maximum temperatures also peak in January (38.0 °C), with the lowest average maximum temperatures also experienced in July (20.7 °C) (Bureau of Meteorology 2011c). Average daily minimum temperatures are also lowest in July, dropping to 5.8 °C. The average annual rainfall for this station is 246.5 mm. Average monthly rainfall peaks in summer, with February averaging 36.1 mm, the highest monthly average (Bureau of Meteorology 2011c). Rainfall at Warburton is likely to be influenced by

tropical cyclones and tropical low pressure systems, which generally form between December and April; this influence may be more pronounced than at the Project area.

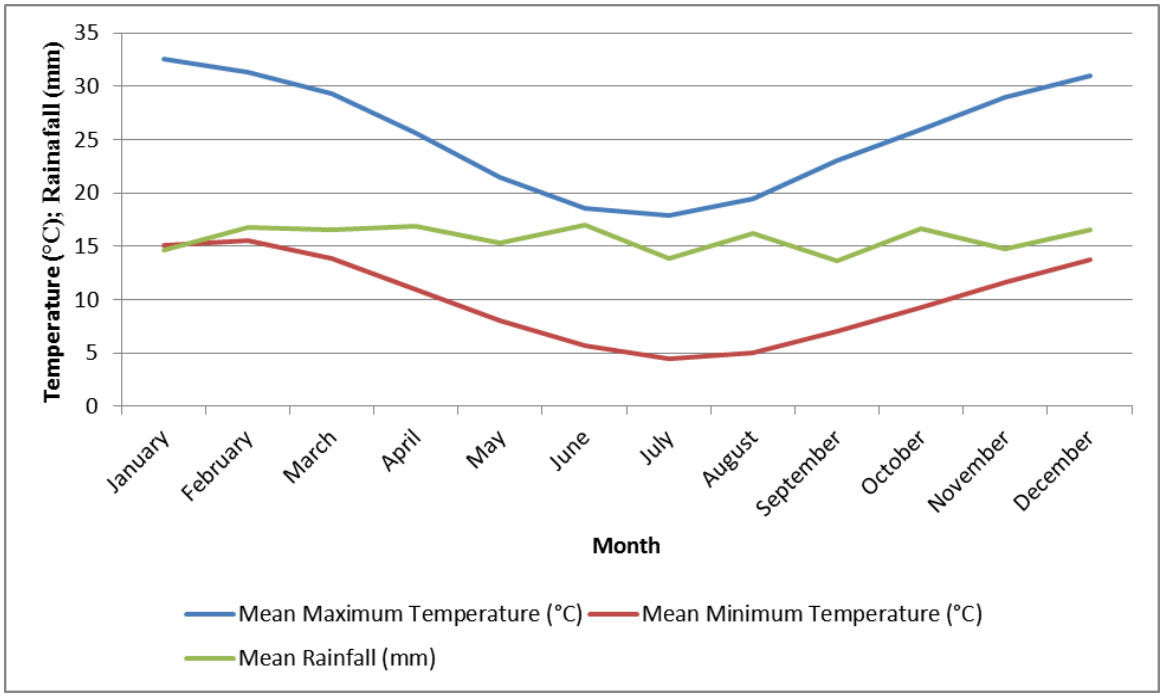

Figure 2: Average maximum and minimum temperatures (° Celsius) and average rainfall (mm) for Forrest Aerodrome (Bureau of Meteorology 2011a)

2.2 Geology, Soils and Landforms

The Project area is located in the Eucla Basin of Western Australia, which was formed by downwarping of the Earth's crust in Palaeozoic to Mesozoic time, with subsequent deposition of some relatively thin and flat-lying sedimentary sequences (Beard 1975). Further deposition of sediments continued with an increase in sea level that inundated the much of the basin, resulting in the formation of sandstone and limestone layers, some of which (e.g. Nullarbor Limestone, Colville Sandstone) now appear at the surface (Beard 1975). The Eucla Basin is dominated by the Bunda Plateau, a vast, featureless plain that slopes gently upwards from the sea-cliffs of the Great Australian Bight. Much of the Project area (the haul road options) lies on the Bunda Plateau, which includes the Carlisle and Nullarbor Plains. There is very little relief, with the exception of undulatory parallel low ridges and corridor flats, and chains of salt lakes, which mark the courses of ancient river valleys (Beard 1975). On the Nullarbor Plain, the soil is generally shallow and rocky, with exposed limestone common at the surface. The soil is usually a highly calcareous pinkish brown silt, having a floury texture and containing lime nodules. However, there are also numerous depressions with heavy clay soil. Further north on the Carlisle Plain, the soil is much deeper and sandier than the Nullarbor Plain, with the most common soil type being a pink calcareous sandy loam. There are also numerous large clay-soil depressions on this plain (Beard 1975).

The northern part of the Project area, including the Cyclone mineral sands deposit, is located in the southern part of the Great Victoria Desert, a relatively monotonous undulating sandbelt, seamed by southward trending valleys and marked by low

sandstone breakaways (Beard 1974). A sandy or loamy surface is general, and frequently sandy seif dunes trending east-west have developed. There are still extensive sand plains where there are no seif dunes or only short linear sandhills of no particular directional trend. The dune sands are red in colour and incoherent, with the sandplains formed of the same material. In sandhill areas, the soil between the dunes may or may not be sandy, and frequently seems to be developed on a truncated profile from which sand has been removed (Beard 1974).

3. FLORA AND VEGETATION

3.1 Regional Flora and Vegetation

The Project area is located within the eastern section of the Great Victoria Desert (GVD) IBRA Region (Interim Biogeographic Regionalisation for Australia), and in the northern and central section of the Nullarbor IBRA region (Government of Australia 2005). The Project area is located specifically within the GVD3 – Great Victoria Desert Eastern subregion, the NUL1 – Nullarbor Northern Band subregion, and the NUL2 – Nullarbor Central Band subregion.

GVD3 is characterized by extensive sandplains of deep Quaternary aeolian sands, which support primarily a tree steppe of *Eucalyptus gongylocarpa*, Mulga (*Acacia aneura*) and *E. youngiana* over hummock grassland dominated by *Triodia basedowii* (Barton & Cowan 2001a). *Acacia* dominates colluvial soils with *Eremophila* and *Santalum* spp., with halophytes confined to the edges of salt lakes and saline drainage systems (Barton & Cowan 2001a).

Immediately to the south of GVD3 is NUL1. In the northern section of this subregion, sandplains, colluvial areas, salt lakes and saline drainage systems occur, with the vegetation identical to that of the sandplains of GVD3 (Barton & Cowan 2001b). In the central and southern areas, low woodlands of *Acacia papyrocarpa* (Western Myall) over *Maireana sedifolia* (bluebush) are present, along with *Myoporum platycarpum* and *Eucalyptus oleosa* in the east and west, and woodlands dominated by *Acacia aneura* (Mulga) (Barton & Cowan 2001b).

The Project area extends into the northern part of NUL2. NUL2 is dominated by the Nullarbor Plain, a vast, flat, treeless plain determined by the combination of aridity and calcareous soils (Barton *et al.* 2002). The vegetation is comprised of Bluebush – Saltbush steppe in central areas, with low woodlands of *Acacia papyrocarpa* over bluebush present in peripheral areas, along with *Myoporum platycarpum* and *Eucalyptus oleosa* in the east and west (Barton *et al.* 2002).

The Great Victoria Desert IBRA Region is equivalent to the Helms Botanical District as defined by Beard (1974), who broadly mapped the vegetation of the Great Victoria Desert at a scale of 1:1,000,000. The Helms Botanical District is very consistent throughout in terms of vegetation, with the most typical formation being tree steppe in which *Eucalyptus gongylocarpa* and *Triodia basedowii* are the principal components. Many areas contain just these two species, while other in other areas these species are mixed with mallees (particularly *E. youngiana*) and large shrubs, with the large shrubs forming a shrub steppe wherever *E. gongylocarpa* is not present. On dunes, the flanks are dominated by *Aluta maisonneuvii*, while on the summits, species such as *Grevillea*

stenobotrya and *Acacia salicina* are common, occasionally with *Callitris preissii.* On the southern boundary with the Nullarbor Plain, *Eucalyptus oleosa* becomes the dominant mallee, and *Triodia scariosa* replaces *T. basedowii.* Many areas of mulga (*Acacia aneura*) occur, particularly on hills, breakaways and on plains, often with *Eremophila latrobei.* Around lakes and drainage channels, *low woodlands* of *Casuarina pauper* occur, with some areas of saltbush flats (Beard 1974).

The Nullabor IBRA Region is equivalent to the Eucla Botanical District as defined by Beard (1975), who broadly mapped the vegetation of the Nullarbor at a scale of 1:1,000,000. The Eucla Botanical District is divided in to a number of natural regions, with the Carlisle Plain (roughly equivalent to the NUL1 IBRA subregion) and Nullarbor Plain (comprising part of the NUL2 IBRA subregion) being relevant to the Project area (Beard 1975). The soils of these limestone plains are usually very shallow, frequently with lumps of limestone at the surface, have a clay texture, and are alkaline. These factors result in the vegetation being more xeromorphic (lower and more open) than in adjoining areas, with the vegetation also predominantly succulent rather than sclerophyllous. The almost universal plant formation is succulent steppe, with or without trees. In the central part of the Nullarbor Plain, there are no trees, however it becomes progressively more wooded in a northward direction on the Carlisle Plain. The ground layer is consistently dominated by *Maireana sedifolia* (bluebush), which is variably scattered, with many grasses and forbs abundant following good rainfall periods.

In the eastern part of the plains, saltbush (*Atriplex* spp.) join bluebush, and occasionally replace it. In the areas regarded as 'lightly wooded', *Acacia papyrocarpa* (Western Myall) provides most of the tree component, with density irregular, however increasing towards the perimeter of the Nullarbor Plain. In the portions of the Nullarbor Region mapped as 'thickly wooded' on the Carlisle Plains (in the northern section), *Acacia papyrocarpa* is almost entirely replaced by *Acacia aneura*, with *Casuarina pauper* and *Myoporum platycarpum*, and sometimes with a few *Eucalyptus oleosa*. Densities are variable. Bluebush and annuals form the ground layer. Dunes are also present in the northern part of the Carlisle plain, with vegetation as for the Helms Botanical District above. There are also numerous depressions or 'dongas' (mapped as claypans), which vary in size and frequency. In the northern part of the Nullarbor Plain they are shallow and vegetated with perennial grasses, while in the north centre there is an area of deeper depressions with a dense tree vegetation. South of this there is a grassy belt, while on the south side of the Plain, depressions are relatively large and have a saltbush vegetation.

Shepherd *et al.* (2002) mapped and described vegetation system associations related to physiognomy, expanding on mapping undertaken by Beard (1974; 1975). Vegetation associations were described at a scale of 1:250,000. The Project area traverses 10 vegetation system associations which are summarised in Figure 3 and Table 1. Table 1 also presents the current extent of each vegetation system association in relation to the pre-European extent, and the extent in DEC-managed lands, including conservation reserves (Government of Western Australia 2010). All vegetation system associations remain at or just below their pre-European extents. Some are also well-reserved in DEC-managed land, however others have very little reserved, including Great Victoria Desert 46, of which none is reserved (Table 1).

Table 1: Extent of Vegetation Associations within the Project Area (Shepherd *et al.* 2002; Government of Western Australia 2010)

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent in DEC-Managed Lands
Bunda Plateau 448	Succulent steppe; bluebush (in dongas)	751,640	100.0	34.3
Bunda Plateau 449	Succulent steppe; bluebush with grassy depressions	2,556,875	99.9	4.3
Bunda Plateau 460*	Succulent steppe; bluebush with saltbush in depressions	2,752,062*	99.9*	0.8*
Carlisle Plain 120	Succulent steppe with open low woodland; mulga & sheoak	342,982	99.8	100
Carlisle Plain 251	Low woodland; mulga & Allocasuarina cristata	101,551	100	100
Carlisle Plain 461*	Succulent steppe with open low woodland; Acaia papyrocarpa over bluebush	2,642,011*	99.9*	24.7*
Carlisle Plain 676	Succulent steppe; samphire	159,933	99.9	19.2
Carlisle Plain 4623	Succulent steppe with low woodland; Acacia papyrocarpa over bluebush	146,064	100	91.5
Great Victoria Desert 46	Shrublands; mallee scrub	578,256	100	0
Great Victoria Desert 85	Hummock grasslands, open low tree & mallee steppe; marble gum & mallee (Eucalyptus youngiana) over hard spinifex on sandplain	6,355,573	99.9	14.3

* Note: although the Project area intersects Bunda Plateau 460 and Carlisle Plain 461 in the pre-European vegetation dataset held by Woodman Environmental, according to Government of Australia (2010), vegetation associations 460 and 461 do not occur in the Bunda Plateau and Carlisle Plain systems. Therefore, the figures presented in Table 1 are for the vegetation associations as a whole.

In 1974, the Department of Agriculture described vegetation site types within part of the West Australian Nullarbor Plain, considering general ecological information, vegetation physiognomy and composition, patterns of variation, conservation status, gradational association and land system representation (Mitchell *et al.* 1988). The Project area is located across 8 land systems, of which the Bullseye and Oasis are the most regionally dominant (Figure 4 and Table 2).

Table 2: Land Systems Located within the Project Area (Mitchell *et al.* 1988)

Land System	Mapped Extent (km^2)	Description of Land System
Bullseye	6,606	Gently undulating stony plains supporting *Maiereana sedifolia* on the rises and *Atriplex vesicaria* and grassland in the drainage floors and on their marginal slopes.
Colville	500	Very gently undulating smooth plain underlain by sand and kankar and supports an *Acacia papyrocarpa* woodland with a chenopod shrub understorey. *Acacia aneura* grows in the dongas and claypans.
Gafa	3,669	Very gently undulating stony plains supporting *Maiereana sedifolia* and *Atriplex vesicaria* on the rises and a mosaic of grassland and *Atriplex vesicaria* in the drainage floors and claypans.
Gunnadorah*	2,963	Flat smooth plains underlain by clay and kankar supporting *Acacia papyrocarpa* woodland with a chenopod understorey. *Acacia anuera* occupies the small dongas while *Atriplex vesicaria* grows in the gilgai soils of the relict river systems.
Jubilee	2,281	Undulating plains; the higher, smooth clay and kankar crests support *Acacia papyrocarpa* whilst the lower stony plains and slopes support *Maireana sedifolia*. The drainage floors and margins to drainage floors support a mosaic of *Atriplex vesicaria* and grassland, whilst large infrequent dongas support *Grevillea* spp. and *Acacia tetragonophylla*.
Oasis	4,663	Flat stony plains supporting *Maireana sedifolia* and small circular dongas with *Pittosporum angustifolium* and *Acacia tetragonophylla.*
Rabbit	550	Flat smooth undissected clay and kankar plain that no longer supports any woody perennials.
Reid	3,419	Gently undulating stony plains supporting *Maiereana sedifolia* on the low rises, *Atriplex vesicaria* and grassland in the drainage floors and on their marginal slopes. Grassland occurs in the claypans

* Note: the Gunnadorah land system is not present in the land systems dataset held by Woodman Environmental; it is believed this land system is equivalent to the Nyanga land system present in the dataset, and therefore Nyanaga land system data is presented in the Table above.

3.2 Local Flora and Vegetation

Because of a combination of extreme remoteness and the lack of historical commercial interest in the general Project area (particularly mineral and petroleum exploration and developments), very few flora and vegetation surveys have been undertaken in the local area. Several surveys reviewed below occur some distance from the Project area, and therefore are not considered local flora and vegetation surveys in the strict sense, however because of the relative uniformity of climatic, topographical and soil features across the majority of the Great Victoria Desert and Nullarbor Plain regions, it is considered that these surveys are potentially of some relevance to this study.

3.1.1 Local Flora

A search of the Project area and surrounds for records of vascular flora taxa was conducted using the online tool *NatureMap* (DEC 2011a). Three search areas were created, each consisting of a circular area with a radius of 40 km; with the search areas roughly covering the northern, central and southern thirds of the Project area. A total of 62 vascular flora taxa have been recorded within these search areas. Given the large size of the total search area, this is a strong indication of the paucity of flora and vegetation surveys in the vicinity of the Project area.

The DEC threatened flora databases, including the Western Australian Herbarium (WAHerb) specimen database and the DEFL (Declared Endangered Flora List) database were interrogated for information regarding conservation significant taxa known from the Project area and surrounds (DEC 2011b). The Declared Rare and Priority Flora list was also interrogated, which provides information on taxa known to occur in the general region of the Project area. The search area is displayed on Figure 1. A total of 17 flora taxa and one lichen taxon of conservation significance were returned; of these, one taxon (*Adenanthos eyrie*) is listed as Threatened (T), and is gazetted as Declared Rare Flora under the State *Wildlife Conservation Act 1950* (WC Act). Only two taxa are known to occur within the search area displayed on Figure 1: *Eucalyptus pimpiniana* and *Lepidium fasciculatum* (both P3). A full list of these taxa is presented in Table 3. Appendix B presents conservation codes for Western Australia flora (DEC 2011c).

Table 3: Conservation Significant Flora Taxa Returned from Interrogation of DEC Databases Potentially Occurring within Project area (DEC 2011b)

*Note: DRPFL = Declared Rare and Priority Flora List
WAHerb = Western Australian Herbarium Specimen Database

Taxon	Code	Description	Known Localities	Source*
Acacia eremophila numerous-nerved variant (A.S. George 11924)	P3	Dense, spreading shrub, 1–2 m high. Fl. yellow, Sep. Sandy soils. Flats.	Norseman, Neale Junction, Great Victoria Desert, Balladonia, Plumridge Lakes.	DRPFL
Adenanthos eyrei	T	Erect shrub, to 1 m high. Fl. red, purple, Oct. Siliceous sand. Sand dunes on cliffs.	Nullarbor Plain	DRPFL
Baeckea sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)	P3	Upright shrub, ca 1 m high. Fl. white, Oct. Orange sand. Flats.	Wiluna, Sandstone, Agnew, Great Victoria Desert	DRPFL
Comesperma viscidulum	P4	Shrub, to ca 0.7 m high with viscid stems. Fl. Yellow, purple, blue, white, May-Sep. Orange or yellow sand, red gritty sand with pebbles, sandstone, Flats, plains, dunes, breakaways,	Queen Victoria Spring, Little Sandy Desert, Carnavon Range, Great Victoria Desert	DRPFL
Conospermum toddii	P4	Spreading shrub, 1.2–2 m high. Fl. white, yellow, Jul–Oct. Yellow sand. Sand dunes.	N of Queen Victoria Spring in Great Victoria Desert	DRPFL
Dampiera eriantha	P1	Erect perennial, herb, to 0.6 m high. Yellow, brown or orange sand. Dunes.	Great Victoria Desert	DRPFL
Eremophila decussata	P1	Low, spreading shrub, to 0.5 m high. Fl. purple, Sep. Skeletal, calcareous soils, orange-brown silty clay, brown sandy clay over limestone. Exposed rocky sites, sand hills, broad depressions, low plains.	Nullarbor Plain	DRPFL
Eremophila sp. Great Victoria Desert (R. Davis 10621)	P2	Compact, perennial shrub 1.8 m high x 1.5 m wide. Fl. pale pink, Sep. Brown clayey sand. Plain	Plumridge Lakes N.R., Great Victoria Desert	DRPFL

Taxon	Code	Description	Known Localities	Source*
Eremophila viscimarginata	P1	Shrub, ca 0.5 m high. Fl. pink, blue, purple, Sep. Red-brown or brown clay or loam, with stones or rocks. Hills, stony plains.	Mt Beadell	DRPFL
Eucalyptus pimpiniana	P3	Straggly shrubby mallee, 0.7–2 m high, bark smooth. Fl. white, May–Oct. Red sand. Sand dunes & plains.	46 km SW of Wanna Lakes ca 3km N of North Boundary of Queen Victoria Nature Reserve; Lake Minigwal, Great Victoria Desert	WAHerb, DRPFL
Hibbertia crispula	P1	Erect to procumbent shrub, to 1 m high. Fl. yellow, Apr/Sep/Dec. Yellow sand. Dunes.	Great Victoria Desert, SA	DRPFL
Labichea deserticola	P1	Shrub, to 1 m high. Fl. yellow. Sandstone ridges.	Great Victoria Desert	DRPFL
Lepidium fasciculatum	P3	Erect annual, herb, (0.1–) 0.3–0.6 m high.	1 mile NE of Forrest/ Reid	WAHerb
Melaleuca nanophylla	P3	Tree or shrub, to 5 m high. Fl. yellow. Gypsum soils. Ridges.	Great Victoria Desert	DRPFL
Olearia arida	P4	Erect shrub, to 0.4 m high. Fl. white, Jul–Sep. Red or yellow sand. Undulating low rises.	Neale Junction, Plumridge Lakes, Great Victoria Desert	DRPFL
Phlegmatospermum richardsii	P1	Erect annual, herb, to 0.2 m high. Fl. white, yellow.	Eucla, Nullabor Plain	DRPFL
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2	Erect shrub to 0.6 m high. Yellow and orange sand. Dunes	Great Victoria Desert, Cundeelee	DRPFL
Xanthoparmelia norpumila	P2	Lichen	Burnabbie, Nullarbor, SA	DRPFL

A search of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) database with regard to environmental matters of national significance as listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), was performed over an area within a radius of approximately 50 km of the Project area (DSEWPC 2011). The results of this search indicate that no federally-listed threatened flora taxa occur within or in the vicinity of the Project area.

The search of the Project area and surrounds for records of vascular flora taxa using the online tool *NatureMap* did not return any introduced (weed) flora taxa. However, the search of the DSEWPC database with regard to environmental matters of national significance as listed under the EPBC Act indicates that 2 taxa or habitat for such taxa may occur in or in the vicinity of the Project area: *Carrichtera annua* (Ward's Weed) and *Lycium ferrocissimum* (African Boxthorn) (DSEWPC 2011). These taxa are considered by the states and territories to pose a particularly significant threat to biodiversity (DSEWPC 2011). Both taxa are known to occur in the Great Victoria Desert (DEC 2011c), and therefore it is possible that they will occur in the Project area.

The DEC and the Spinifex people have recently undertaken a botanical survey in the Ilkurlka area in the Great Victoria Desert, located approximately 70 km west of the Project area (DEC 2011d). The full results of this survey have not been published, however it is known that more than 200 vascular plant taxa were identified. Two new taxa were confirmed as being discovered during the survey, with a further 2 collections expected to also be confirmed as new taxa. According to W.A. Herbarium specimen records (DEC 2011c), 2 Priority flora taxa were also recorded, with a further taxon considered to have affinities to, but not completely match, a known Priority flora taxon. One introduced weed taxon was also recorded. These significant taxa are listed in Table 4 below.

Table 4: Significant Flora Taxa Recorded in the Ilkurlka area (DEC 2011c; d)

Taxon	Code	Comments
Acacia eremophila numerous-nerved variant (A.S. George 11924)	P3	Lodged at W.A. Herbarium
Dicrastylis sp. Ilkurlka (R. Davis et al. RD 11637)	P1	Discovered during survey
Eragrostis sp.	-	Lodged at W.A. Herbarium; potential new taxon
Eremophila aff. *viscimarginata*	-	Lodged at W.A. Herbarium; *Eremophila viscimarginata* is P1
Gnephosis sp.	-	Lodged at W.A. Herbarium; potential new taxon
Grevillea ilkurlka ms	-	Discovered during survey
Ptilotus blackii	P3	Lodged at W.A. Herbarium
Tribulus terrestris	Introduced	Lodged at W.A. Herbarium

A number of detailed flora and vegetation surveys, as well as targeted surveys for conservation-significant flora taxa, have been undertaken for the Tropicana Gold Project, located approximately 275 km west of the Project area (Tropicana Joint Venture 2009). As these surveys were located some distance away from the Project area, a brief summary of each of these surveys is presented in Table 5 below. Table 6 presents a list of currently listed conservation significant flora recorded from these surveys, while Table 7 lists introduced taxa recorded during these surveys.

Table 5: Summary of Surveys Undertaken for the Tropicana Gold Project

Survey Title	Reference	Number of Flora Taxa Recorded	Number of Conservation Significant Flora Taxa Recorded*	Number of Introduced Flora Taxa Recorded
Tropicana Gold Project Regional Threatened Flora Survey	AngloGold Ashanti Australia (2009)	-	6	-
Tropicana Gold Project – Flora and Vegetation Assessment of the Proposed Operational Area and its Surroundings	Ecologia Environment (2009a)	446	9	3
Tropicana Gold Project – Operational Area Threatened Flora Assessment	Ecologia Environment (2009b)	-	8	
Tropicana Gold Project – Tropicana Joint Venture Tropicana-Transline Infrastructure Corridor: Vegetation and Flora Survey	Ecologia Environment (2009c)	417	9	1
Flora and Vegetation Survey: Pinjin Infrastructure Corridor	Mattiske Consulting Pty Ltd (2009)	267	8	1
Tropicana Gold Project – Minigwal Trough Water Supply Area and Pipeline Corridor Vegetation and Flora Survey	Botanica Consulting (2009a)	179	2	0
Neale Junction Flora and Vegetation Survey	Botanica Consulting (2009b)	139	5	0

* Note: This number is currently listed conservation significant flora, and may therefore differ from that listed in the respective report

Table 6: Conservation Significant Flora Recorded during Surveys for the Tropicana Gold Project

Taxon	Code
Acacia eremophila numerous-nerved variant (A.S. George 11924)	P3
Acacia eremophila var. *variabilis*	P3
Baeckea sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)	P3

Taxon	Code
Caesia rigidifolia	P1
Caesia talingka ms	P2
Calytrix warburtonensis	P2
Comesperma viscidulum	P4
Conospermum toddii	P4
Dampiera eriantha	P1
Dicrastylis cundeeleensis	P4
Eremophila undulata	P2
Grevillea secunda	P4
Isotropis canescens	P2
Malleostemon sp. Officer Basin (D. Pearson 350)	P2
Micromyrtus serrulata	P3
Olearia arida	P4
Physopsis chrysotricha	P2
Thryptomene eremaea	P2

Table 7: Introduced Flora Recorded during Surveys for the Tropicana Gold Project

Taxon	Comments
Carrichtera annua	Considered by the states and territories to pose a particularly significant threat to biodiversity
Erodium aureum	-
Salvia verbenaca	-
Sonchus olearaceus	-
Spergularia rubra	-

3.1.2 Local Vegetation

The DEC's Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) database was interrogated for information regarding any occurrences of TECs or PECs within 50 kilometres of the Project area (DEC 2011e). The search area is displayed on Figure 1. There were no known occurrences of TECs and PECs within the search area. The search of the DSEWPC database with regard to environmental matters of national significance as listed under the EPBC Act also did not return any federally-listed threatened ecological communities. However, one Priority 3 PEC, 'Yellow sandplain communities of the Great Victoria Desert', is known to occur within the Great Victoria Desert region (DEC 2010a), and therefore could potentially occur in the Project area. Appendix B presents definitions, categories and criteria for TECs and PECs (DEC 2010b).

Ecologia Environment (2009a) mapped 11 major vegetation communities in the Tropicana Gold Project operational area. These communities were mapped in interdunal swales and sandplains, longitudinal sand dunes, saline clay pans and associated saline loam plains, on rocky breakaways and associated slopes, and in narrow drainage channels. Several of these were considered to be of local significance.

Ecologia Environment (2009c) mapped 9 main vegetation units in the Tropicana-Transline Infrastructure Corridor. These included mixed *Eucalyptus* woodlands over *Triodia* hummock grasslands, *Acacia aneura* (Mulga) woodlands, *Triodia* hummock grasslands, *Casuarina* shrubland over low heath, and *Callitris preissii* tall shrubland. The Priority 3 PEC, 'Yellow sandplain communities of the Great Victoria Desert', was noted as potentially being present in the infrastructure corridor. Several vegetation units were also were considered to be of local significance.

Mattiske Consulting Pty Ltd (2009) mapped 37 plant communities in the Tropicana Gold Project Pinjin Infrastructure Corridor. These included *Eucalyptus, Casuarina* and *Acacia* woodlands, shrublands (including *Acacia*), grasslands and chenopod shrublands. The Priority 3 PEC, 'Yellow sandplain communities of the Great Victoria Desert', was thought to occur in the infrastructure corridor. Another plant community was considered to be of local significance, as it supported habitat for significant flora.

Botanica Consulting (2009a) mapped 13 plant communities in the Minigwal Trough Water Supply Area and Pipeline Corridor. These were mapped on longitudinal red sand dunes, sandy flats and swales, rocky breakaways and stony rises, lake edges, and clay pans. The vegetation included *Eucalyptus, Casuarina* and *Acacia* woodlands. No TECs or PECs were identified, and none of the vegetation communities were considered to be of local or regional significance.

4. SUMMARY OF ENVIRONMENTAL FACTORS AND RECOMMENDATIONS

This desktop review of flora and vegetation within the Cyclone Project area has identified the following key issues that may be relevant with regard to proposed mining activities:

1. Potentially one Threatened flora taxon, 16 Priority flora taxa and 1 Priority lichen taxon present within or in close proximity to the Project area, and a further 15 Priority flora taxa and 4 new and potentially new taxa considered possible but less likely to occur in the Project area;
2. No known weed taxa present within or in close proximity to the Project area, with five weed taxa considered possible but less likely to occur in the Project area;
3. No known TECs or PECs present within or in close proximity to the Project area, with one PEC considered possible but unlikely to occur in the Project area;
4. A significant lack of local information regarding the flora and vegetation characteristics of the Project area.

As mentioned in Section 1.3, a Level 2 comprehensive survey is recommended for the Cyclone Project. This is primarily because of the lack of existing knowledge of the flora and vegetation characteristics of the Project area, and the potential for discovery of new and restricted flora taxa, and to a lesser extent, restricted vegetation communities. A comprehensive survey purpose as defined by Guidance Statement No. 51 (EPA 2004) is to enhance the level of knowledge at the locality scale and the context at the local scale. In some cases sub-region survey may be required to provide a wider context. This applies where there is only broad general context. The comprehensive survey involves one or more visit/s in the main flowering season, and visits in other seasons,

and replication of vegetation survey plots in vegetation units over a greater proportion of the Project area.

The comprehensive survey is preferred to the detailed survey as the general context of the area is poorly known and the survey will provide a clearer indication of the conservation significance of species and plant communities at the local and regional scales. This would potentially mean additional survey in the local or sub-regional area outside the Project area, particularly in areas that are reserved for the purposes of conservation such as nature reserves. The purpose of broader surveys would be to understand the broader distribution of conservation significant flora species and plant communities that may be impacted by the proposal. This may be necessary to place the proposed impacts into a conservation context.

Due to the significant distances and areas covered by the proposed transport corridors, Level 1 Reconnaissance surveys should be considered as a first step to identify any conservation significant flora species or plant communities that may occur within these corridors. This approach may help with the establishment of the preferred option which would then be the subject of a comprehensive survey for the impact assessment A nominal corridor width of 500m would be suitable for the purposes of this type of survey. The Level 1 survey should focus on looking for species expected from the area (Declared Rare and Priority species) as well as describing the vegetation units encountered through plotless site assessments. Maps of structural plant communities can then be developed based on orthophotos to aid in re-alignment of routes and/or planning of the Level 2 assessment of the preferred option. Plant communities that are potentially restricted or sensitive to disturbance can be identified and mapped for avoidance or used to facilitate selection of the preferred option. The Level 1 surveys can be conducted outside of the main flowering period for the region, however this may restrict the potential for identifying some conservation significant taxa.

For the Cyclone Project Level 2 studies, visits to the Project area approximately 4 weeks following any significant rainfall event, and in the cooler winter months when some species may flower regardless of rainfall, would likely be required, with multiple survey plots established in each distinct vegetation unit encountered. A reconnaissance survey should be conducted prior to the main flowering period for the area to understand the range of plant communities present and aid in planning both sample intensity and field logistics for the comprehensive survey. This reconnaissance survey should utilise high quality orthorectified aerial photography to plan access and map community boundaries supported by field survey.

5. RECOMMENDATIONS

The following recommendations are presented:

* Prior to mining activities commencing, a comprehensive flora and vegetation survey should be undertaken, as detailed in EPA Guidance Statement No. 51 and Section 4 of this report.
* The proponent should consider conducting Level 1 Reconnaissance surveys over the proposed transport corridor options to identify any conservation significant flora species or plant communities that may occur and aid in

defining the preferred transport option over which the comprehensive survey would be conducted.

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225000 300000 375000 450000 525000 600000 675000 750000

6850000 6775000 6700000 6625000 6550000

Inset 1

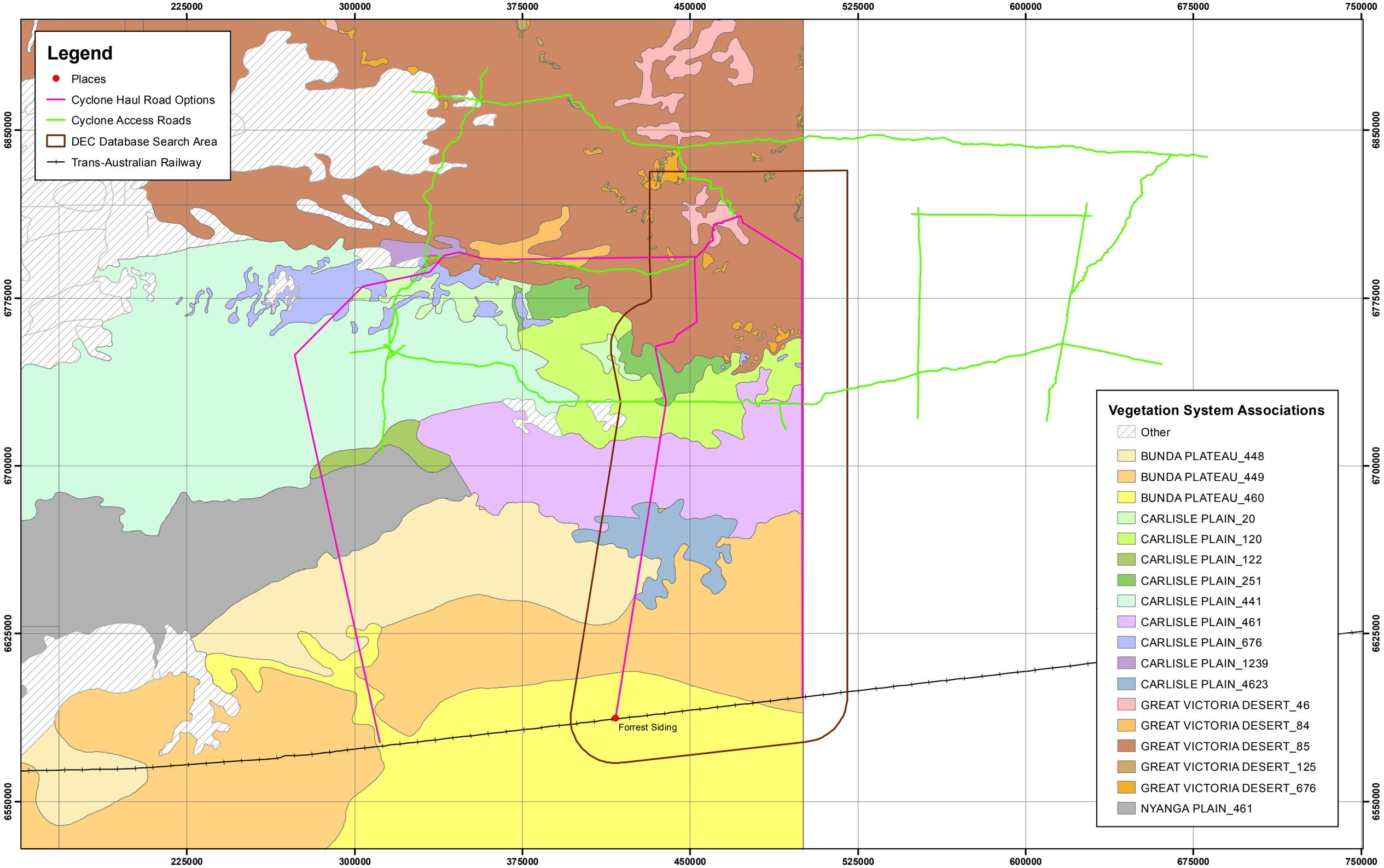
Inset 1

Forrest Siding

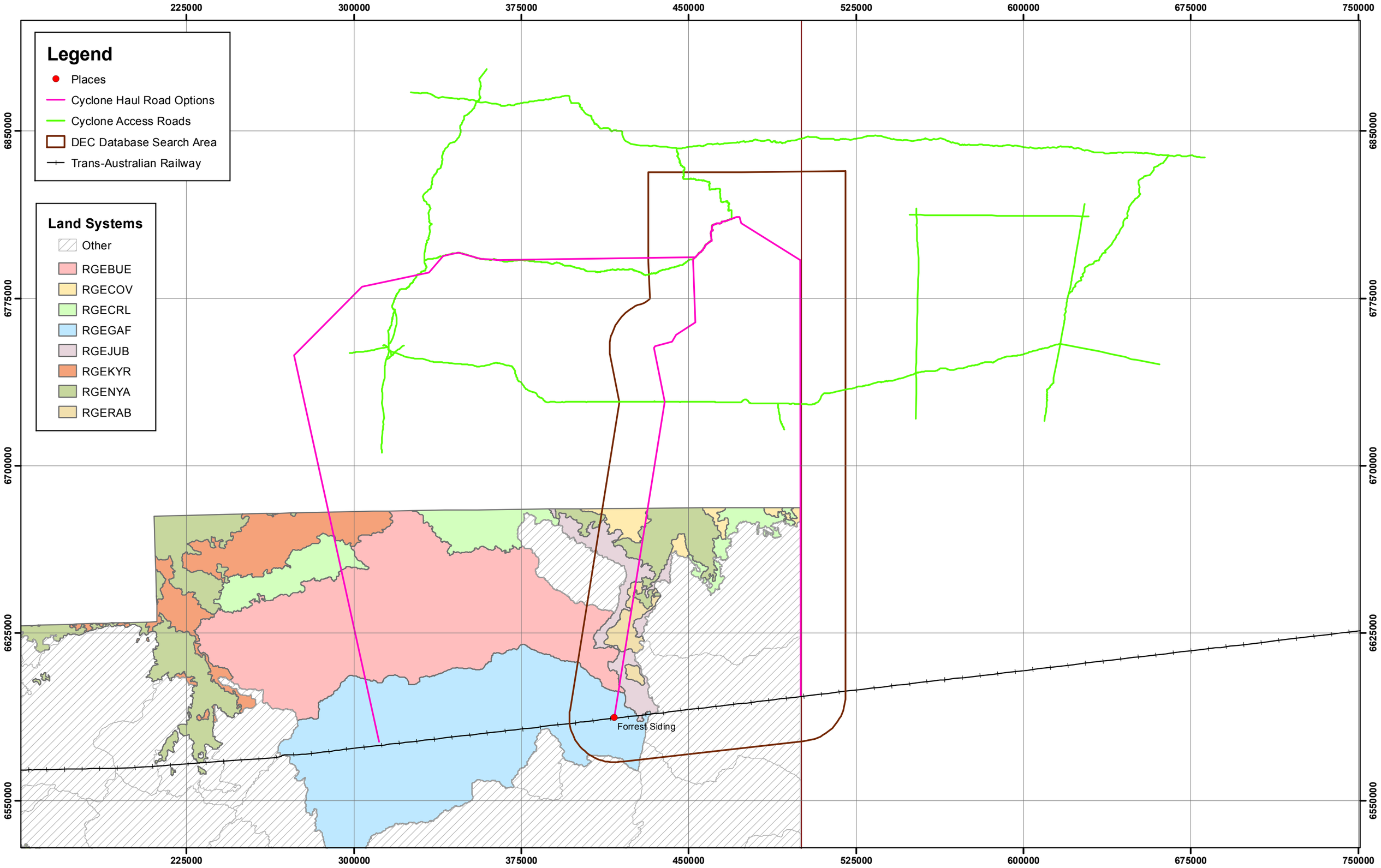
Legend

- Places
- Cyclone Haul Road Options
- Cyclone Access Roads
- Cyclone Infrastructure
- Cyclone_Infrastructure_Area
- DEC Database Search Area
- Trans-Australian Railway

woodmanenvironmentalconsulting	**Cyclone Project Locality Overview** This map should only be used in conjunction with WEC report Sust11-36-01.	Author: David Coultas	Filename:Sust11-36-01-f01.mxd	Scale: 1:1,500,000 (A3)	**Figure** 1
		WEC Ref: Sust11-36-01	Revision: B - October 2011	Grid: GDA94 MGA Zone 52	



woodmanenvironmentalconsulting	**Cyclone Project** **Vegatation System Associations** This map should only be used in conjunction with WEC report Sust11-36-01.	Author: David Coultas	Filename:Sust11-36-01-f03.mxd	Scale: 1:1,500,000 (A3)	**Figure** 3
		WEC Ref: Sust11-36-01	Revision: A - October 2011	Grid: GDA94 MGA Zone 52	



woodmanenvironmentalconsulting	**Cyclone Project Land Systems** This map should only be used in conjunction with WEC report Sust11-36-01.	Author: David Coultas	Filename: Sust11-36-01-f04.mxd	Scale: 1:1,500,000 (A3)	**Figure** 4
		WEC Ref: Sust11-36-01	Revision: A - October 2011	Grid: GDA94 MGA Zone 52	

Appendix A: Conservation Codes for Western Australian Flora (DEC 2011c)

T: Threatened Flora (Declared Rare Flora –Extant)

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act 1950).
Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

- CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild
- EN: Endangered – considered to be facing a very high risk of extinction in the wild
- VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

X: Presumed Extinct Flora (Declared Rare Flora –Extinct)

Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950).

1: Priority One – Poorly-known taxa

Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

2: Priority Two – Poorly-known taxa

Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.

3: Priority Three – Poorly-known taxa

Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from

several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

4: Priority Four – Rare, Near Threatened and other taxa in need of monitoring

1. Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
2. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
3. Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy

5: Priority Five – Conservation Dependent taxa

Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Appendix B: Definitions, Categories and Criteria for Threatened Ecological and Priority Ecological Communities (DEC 2010b)

DEFINITIONS, CATEGORIES AND CRITERIA FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1. GENERAL DEFINITIONS

Ecological Community
A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix B: Conservation Codes for Western Australian Flora (DEC 2012c)

T: Threatened Flora (Declared Rare Flora –Extant)

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act 1950).
Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

- CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild
- EN: Endangered – considered to be facing a very high risk of extinction in the wild
- VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

X: Presumed Extinct Flora (Declared Rare Flora –Extinct)

Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950).

1: Priority One – Poorly-known taxa

Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

2: Priority Two – Poorly-known taxa

Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.

3: Priority Three – Poorly-known taxa

Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

4: Priority Four – Rare, Near Threatened and other taxa in need of monitoring

1. Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
2. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
3. Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy

5: Priority Five – Conservation Dependent taxa

Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Appendix C: Definitions, Categories and Criteria for Threatened Ecological and Priority Ecological Communities (DEC 2010b)

DEFINITIONS, CATEGORIES AND CRITERIA FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1. GENERAL DEFINITIONS

Ecological Community
A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a
direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)

An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a

category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well

known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix D: Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces (adapted from Keighery 1994)

Condition Ranking	Description
E (Excellent)	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
VG (Very Good)	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
G (Good)	More obvious signs of damage caused by human activities since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
P (Poor)	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
VP (Very Poor)	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
D (Completely Degraded)	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising of weed or crop species with isolated native trees or shrubs.

Appendix E: Vascular Plant Taxa Recorded in the Project Area

Note: * denotes introduced taxon

Family	Taxon
Amaranthaceae	*Hemichroa diandra*
	Ptilotus gaudichaudii var. *gaudichaudii*
	Ptilotus obovatus
Asteraceae	*Brachyscome ciliaris*
	Calotis sp. Carnarvon Range (D.J. Edinger & K.F. Kenneally D 2708 K 12243)
	Chrysocephalum pterochaetum
	Cratystylis conocephala
	Leiocarpa semicalva subsp. *semicalva*
	Olearia exiguifolia
	Olearia incana
	Olearia muelleri
	Streptoglossa ?*adscendens*
	Vittadinia sp.
	Xerochrysum bracteatum
Boraginaceae	*Halgania cyanea* var. Allambi Stn (B.W. Strong 676)
	Trichodesma zeylanicum var. *zeylanicum*
Brassicaceae	*Arabidella trisecta*
	*?*Carrichtera annua*
Casuarinaceae	*Casuarina pauper*
Chenopodiaceae	*Atriplex acutibractea* subsp. *acutibractea*
	Atriplex cryptocarpa
	Atriplex nummularia subsp. *spathulata*
	Atriplex vesicaria
	Chenopodium desertorum subsp. *desertorum*
	Chenopodium desertorum subsp. *rectum*

Family	Taxon
Chenopodiaceae cont.	*Chenopodium nitrariaceum*
	Enchylaena tomentosa var. *tomentosa*
	Maireana integra
	Maireana pentatropis
	Maireana radiata
	Maireana sedifolia
	Maireana ?trichoptera
	Maireana turbinata
	Rhagodia spinescens
	Salsola australis
	Sclerolaena deserticola
	Sclerolaena diacantha
	Sclerolaena obliquicuspis
	Sclerolaena patenticuspis
	Sclerolaena symoniana
	Sclerolaena uniflora
	Tecticornia indica subsp. *bidens*
	Tecticornia pruinosa
	Tecticornia sp.
Convolvulaceae	*Convolvulus remotus*
Cupressaceae	*Callitris verrucosa*
Euphorbiaceae	*Beyeria ?sulcata*
	Euphorbia drummondii subsp. *drummondii*
Fabaceae	*Acacia aneura*
	Acacia aptaneura ms
	Acacia burkittii
	Acacia caesaneura ms
	Acacia colletioides

Family	Taxon
Fabaceae cont.	*Acacia* eremophila numerous-nerved variant (A.S. George 11924) (P3)
	Acacia gilesiana
	Acacia helmsiana
	Acacia kempeana
	Acacia ligulata
	Acacia minyura
	Acacia nyssophylla
	Acacia oswaldii
	Acacia papyrocarpa
	Acacia prainii
	Acacia pteraneura ms
	Acacia ramulosa var. *linophylla*
	Acacia ramulosa var. *ramulosa*
	Acacia tetragonophylla
	Bossiaea walkeri
	Daviesia sp. Kanandah (R. Davis 10604)
	Daviesia ulicifolia subsp. *aridicola*
	Senna artemisioides subsp. *filifolia*
	Senna artemisioides subsp. *petiolaris*
	Senna artemisioides subsp. *petiolaris* (broad petiole form)
	Senna artemisioides subsp. *x artemisioides*
Frankeniaceae	*Frankenia cinerea*
	Frankenia cordata
Goodeniaceae	*Dampiera* ?*eriantha* (P1)
	Goodenia gypsicola
	Scaevola basedowii
	Scaevola collaris
	Scaevola spinescens (Great Victoria Desert Form)
	Scaevola spinescens (Nullarbor Form)

Family	Taxon
Gyrostemonaceae	*Codonocarpus cotinifolius*
	Gyrostemon ramulosus
Lamiaceae	*Dicrastylis beveridgei*
	Microcorys macredieana
	Prostanthera althoferi subsp. *althoferi*
	Prostanthera sericea
	Westringia rigida
Loranthaceae	*Amyema miquelii*
	Amyema nestor
	Amyema preissii
	Lysiana exocarpi subsp. *exocarpi*
Malvaceae	*Abutilon otocarpum*
	Hibiscus sturtii var. ?*truncatus*
	**Malvastrum americanum*
	Sida ammophila
	Sida calyxhymenia
	Sida intricata
	Sida spodochroma
Myrtaceae	*Aluta maisonneuvei* subsp. *auriculata*
	Eucalyptus canescens subsp. *beadellii*
	Eucalyptus canescens subsp. *canescens*
	Eucalyptus concinna
	Eucalyptus eremicola subsp. *eremicola*
	Eucalyptus gongylocarpa
	Eucalyptus gracilis
	Eucalyptus gypsophila
	Eucalyptus leptophylla

Family	Taxon
Myrtaceae cont.	*Eucalyptus oleosa* subsp. *oleosa*
	Eucalyptus pimpiniana (P3)
	Eucalyptus socialis subsp. *eucentrica*
	Eucalyptus socialis subsp. *victoriensis*
	Eucalyptus sp. (unidentified 1)
	Eucalyptus youngiana
	Melaleuca zeteticorum
	Thryptomene biseriata
	Thryptomene elliottii
Pittosporaceae	*Pittosporum angustifolium*
Poaceae	*Amphipogon caricinus* var. *caricinus*
	Aristida contorta
	Aristida holathera var. *holathera*
	Aristida ?inaequiglumis
	Austrostipa nullanulla
	Enneapogon avenaceus
	Enneapogon caerulescens
	Enneapogon cylindricus
	Enteropogon ramosus
	Eragrostis dielsii
	Eragrostis laniflora
	Eragrostis ?pergracilis
	Eragrostis xerophila
	Eriachne helmsii
	Monachather paradoxus
	Paspalidium basicladum
	Paspalidium reflexum
	Rytidosperma ?acerosa
	Triodia basedowii
	Triodia scariosa
	Triraphis mollis

Family	Taxon
Polygonaceae	*Muehlenbeckia florulenta*
Proteaceae	*Grevillea juncifolia* subsp. *juncifolia*
	Grevillea nematophylla subsp. *supraplana*
	Grevillea stenobotrya
	Hakea leucoptera subsp. *sericipes*
Rubiaceae	*Pomax* sp. desert (A.S. George 11968)
	Psydrax ammophila
Santalaceae	?*Anthobolus leptomerioides*
	Exocarpos aphyllus
	Santalum acuminatum
Sapindaceae	*Alectryon oleifolius* subsp. *canescens*
	Dodonaea lobulata
	Dodonaea stenozyga
	Dodonaea viscosa subsp. *angustissima*
Scrophulariaceae	*Eremophila alternifolia*
	Eremophila ?*attenuata* (P1)
	Eremophila falcata
	Eremophila gibsonii
	Eremophila glabra subsp. *glabra*
	Eremophila latrobei subsp. *glabra*
	Eremophila longifolia
	Eremophila paisleyi subsp. *paisleyi*
	Eremophila platythamnos subsp. *platythamnos*
	Eremophila scoparia
	Eremophila sp. Plumridge Lakes (S.G.M. Carr 534)
	Eremophila willsii subsp. *integrifolia*

Family	Taxon
Scrophulariaceae cont.	*Myoporum platycarpum* subsp. *platycarpum*
Solanaceae	*Anthotroche pannosa*
	Duboisia hopwoodii
	Lycium australe
	Solanum coactiliferum
	Solanum ellipticum
	Solanum orbiculatum subsp. *orbiculatum*
Thymelaeaceae	*Pimelea microcephala* subsp. *microcephala*
Zygophyllaceae	*Zygophyllum eremaeum*
	Zygophyllum ovatum