



PHOENIX

ENVIRONMENTAL SCIENCES

Flora and fauna and fauna assessment for the Lyons East Road to
Gatti Road study area – Report Addendum

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads
WA, Jacobs and Arup)

December 2016

Final report



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Final Report

Authors:

Reviewer:

Date:

Submitted to:

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Contents

| | |
|-----------------------------------------------------------------------------------------------------------|-----|
| CONTENTS..... | II |
| LIST OF FIGURES..... | III |
| LIST OF TABLES..... | III |
| ABBREVIATIONS | IV |
| EXECUTIVE SUMMARY | V |
| 1 INTRODUCTION..... | 1 |
| 1.1 Study area | 1 |
| 1.2 Scope of work..... | 1 |
| 2 METHODS..... | 3 |
| 2.1 Desktop review | 3 |
| 2.2 Level 2 flora and vegetation survey | 3 |
| 2.2.1 Quadrat and relevé selection..... | 3 |
| 2.2.2 Vegetation community and condition mapping | 5 |
| 2.2.3 Targeted flora searches..... | 5 |
| 2.3 Transect searches for <i>Caladenia drakeoides</i> | 6 |
| 2.4 Evaluation of the Eucalypt Woodlands of the Western Australian Wheatbelt EPBC Act listed TEC | 6 |
| 2.5 Extrapolation of remnant native vegetation associations..... | 7 |
| 2.6 Level 1 and targeted conservation significant fauna survey | 7 |
| 2.7 Survey of black cockatoo species..... | 7 |
| 2.8 Taxonomy and nomenclature | 7 |
| 2.9 Survey personnel | 8 |
| 3 RESULTS | 9 |
| 3.1 Survey limitations | 9 |
| 3.2 Flora and vegetation | 10 |
| 3.2.1 Conservation significant flora | 10 |
| 3.2.2 Introduced flora | 13 |
| 3.2.3 Range extensions | 13 |
| 3.2.4 Vegetation associations | 13 |
| 3.2.5 Vegetation condition | 16 |
| 3.2.1 Threatened and Priority ecological communities | 16 |
| 3.2.2 Local and regional significance of vegetation | 18 |
| 3.2.1 Extrapolation of remnant native vegetation | 19 |
| 3.3 Fauna and fauna habitat | 21 |
| 3.3.1 Fauna habitats..... | 21 |
| 3.3.2 Conservation significant fauna..... | 21 |
| 3.3.3 Introduced species | 21 |
| 3.3.4 Survey of black cockatoo species..... | 23 |
| 4 DISCUSSION..... | 24 |

| | | |
|-----|-------------------------------|----|
| 4.1 | Flora and vegetation | 24 |
| 4.2 | Fauna and fauna habitat | 25 |
| 5 | REFERENCES..... | 26 |

List of Figures

| | | |
|------------|------------------------------------------------------------------------------------|----|
| Figure 1-1 | Miling Bypass study area..... | 2 |
| Figure 2-1 | Survey sites | 4 |
| Figure 3-1 | <i>Caladenia drakeoides</i> recorded at site MBYCD003, outside MB study area | 11 |
| Figure 3-2 | Conservation significant flora and declared pests..... | 12 |
| Figure 3-3 | Vegetation associations | 15 |
| Figure 3-4 | Vegetation condition | 17 |
| Figure 3-5 | Vegetation extrapolated to 500 m..... | 20 |
| Figure 3-6 | Fauna habitats and Carnaby’s Black Cockatoo potential breeding trees | 22 |

List of Tables

| | | |
|-----------|-----------------------------------------------------------------------------------|----|
| Table 2-1 | Target conservation significant flora in MB study area | 5 |
| Table 2-2 | Project team..... | 8 |
| Table 3-1 | Limitations and constraints associated with the field survey..... | 9 |
| Table 3-2 | Vegetation associations in the MB study area..... | 13 |
| Table 3-3 | Vegetation condition in the MB study area | 16 |
| Table 3-4 | Vegetation associations considered locally significant in the MB study area | 18 |
| Table 3-5 | Status of vegetation associations recorded in MB study area..... | 18 |
| Table 3-6 | Distribution of extrapolated remnant vegetation in the MB study area..... | 19 |

List of Appendices

| | |
|------------|---------------------------------------------------------------------------------------------------------------|
| Appendix 1 | Quadrat data |
| Appendix 2 | Key to determining presence of the EPBC Act listed TEC Eucalypt woodlands of the Western Australian Wheatbelt |
| Appendix 3 | Flora species inventory for additional survey of MB study area |
| Appendix 4 | Eucalypt woodlands of the Western Australian wheatbelt TEC – site assessment |
| Appendix 5 | Carnaby’s Black Cockatoo potential breeding tree records |

ABBREVIATIONS

CR – Critically Endangered

DBH – diameter at breast height

DoE - Department of the Environment

DSEWPaC – Department of Sustainability, Environment, Water, Population and Communities

EN – Endangered

EP Act – *Environmental Protection Act 1986*

EPA – Environmental Protection Authority

EPBC Act – *Environmental Protection and Biodiversity Act 1999*

EPP – Environmental Protection Policy

GNH – Great Northern Highway

GPS – Global Positioning System

IBRA – Interim Biogeographic Regionalisation of Australia

NES – national environmental significance

PDA – personal data assistant

SC – special conservation need

SLK – straight line kilometre

sp. – species (singular)

spp. – species (plural)

subsp. – subspecies (singular)

VU – Vulnerable

WA – Western Australia

WC Act – *Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

The Muchea to Wubin Upgrade Stage 2 (the Project) Integrated Project Team (IPT) is supporting a significant program of works for Main Roads WA to improve safety and efficiency of the 218 km section of the Great Northern Highway (GNH) between Muchea and Wubin, north of Perth, to meet National Highway Standards. Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by the IPT (Main Roads Western Australia, Jacobs and Arup) to undertake flora and fauna assessments for the Project.

The initial flora and fauna assessment relevant to this addendum report was conducted for the Lyons East to Gatti Road study area between October 2014 and June 2015 and is reported in Phoenix (2015). This report addendum documents an additional flora and fauna assessment conducted for the Lyons East to Gatti Road part of the Project, specifically for the Miling Bypass (MB study area) which partly intersects the Lyons East to Gatti Road study area and includes some previously unsurveyed areas.

The additional flora and fauna assessment comprised:

- completing a two-season Level 2 flora and vegetation survey and Level 1/targeted conservation significant fauna survey
- transect searches for the Threatened orchid *Caladenia drakeoides*
- assessment of Eucalypt Woodlands of the Western Australian Wheatbelt Threatened Ecological Community (TEC)
- extrapolation of remnant native vegetation within 500 m either side of the MB study area (referred to as extrapolation study area).

Field surveys were undertaken on 4 April, 31 May and 31 August – 9 September 2016 to obtain dual season quadrat data (where required) and to coincide with the peak flowering times for flora including conservation significant flora species.

Where relevant, flora and fauna survey methodology was consistent with that employed in the initial flora and fauna assessment.

A total of 58 plant taxa (including subspecies and varieties) representing 38 native species and 20 introduced species were recorded in the MB study area in the additional assessment. Of these, 16 species were not recorded in the previous surveys (Phoenix 2015).

One conservation significant flora species was recorded in the MB study area, *Chamelaucium* sp. Wongan Hills (Priority 3)¹. The records are additional to previous collections in the MB study area, with 19 new plants added to a population that was recorded in the initial surveys. New populations of *Chamelaucium* sp. Wongan Hills (Priority 3) and *Frankenia glomerata* (Priority 4) were recorded just outside the MB study area at a location targeted for *Caladenia drakeoides* habitat characterisation.

Caladenia drakeoides was not recorded in the MB study area but was confirmed at one of the known locations outside the study area, approximately 35 km to the east, with several flowering individuals found on the margin of a salt lake. Taking into account habitat suitability, survey intensity, seasonal

¹ The initial report Phoenix. 2015. *Flora and fauna assessment for Lyons East Road to Gatti Road study area*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Jacobs. erroneously lists this species as Threatened in the executive summary.

conditions and expertise of the survey team, it is considered unlikely that *C. drakeoides* occurs in the study area.

Additional locations of two declared pests, *Echium plantagineum* and *Opuntia monacantha*, were found. Both species were recorded in the initial surveys in the MB study area.

Six vegetation associations were mapped in the MB study area; all of these were recorded in the initial surveys. The condition of remnant native vegetation across the MB study area ranged from Excellent to Degraded with areas in Very Good to Excellent condition accounting for 56 ha (14%) of the study area.

Three of the vegetation associations may be considered locally significant as they provide habitat for a conservation significant flora species (631, 676, 1048), and/or contain vegetation of Excellent condition (676, 1048).

The assessment undertaken for the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Eucalypt Woodlands of the Western Australian Wheatbelt TEC concluded that the community is not present in the MB study area.

Five fauna habitat types were mapped in the previously unsurveyed areas of the MB study area, including four habitats comprising remnant native vegetation. These were all previously mapped in the initial surveys. No conservation significant fauna species were recorded in the additional surveys.

The additional survey marginally increased the number of potential breeding trees for Carnaby's Black Cockatoo recorded in the MB study area (14 new trees); however, none of these were suitable for current breeding by the species and the assessment did not identify any areas of quality foraging habitat for the species, consistent with the findings of the initial survey for the Lyons East Road to Gatti Road study area.

1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by the Muchea to Wubin Integrated Project Team (Main Roads Western Australia, Jacobs and Arup) to undertake flora and fauna assessments for the Muchea to Wubin Upgrade Stage 2 (the Project). The Project is supporting a significant program of works by Main Roads WA to improve safety and efficiency of the 218 km section of the Great Northern Highway (GNH) between Muchea and Wubin, north of Perth, to meet National Highway Standards.

The initial flora and fauna assessment relevant to this addendum report was conducted for the Lyons East to Gatti Road study area between October 2014 and June 2015 and is reported in Phoenix (2015). This report addendum documents an additional flora and fauna assessment conducted for the Lyons East to Gatti Road part of the Project, specifically for the Miling Bypass, and is supplementary to Phoenix (2015). The additional assessment was conducted between April and September 2016.

1.1 STUDY AREA

The study area for the additional flora and fauna assessment of Miling Bypass (referred to in this report as **MB study area**; 398.23 ha) is shown in Figure 1-1. It includes part of the original Lyons East to Gatti Road study area and additional areas not surveyed in the initial flora and fauna assessment (Phoenix 2015). The MB study area extends from straight line kilometre (SLK) 177.30 to 186.34.

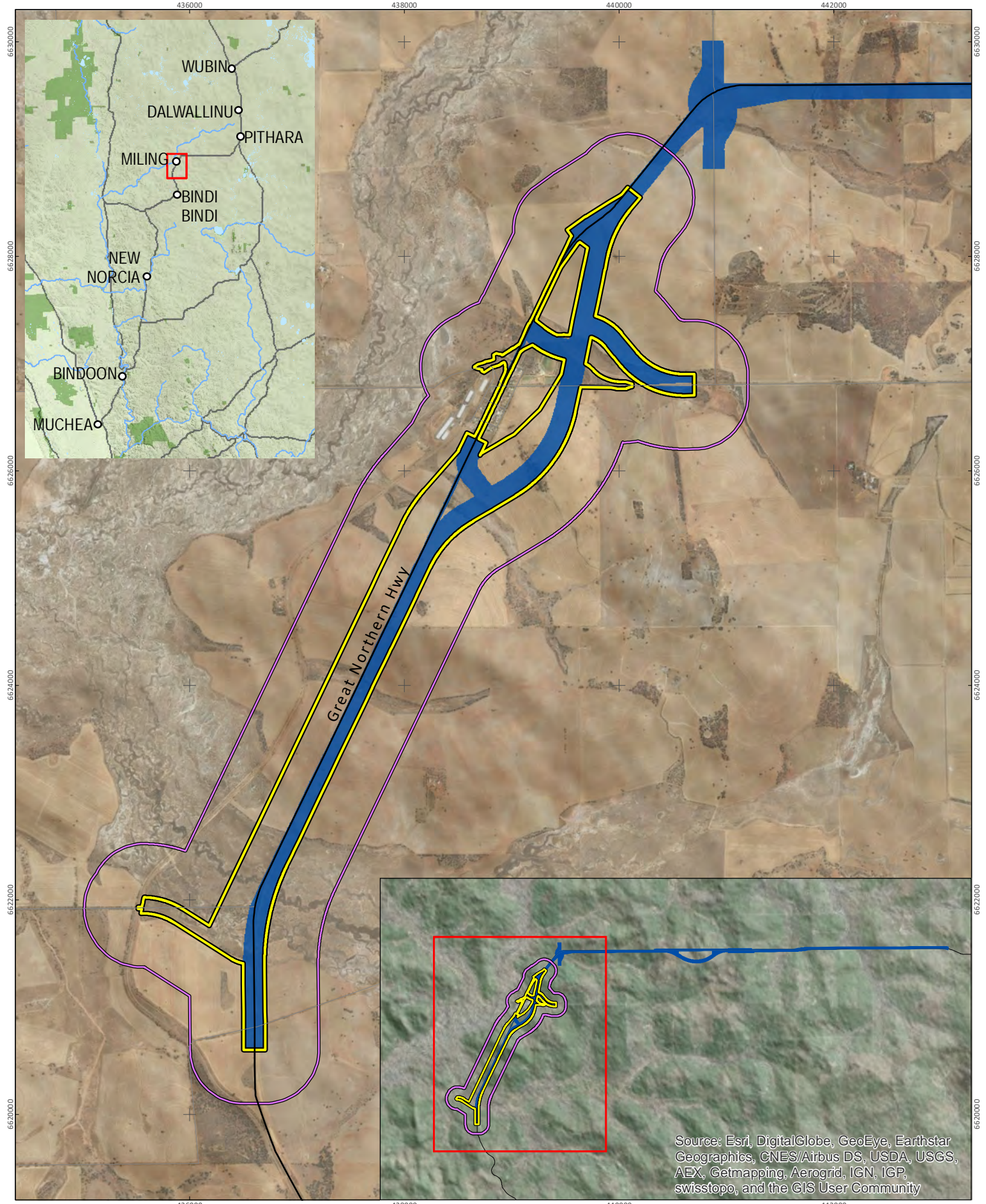
This report also documents vegetation extrapolation mapping undertaken within 500 m either side of the MB study area (referred to as **extrapolation study area**; 244.25 ha).

1.2 SCOPE OF WORK

The scope of works for the MB study area is as follows:

- Level 2 flora and vegetation survey including
 - two seasons of sampling in previously unsurveyed areas
 - second season of quadrat sampling in areas surveyed only once and ground-truthing the accuracy of vegetation association and vegetation condition
 - targeted searches for potentially occurring conservation significant flora identified from the desktop review (Phoenix 2015)
- intensive transect searches for the Threatened orchid *Caladenia drakeoides* listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in areas identified as suitable habitat
- detailed field assessment and mapping distribution of the Eucalypt Woodlands of the Western Australian Wheatbelt Threatened Ecological Community (TEC)
- Level 1 and where necessary targeted conservation significant fauna survey in previously unsurveyed areas
- survey of black cockatoo species including potential breeding trees, roosting and breeding sites, and mapping of breeding and foraging habitat in previously unsurveyed areas.

The scope of work in the extrapolation study area entailed extrapolation of remnant native vegetation associations using vegetation mapping of the MB study area and aerial photography.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Jacobs
 Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum
 Project No 1024
 Date 06-Dec-16
 Drawn by KW
 Map author KC

0 0.25 0.5 1 1.5
 Kilometres

1:45,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Previously surveyed areas
- Extrapolation study area

Figure 1-1
Miling Bypass study area



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2 METHODS

Survey methodology was consistent with that employed in previous surveys of the Lyons East Road to Gatti Road study area (Phoenix 2015) and was conducted in accordance with the relevant state and federal guidelines:

- Environmental Protection Authority (EPA) Guidance Statement No. 51: Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (EPA 2004b).
- Technical Guide: Flora and vegetation surveys for environmental impact assessment (EPA & DPaW 2015).
- Position Statement No. 3: Terrestrial biological surveys as an element of biodiversity protection (EPA 2002).
- EPA and Department of Parks and Wildlife (DPaW) Technical guide: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA & DEC 2010)
- EPBC Act referral guidelines for threatened black cockatoo species (DSEWPaC 2012)
- EPBC Act survey guidelines for Australia's threatened orchids. Guidelines for detecting orchids listed as 'Threatened' under the Environmental Protection and Biodiversity Conservation Act 1999 (Department of the Environment 2014).

2.1 DESKTOP REVIEW

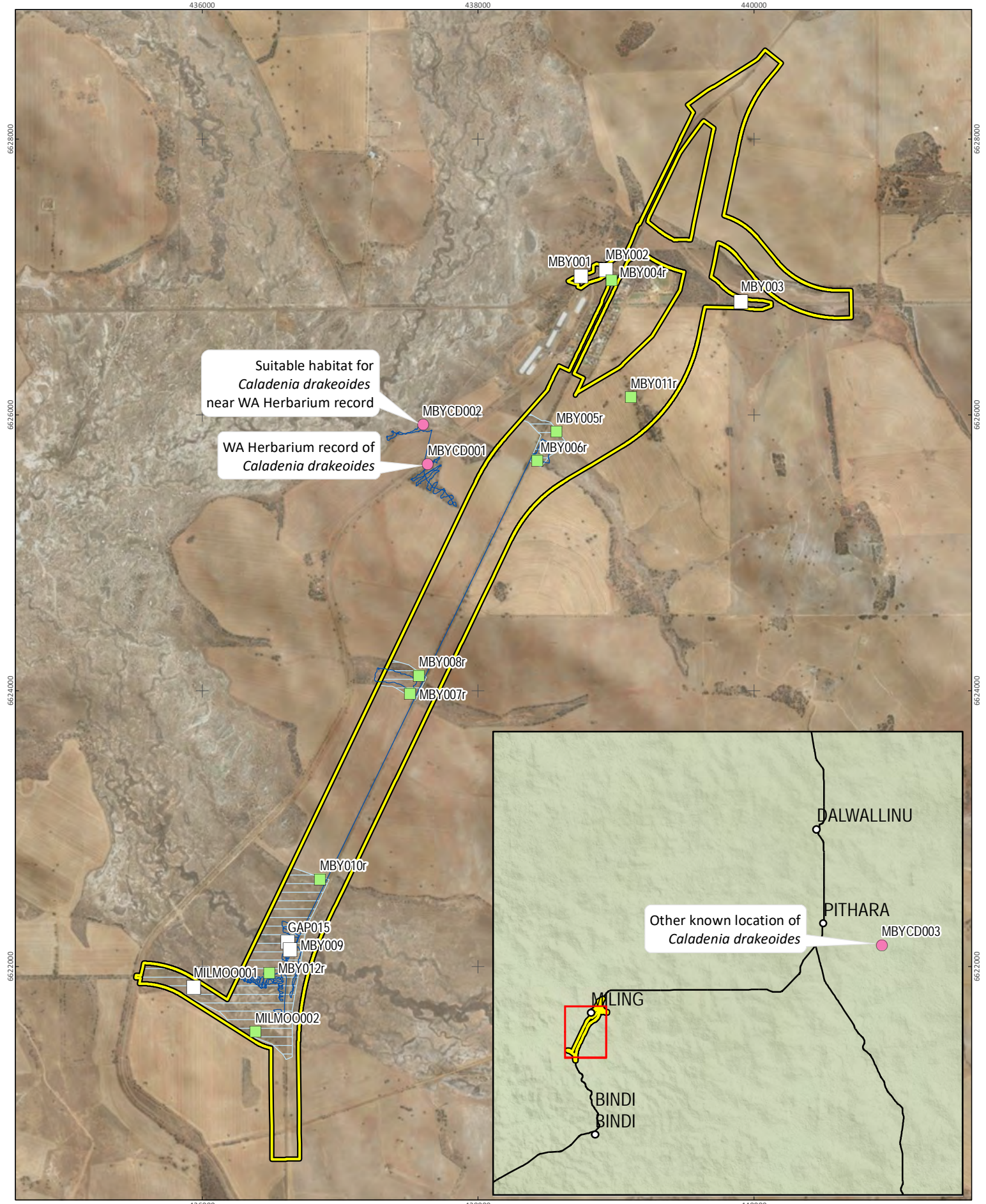
2.2 LEVEL 2 FLORA AND VEGETATION SURVEY

2.2.1 Quadrat and relevé selection

A total of four new flora quadrats and eight new relevés were sampled in the MB study area in April 2016 (Figure 2-1; Appendix 1). Quadrat locations were selected to ensure that an adequate representation of the major vegetation types and flora present was sampled, and considered existing quadrat locations in adjacent previously surveyed areas.

All 12 previously sampled sites were re-sampled in September 2016. In addition, two quadrats (GAP015 and MILMOO001) and one relevé (MILMOO002) were sampled in small sections added to the MB study area.

Quadrat and relevé sampling was conducted in accordance with the methods outlined in (Phoenix 2015).



Suitable habitat for *Caladenia drakeoides* near WA Herbarium record

WA Herbarium record of *Caladenia drakeoides*

Other known location of *Caladenia drakeoides*



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 Project No 1024
 Date 06-Dec-16
 Drawn by KW
 Map author KC

0 0.25 0.5 1 1.5
 Kilometres
 1:35,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Quadrat
- Relevé
- Quadrat: known locations for *Caladenia drakeoides*
- Transects searches for *Caladenia drakeoides*
- Targeted search areas for *Caladenia drakeoides*

Figure 2-1
Survey sites

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2.2.2 Vegetation community and condition mapping

The vegetation descriptions from quadrats were grouped according to similarity of community structure (i.e. canopy levels) and species composition. These were then matched with vegetation associations of Shepherd *et al.* (2002) based on predominant overstorey species or combination of species and prevalent community structure, in accordance with methods outlined in Phoenix (2015). The vegetation boundaries were mapped utilising high quality colour aerial photography (supplied) and from vegetation boundaries recorded on a global positioning system (GPS) during the field survey. Vegetation mapping also considered mapped vegetation associations in adjacent previously surveyed areas, where relevant.

In the follow up survey in September 2016, the accuracy of the mapping was checked by re-sampling surveyed quadrats and groundtruthing boundaries in the field.

2.2.3 Targeted flora searches

Targeted searches for conservation significant flora were undertaken in April, May and September 2016 and focussed on species identified in the desktop review (Phoenix 2015) as relevant to MB study area (Table 2-1). The status of conservation significant flora from the desktop review was also checked against the EPBC Act, the *Wildlife Conservation Act 1950* (WC Act), and the DPaW Priority flora list prior to the survey.

In the field, targeted searches and data collection were conducted in accordance with methods outlined in Phoenix (2015). The searches focussed on habitats considered likely to contain or support conservation significant flora, with most remnant vegetation patches traversed by foot. Searches were conducted at the locations of all known previous records of conservation significant flora in the gaps study area to re-locate these populations.

Table 2-1 Target conservation significant flora in MB study area

| Species | EPBC Act ¹ | WA Status ¹ |
|----------------------------------------------------------|-----------------------|------------------------|
| <i>Acacia trinalis</i> | | P1 |
| <i>Caladenia cristata</i> | | P1 |
| <i>Caladenia drakeoides</i> | EN | EN |
| <i>Chamelaucium</i> sp. Wongan Hills | | P3 |
| <i>Frankenia glomerata</i> | | P4 |
| <i>Gastrolobium appressum</i> | VU | EN |
| <i>Gastrolobium rotundifolium</i> | | P3 |
| <i>Grevillea asparagoides</i> | | P3 |
| <i>Grevillea bracteosa</i> subsp. <i>bracteosa</i> | | EN |
| <i>Urodon capitatus</i> | | P3 |
| <i>Verticordia muelleriana</i> subsp. <i>muelleriana</i> | | P3 |
| <i>Verticordia venusta</i> | | P3 |

1 EN – Endangered; VU – Vulnerable; P1, P3, P4 – Priority 1, 3, 4.

2.3 TRANSECT SEARCHES FOR *CALADENIA DRAKEOIDES*

The EPBC Act listed orchid *Caladenia drakeoides* (EN) was identified in the desktop review as occurring within a 10 km buffer of the Lyons East to Gatti Road study area (Phoenix 2015). The closest DPaW record to the MB study area was identified within 2 km (DPaW 2016b) and an additional record of *C. drakeoides* was known by orchid specialist Dr Andrew Batty approximately 35 km to the east of the MB study area (Figure 2-1).

Habitat suitability area for *C. drakeoides* in the MB study was assessed based on existing vegetation mapping and field reconnaissance. Some areas on the fringe of saline patches were identified as suitable habitat (Figure 2-1), therefore transect searches were undertaken for the species in accordance with the EPBC Act orchid survey guidelines (Department of the Environment 2014).

Prior to the commencement of the transect searches in the MB study area, suitable timing for the survey was confirmed by visiting the nearby known populations (Figure 2-1) where habitat was assessed utilising survey methods consistent with quadrat sampling (Phoenix 2015) and supplemented with transect foot searches spaced at 5-10 m intervals.

As flowering was considered optimal with approximately 60% of individuals at the known location observed to be in early to full flower, parallel transect foot searches were undertaken at 5-10 m spacing in suitable habitat in the MB study area (Figure 2-1), marking any evidence of presence, e.g on-ground markers of emergent leaves. To maximise the likelihood of detection, search efforts were intensified in areas of Very Good to Excellent condition, moist habitats adjacent to salt lakes and habitats associated with saline waterways/depressions known to be favoured by *C. drakeoides*.

2.4 EVALUATION OF THE EUCALYPT WOODLANDS OF THE WESTERN AUSTRALIAN WHEATBELT EPBC ACT LISTED TEC

Assessment and mapping of the extent of the EPBC Act listed Eucalypt Woodlands of the Western Australian Wheatbelt TEC in the MB study area was undertaken using a key and customised data collection template derived from conservation advice for TEC (Threatened Species Scientific Committee 2015) (Appendix 2). At the time of writing the initial report (Phoenix 2015), this community was only listed as a Priority 3 Priority Ecological Community (PEC). The presence of this PEC was preliminarily identified in the initial flora and fauna assessment in the Lyons East Road to Gatti Road study area.

The detailed TEC assessment was conducted at all quadrat sites (Figure 2-1 **Appendix 1**). In determining the presence of the TEC, features of the remnant woodland patch including vegetation condition, patch size (or in the case of roadside patches, patch width) and the density of mature trees (an average of 5 mature trees per 0.5 ha) were considered in accordance with the conservation advice.

Prior to undertaking the field assessment, maps of the remnant woodland patches potentially representing the TEC in the MB study area were uploaded to digital tablets for identifying the size of each patch where required (i.e. where vegetation was in good or degraded condition). Suitable patches were foot-searched and the number of mature trees counted to determine if density was sufficient to be considered TEC.

2.5 EXTRAPOLATION OF REMNANT NATIVE VEGETATION ASSOCIATIONS

Remnant native vegetation was extrapolated in accordance with methodology outlined in the Technical Guide (EPA & DPaW 2015). Vegetation associations mapped in the MB study area and mapped previously (Phoenix 2015), were assigned to native vegetation present within 500 m on both sides of the survey corridor by matching similar features visible on high quality colour aerial photography (supplied), native vegetation extent shapefile and contour lines utilising ArcGIS.

2.6 LEVEL 1 AND TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEY

The level 1/targeted level 2 fauna assessment in previously unsurveyed areas of MB study area entailed:

- habitat assessment and mapping
- assessment of likelihood of occurrence within the study area for conservation significant fauna
- targeted searches for conservation significant species.

Survey methods were consistent with those in Phoenix (2015).

Targeted searches for conservation significant fauna focussed on species identified in the desktop review in Phoenix (2015). The current status of Threatened and Priority fauna was checked prior to the survey. Searches were conducted in areas containing suitable habitat.

2.7 SURVEY OF BLACK COCKATOO SPECIES

The following assessment was conducted for black cockatoo species in the previously unsurveyed study area:

- survey of potential breeding trees, roosting sites and feeding sites for black cockatoo species, particularly Carnaby's Black Cockatoo
- mapping of breeding and foraging habitat for Carnaby's Black Cockatoo
- mapping of foraging habitat for Forest Red-tailed Black Cockatoo.

Survey methods were consistent with those in Phoenix (2015).

2.8 TAXONOMY AND NOMENCLATURE

Species that were well known to the survey botanists were identified in the field, while unknown and unconfirmed species were collected and assigned a unique number to facilitate tracking. All plant voucher specimens collected during the field program were preserved in accordance with the requirements of the WA Herbarium. Plant species were identified using local and regional flora taxonomic keys, and comparisons with named species held at the WA Herbarium.

The conservation status of all recorded flora was compared against the current lists available on FloraBase (DPaW 2016a), Protected Matters Database (Department of the Environment and Energy 2016) and recent changes introduced in WA Government Gazette number 166 (Western Australian Government 2015). Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DPaW 2016a) and the WA Herbarium.

2.9 SURVEY PERSONNEL

The personnel involved in the survey are presented below (Table 2-2).

Table 2-2 Project team

| Name | Qualifications | Role/s |
|-------------------|---------------------------|------------------------------------------------|
| Mrs Karen Crews | BSc (Env. Biol.) (Hons) | Project Manager, report review |
| Dr Grant Wells | PhD (Botany) | Field surveys, taxonomy |
| Dr Grace Wells | PhD (Plant Conservation) | GIS, vegetation mapping, report writing |
| Dr Andrew Batty | PhD (botany) | Field surveys, taxonomy |
| Mr Jarrad Clark | BSc (Env. Mgt.) | Field surveys, data management, report writing |
| Ms Anna Leung | BSc (Env. Sci.) (Hons) | Field surveys, data analysis |
| Mrs Kathryn Wyatt | B. Information Technology | GIS |

3 RESULTS

3.1 SURVEY LIMITATIONS

The limitations of the surveys have been considered in accordance with the potential survey limitations listed in Guidance Statement 51 (EPA 2004b) and Guidance Statement 56 (EPA 2004a) (Table 3-1).

Table 3-1 Limitations and constraints associated with the field survey

| Variable | Impact on survey outcomes |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Availability of contextual information | Not a constraint. Existing information on the vegetation and land systems of the study area has been mapped by Shepherd <i>et al.</i> (2002). Access to online floristic records and information including previous studies undertaken on or near the study area provided adequate information on the vegetation of the study area. |
| Access problems | Not a constraint. No access problems were encountered during the field survey and most the study area (open paddocks excepted) was traversed by foot. Where required, property owners were notified and entry was gained. |
| Experience levels | Not a constraint. The survey was undertaken by suitably qualified and experienced botanists. |
| Timing, weather, season | Not a constraint. Flora surveys were undertaken in the study area during the appropriate seasons according the relevant EPA guidelines. Weather and climate leading up to the 2016 survey was ideal for the survey timing. I.e. the study area received sufficient rainfall and normal temperatures the preceeding winter, with Dalwallinu weather station recording above average rainfall and cooler temperatures in the six months preceeding the survey (BoM 2016). Survey timing was considered optimal for <i>Caladenia drakeoides</i> searches, as approximately 60% of individuals at the known location were observed to be in early to full flower at the time the searches were undertaken in the MB study area. |
| Disturbances | Slight constraint. Large sections of the study area were in degraded to completely degraded condition from multiple historical disturbances, particularly clearing and weed infestation, making it difficult to discern changes in vegetation association in some areas. |
| Survey intensity | Not a constraint. All patches of remnant and planted vegetation were traversed by foot in search of conservation significant flora. Transect searches were conducted for <i>Caladenia drakeoides</i> at appropriate spacings, in accordance with the EPBC Act orchid survey guidelines (Department of the Environment 2014). |
| Completeness | Not a constraint. All prospective conservation significant flora habitats were traversed by foot during the survey. |
| Determination | Not a constraint. Determinations regarding taxonomy and conservation status of flora were made on the basis of current classifications and no limitations were encountered in this regard. |

3.2 FLORA AND VEGETATION

A total of 58 plant taxa (including subspecies and varieties) representing 38 genera and 15 families were recorded in the MB study area in the additional surveys. This total is comprised of 38 (66%) native species and 20 (34%) introduced (weed) species, and included 20 annual and 38 perennial species (Appendix 3). The most prominent families were Chenopodiaceae (20), Asteraceae (9) and Poaceae (9) (Appendix 3).

Of a total of 251 species recorded for the Lyons East Road to Gatti Road and MB study areas up to the current time, 16 of the species are new collections (spring 2016).

3.2.1 Conservation significant flora

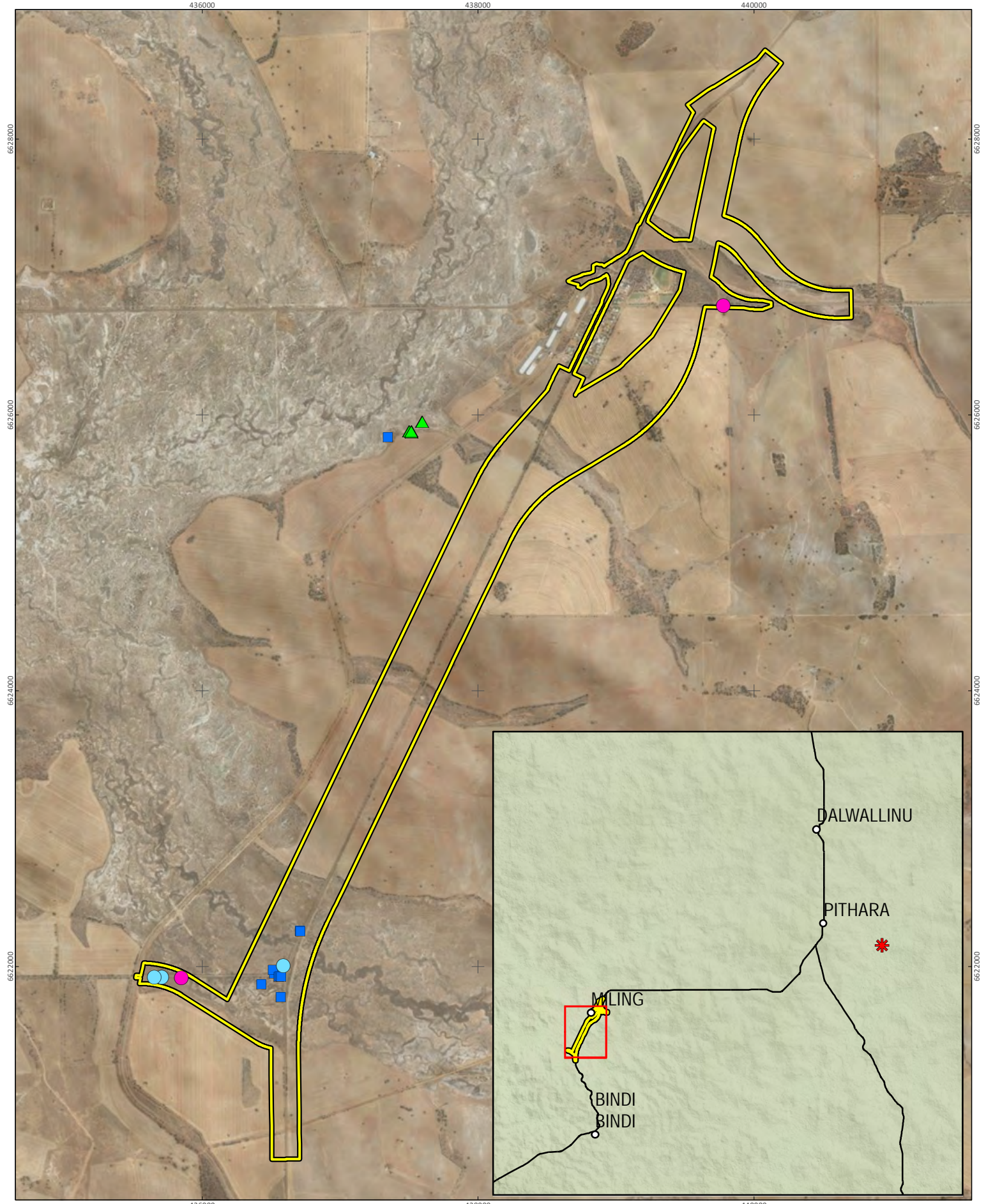
One conservation significant flora species was recorded in the MB study area, *Chamelaucium* sp. Wongan Hills, listed as Priority 3 by DPaW. A population of this species was recorded in the MB study area in the initial surveys (Phoenix 2015). The population was extended in the additional surveys with 17 new plants recorded in April 2016 and an additional two plants recorded in September 2016 (Figure 3-2). The records are primarily from succulent steppe/samphire habitats (631 and 676). A new population was also recorded outside the MB study area at the location of the *Caladenia drakeoides* habitat characterisation (Figure 3-2). The identity of *C.* sp. Wongan Hills from the survey was confirmed by the WA Herbarium. *Chamelaucium* sp. Wongan Hills is typically found in the Avon Wheatbelt, Geraldton Sandplains and Yalgoo bioregions (DPaW 2016a). The species is known from 24 records (DPaW 2016a), one of which is located in a nature reserve.

Frankenia glomerata was not recorded within the MB study area in the additional surveys, but was recorded in quadrats completed for the *C. drakeoides* habitat characterisation, just outside of the MB study area. *F. glomerata* was previously recorded in the MB study area in the earlier surveys (Phoenix 2015). The species has a wide distribution with records from the Avon Wheatbelt, Coolgardie, Gascoyne, Geraldton Sandplains, Great Victoria Desert, Little Sandy Desert, and Mallee bioregions (DPaW 2016a).

Caladenia drakeoides was not recorded in the MB study area but was confirmed at one of the known locations outside the study area (MBYCD003), approximately 35 km to the east, with several flowering individuals found at this location on the margin of a salt lake (Figure 3-1; Figure 3-2). *C. drakeoides* was not confirmed at the known location (recorded 20/09/1986) 2 km east of the MB study area. The habitat at this location was assessed as unsuitable for the species; however, suitable habitat was identified approximately 400 m from this location (Figure 2-1). Transect searches of this area did not return *C. drakeoides* records. *C. drakeoides* is a perennial herb which typically grows in the margins around salt lakes with records from the Avon Wheatbelt and Geraldton Sandplains bioregions (DPaW 2016a). The species has only been recorded twice since 2003 (DPaW 2016a).



Figure 3-1 *Caladenia drakeoides* recorded at site MBYCD003, outside MB study area



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| | |
|------------|-----------|
| Project No | 1024 |
| Date | 06-Dec-16 |
| Drawn by | KW |
| Map author | KC |

0 0.25 0.5 1 1.5
 Kilometres

1:35,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Conservation significant flora
 - T. Caladenia drakeoides*
 - P3, *Chamaelacium* sp. Wongan Hills (B.H. Smith 1140)
 - P4, *Frankenia glomerata*
- Declared pests
 - *Echium plantagineum*
 - *Opuntia monacantha*

Figure 3-2
Conservation significant flora and declared pests

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 ENVIRONMENTAL SCIENCES

3.2.2 Introduced flora

Two of the 20 introduced flora recorded in the additional surveys are declared pests, *Echium plantagineum* and *Opuntia monacantha* (Figure 3-2). *O. monacantha* is also a Weed of National Significance (WoNS). Both species were recorded in previous surveys in the MB study area but the records reported here are additional to those earlier records.

3.2.3 Range extensions

The records from the MB study area did not represent a range extension for any of the flora recorded.

3.2.4 Vegetation associations

Six vegetation associations mapped in the MB study area (Table 3-2; Figure 3-3). No new vegetation associations were mapped to those previously reported in Phoenix (2015). Only two vegetation associations were mapped by Shepherd *et al.* (2002) in the MB study area, 142 and 631.

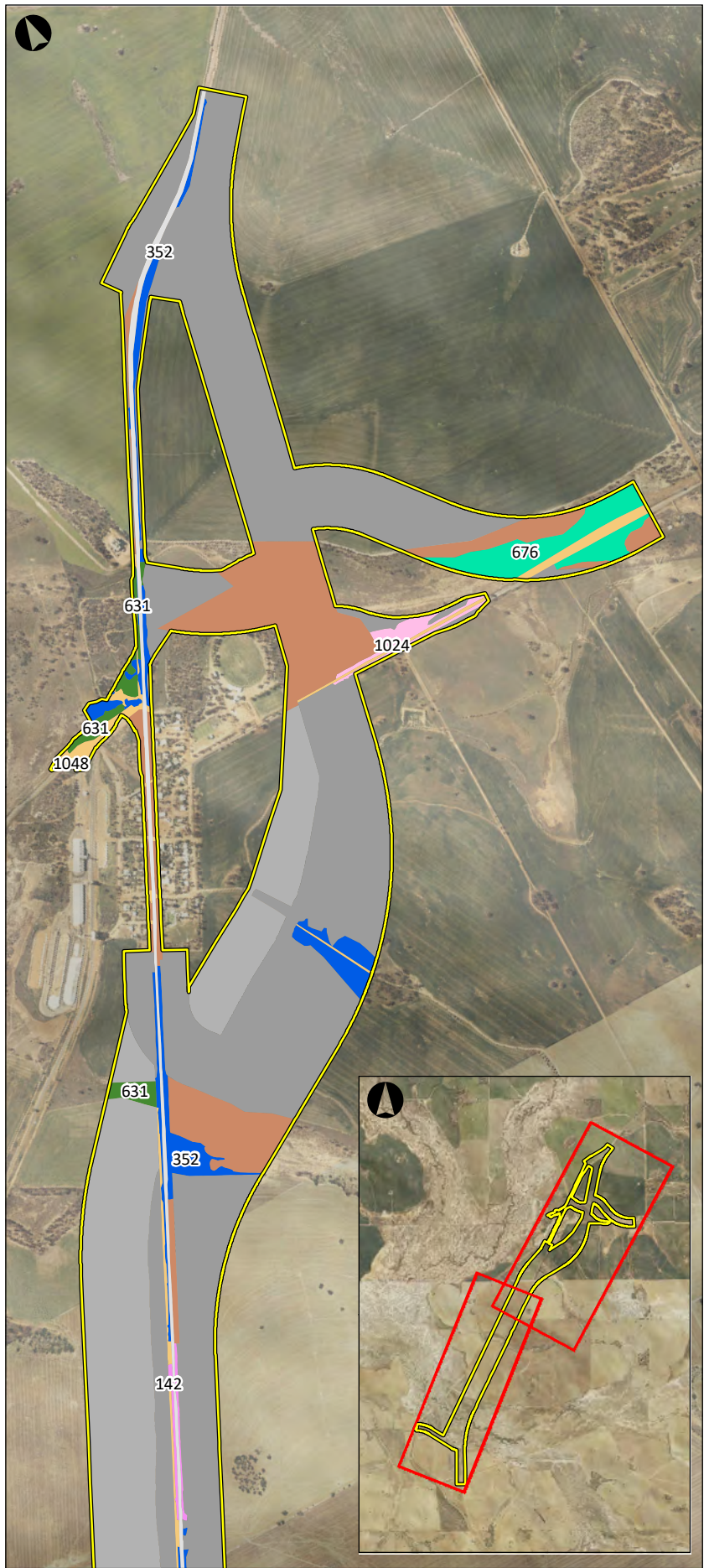
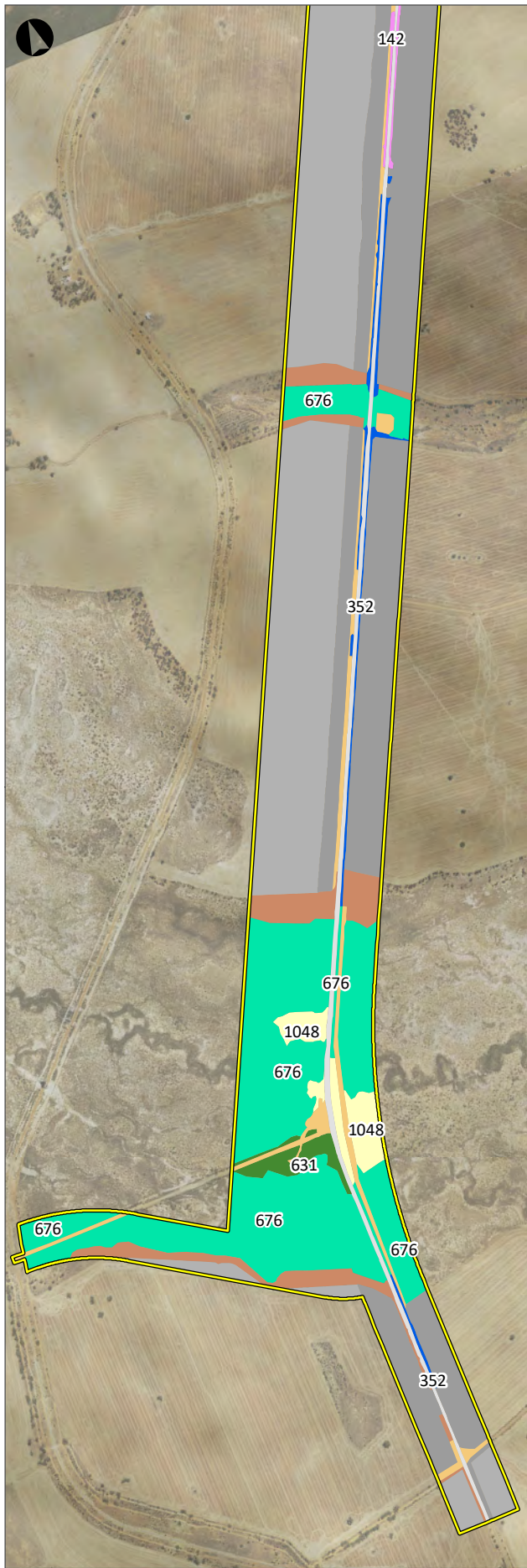
The vegetation present represents low to mid Eucalypt woodlands with *Melaleuca* and *Casuarina* thickets, succulent steppe shrublands (samphire, *Tecticornia* spp.), scattered trees and mosaics of shrublands and samphires.

Table 3-2 Vegetation associations in the MB study area

| Code | Vegetation Description as per Shepherd <i>et al.</i> 2002 | Quadrat | Vegetation description (current survey) |
|------|---------------------------------------------------------------------------------------------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 142 | Medium woodland; York Gum and Salmon Gum | P5.16 ¹ | Isolated tall <i>Eucalyptus salmonophloia</i> trees over a low open <i>E. ebbanoensis</i> subsp. <i>ebbanoensis</i> and <i>E. ewartiana</i> mallee forest over isolated low <i>Maireana brevifolia</i> , <i>Enchylaena tomentosa</i> and <i>Rhagodia</i> sp. Watheroo shrubs over isolated low <i>Ehrharta calycina</i> tussock grasses and low isolated <i>Ptilotus divaricatus</i> and <i>Sclerolaena diacantha</i> forbs. |
| 352 | Medium woodland; York Gum | MBY002, MBY006r, MBY0011r | Mid <i>Eucalyptus loxophleba</i> open forest over mid <i>Santalum acuminatum</i> and <i>Melaleuca eleuterostachya</i> shrubland over low <i>Atriplex semibaccata</i> and <i>Maireana brevifolia</i> chenopod shrubland over low <i>Avena barbata</i> and <i>Bromus diandrus</i> tussock grassland. |
| 631 | Succulent steppe with woodland and thicket; York gum over <i>Melaleuca thyooides</i> and samphire | MBY001, MBY0012r | Isolated low <i>Eucalyptus loxophleba</i> trees over isolated tall <i>Melaleuca acuminata</i> shrubs over sparse mid <i>Acacia ancistrophylla</i> var. <i>ancistrophylla</i> and <i>Rhagodia drummondii</i> shrubland over sparse low <i>Maireana brevifolia</i> and <i>Tecticornia undulata</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> tussock grasses and low open <i>Mesembryanthemum nodiflorum</i> forbland. |
| 676 | Succulent steppe; samphire | MBY009 | Low open <i>Tecticornia</i> spp. and <i>Rhagodia drummondii</i> chenopod shrubland over isolated low <i>Avena barbata</i> , <i>Eragrostis curvula</i> and <i>Lolium rigidum</i> tussock grasses and low sparse <i>Mesembryanthemum nodiflorum</i> forbland. |
| | | MILMOO001 | Low <i>Tecticornia indica</i> subsp. <i>bidens</i> shrubland over low <i>Lolium rigidum</i> , <i>Bromus diandrus</i> and <i>Vulpia myuros</i> forma <i>myuros</i> tussock grassland and isolated ow <i>Didymanthus roei</i> , |

| Code | Vegetation Description as per Shepherd <i>et al.</i> 2002 | Quadrat | Vegetation description (current survey) |
|------|--------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | | * <i>Arctotheca calendula</i> and <i>Trifolium arvense</i> forbs. |
| | | GAP015 | Mid sparse <i>Rhagodia drummondii</i> shrubland over low closed <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>T. pergranulata</i> subsp. <i>pergranulata</i> chenopod shrubland over low * <i>Lolium rigidum</i> grassland. |
| 1024 | Shrublands; mallee and <i>Casuarina</i> thicket | MBY003 | Low <i>Eucalyptus leptopoda</i> and <i>E. loxophleba</i> woodland over low open <i>Atriplex codonocarpa</i> , <i>A. semibaccata</i> and <i>Maireana brevifolia</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> and * <i>Bromus diandrus</i> tussock grasses and isolated low * <i>Mesembryanthemum nodiflorum</i> forbs. |
| 1048 | Mosaic: Shrublands; <i>Melaleuca</i> patchy scrub / succulent steppe; samphire | P5.9 ¹ | Tall <i>Hakea preissii</i> shrubland over low open <i>Rhagodia</i> sp. Watheroo and <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>T. lepidosperma</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> , * <i>Avena barbata</i> and * <i>Lolium rigidum</i> tussock grasses and low sparse <i>Pogonolepis muelleriana</i> and <i>Eriochiton sclerolaenoides</i> forbs and isolated <i>Comesperma integerrima</i> vines. |

¹ Quadrat sampled in the initial survey (Phoenix 2015). Site is representative of the vegetation association in MB study area.



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| | |
|------------|-----------|
| Project No | 1024 |
| Date | 06-Dec-16 |
| Drawn by | KW |
| Map author | KC |

0 200 400 800
 Metres

1:20,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- 1024 - Shrublands; Mallee and *Casuarina* thicket
- 142 - Medium woodland; York Gum and Salmon Gum
- 1048 - Mosaic: Shrublands; *Melaleuca* patchy scrub/succulent steppe; samphire
- 352 - Medium woodland; York Gum
- Cleared
- 631 - Succulent steppe with woodland and thicket; York Gum over *Melaleuca thyoidea* and samphire
- Cleared and Planted
- 676 - Succulent steppe; samphire
- GNH
- Pasture
- Pasture and Cleared

Figure 3-3
Vegetation associations



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3.2.5 Vegetation condition

The condition of remnant native vegetation across the MB study area ranged from Excellent to Degraded (Figure 3-4; Table 3-3). Most the MB study area (79%) was mapped as Completely Degraded, representing cleared (3%), cleared and planted (10%), pastures (64%) and GNH road reserve (3%). Patches of Good to Degraded vegetation were found in all vegetation associations and represented 26 ha (7%) of the MB study area. Areas in Very Good to Excellent condition accounted for 56 ha (14%) of the MB study area, mostly comprising succulent steppe shrublands, and mosaic of shrublands with scattered trees and succulent steppe (vegetation type 631, 676, 1048).

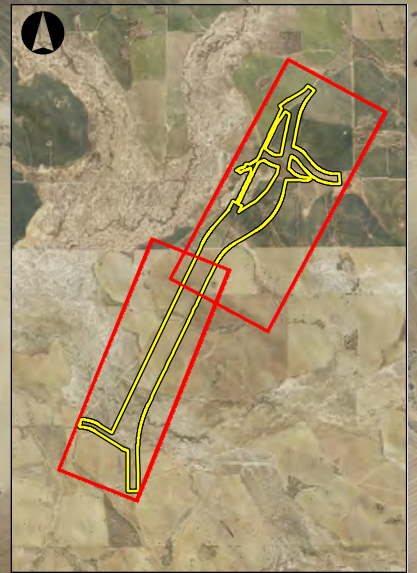
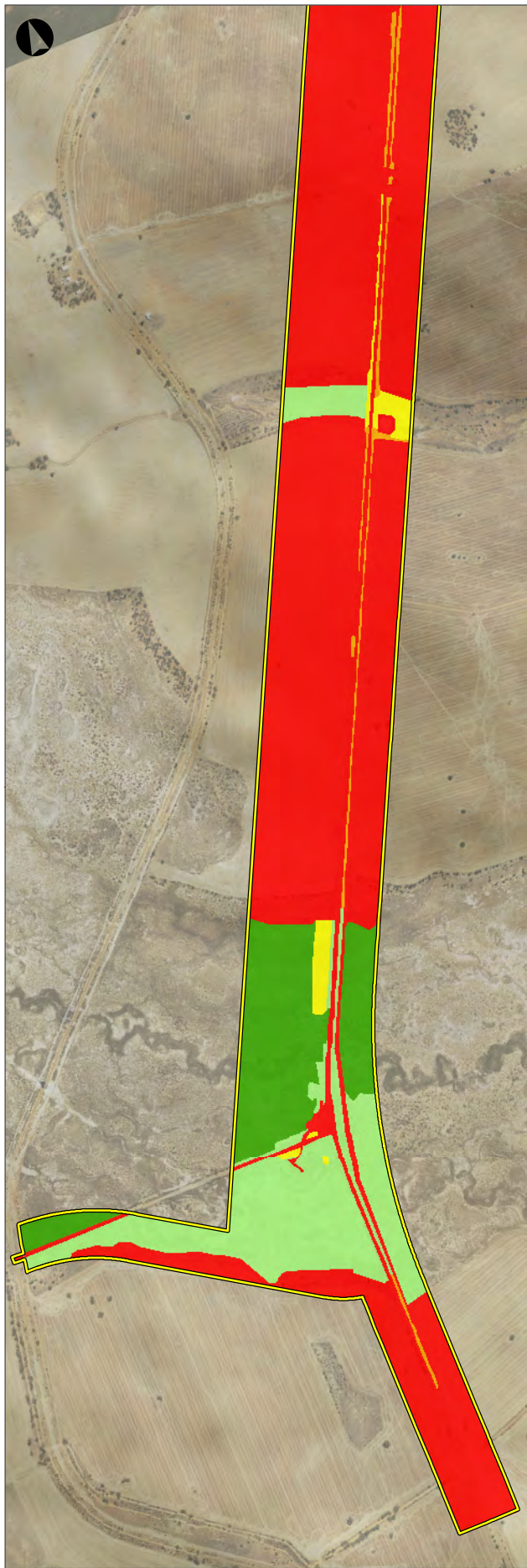
Table 3-3 Vegetation condition in the MB study area

| Condition | Area (ha) | % of MB study area |
|---------------------|-----------|--------------------|
| Completely Degraded | 316 | 79 |
| Degraded | 15 | 4 |
| Good | 11 | 3 |
| Very good | 32 | 8 |
| Excellent | 24 | 6 |

3.2.1 Threatened and Priority ecological communities

None of the remnant vegetation in the MB study area was considered representative of any Commonwealth or State listed TECs, or any State listed PECs.

In the review of all vegetation quadrats in the MB study area against the Eucalypt Woodlands of the Western Australian Wheatbelt TEC diagnostic characteristics (Appendix 4), none were identified as matching the TEC. Four of the five diagnostic characteristics for the TEC could be assigned to five quadrats in the MB study area (Appendix 4); however, the combination of presence of weeds, lack of mature trees, degraded vegetation condition and the overall small area of the vegetation patches did not meet the requirements for the TEC.



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| Map author | KC |

0 100 200 400 600 800
 Metres

1:20,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Vegetation condition
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

Figure 3-4

Vegetation condition



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3.2.2 Local and regional significance of vegetation

Within the MB study area three of the six vegetation associations may be considered locally significant because they (Table 3-4):

- provide habitat for a conservation significant flora species, and/or
- contain excellent condition vegetation that represents patches of comparatively high native species diversity surrounded by highly impacted vegetation.

All three associations were identified as locally significant in the Lyons East Road to Gatti Road study area in the initial assessment (Phoenix 2015). Vegetation association 676 was identified in Phoenix (2015) as locally significant for the Lyons East Road to Gatti Road study area as it represented habitat for conservation significant flora. Additional individuals of *Chamelaucium* sp. Wongan Hills (P3) were recorded in vegetation type 631, 676 and 1048 between March and November 2016.

Table 3-4 Vegetation associations considered locally significant in the MB study area

| Vegetation code | Reason for local significance |
|-----------------|---------------------------------------------------------------------------------------------------------------|
| 631 | Provides habitat for <i>Chamelaucium</i> sp. Wongan Hills (P3) |
| 676 | Contains vegetation in excellent condition and provides habitat for <i>Chamelaucium</i> sp. Wongan Hills (P3) |
| 1048 | Contains vegetation in excellent condition and provides habitat for <i>Chamelaucium</i> sp. Wongan Hills (P3) |

Based on the most current remnant vegetation statistics (Government of Western Australia 2015), three vegetation associations in the MB study area (352, 676 and 1024) may be considered regionally conservation significant as less than 30% of their pre-European extent remains in the Avon Wheatbelt bioregion (Table 3-5).

Table 3-5 Status of vegetation associations recorded in MB study area

| Code | Pre-European extent (ha) ¹ | Current total extent (ha) ¹ | % remaining ¹ | Status ² | Extent in study area (ha) | % of current extent within study area ³ |
|-----------------------|---------------------------------------|----------------------------------------|--------------------------|---------------------|---------------------------|----------------------------------------------------|
| WA | | | | | | |
| 352 | 724,273 | 142,767 | 19.71 | VU | 3.064 | 0.002 |
| 631 | 106,853 | 50,244 | 47.02 | D | 0.502 | 0.001 |
| 676 | 2,063,414 | 1,963,862 | 95.18 | LC | 2.236 | 0.000 |
| 1024 | 742,951 | 87,212 | 11.74 | VU | 1.836 | 0.002 |
| 1048 | 13,815 | 5,582 | 40.40 | D | 0.306 | 0.005 |
| Avon Wheatbelt | | | | | | |
| 352 | 630,582 | 109,441 | 17.36 | VU | 3.064 | 0.003 |
| 631 | 104,051 | 47,875 | 46.01 | D | 0.502 | 0.001 |
| 676 | 124,573 | 30,396 | 24.40 | VU | 2.236 | 0.007 |
| 1024 | 738,927 | 84,626 | 11.45 | VU | 1.836 | 0.002 |
| 1048 | 13,815 | 5,582 | 40.40 | D | 0.306 | 0.005 |

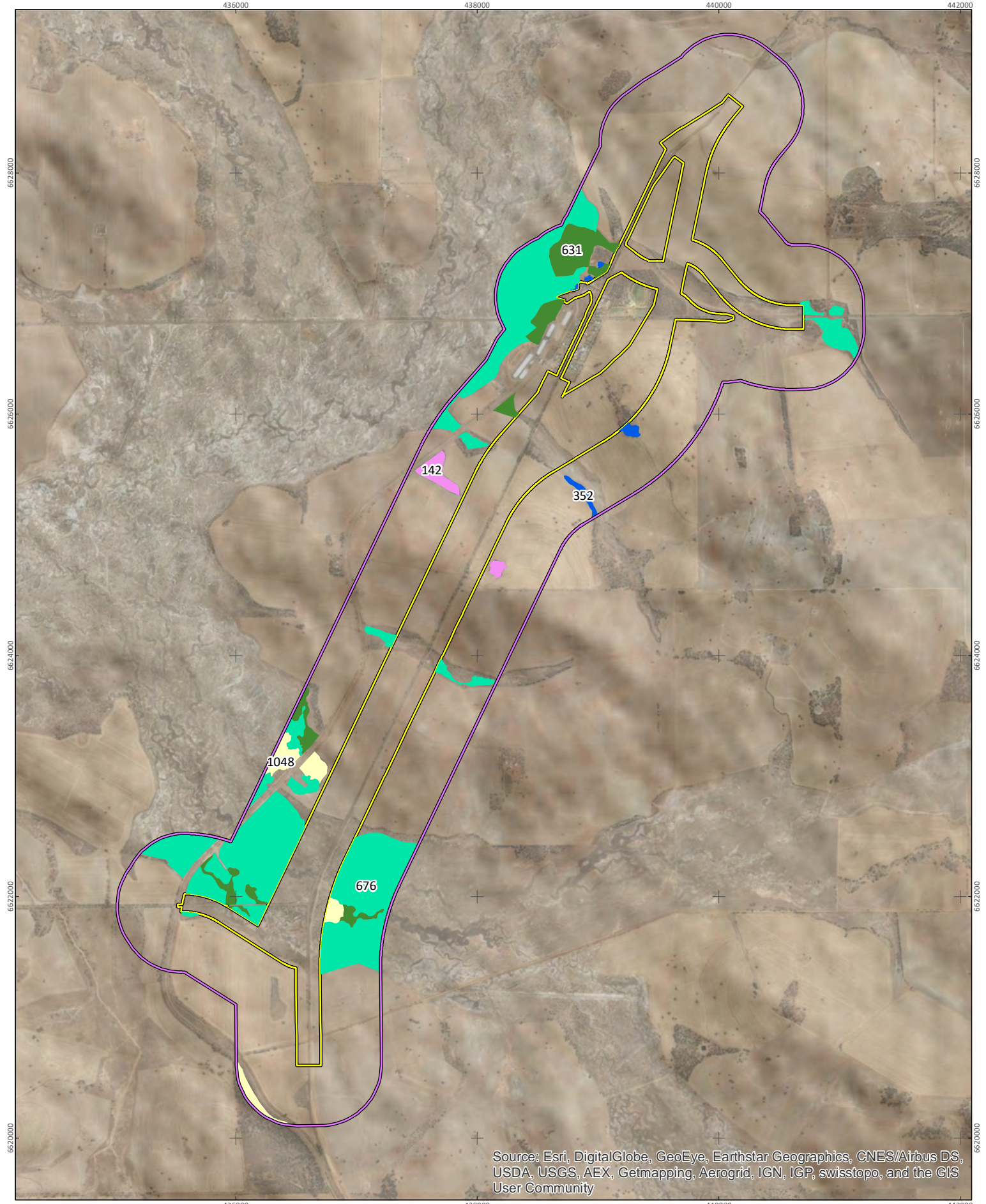
¹ Source: DPaW (2015a). ² VU – vulnerable; D – depleted; LC – least concern. ³ Inaccuracies in broad scale vegetation mapping (Government of Western Australia 2015) may cause the % of current extent within study area to become inflated or deflated.

3.2.1 Extrapolation of remnant native vegetation

Extrapolation of the vegetation mapping identified five vegetation associations covering an area of 244.25 ha in the extrapolation study area. Vegetation association 676 Succulent steppe; samphire represented approximately 76.4% of the mapped vegetation (Table 3-6; Figure 3-5).

Table 3-6 Distribution of extrapolated remnant vegetation in the MB study area

| Code | Vegetation association description as per Shepherd <i>et al.</i> (2002) | Area (ha) |
|--------------|-------------------------------------------------------------------------------------------|---------------|
| 142 | Medium woodland; York Gum and Salmon Gum | 6.40 |
| 352 | Medium woodland; York Gum | 3.77 |
| 631 | Succulent steppe with woodland and thicket; York Gum over Melaleuca thyoides and samphire | 33.03 |
| 676 | Succulent steppe; samphire | 186.62 |
| 1048 | Mosaic: Shrublands; melaleuca patchy scrub / succulent steppe; samphire | 14.44 |
| Total | | 244.25 |



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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 Date 06-Dec-16
 Drawn by KW
 Map author KC

0 0.25 0.5 1 1.5
 Kilometres

1:40,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Extrapolation study area
- 142 - Medium woodland; York Gum and Salmon Gum
- 352 - Medium woodland; York Gum
- 631 - Succulent steppe with woodland and thicket; York Gum over *Melaleuca thyooides* and samphire
- 676 - Succulent steppe; samphire
- 1048 - Mosaic: Shrublands; *Melaleuca* patchy scrub/succulent steppe; samphire

Figure 3-5
Vegetation extrapolated to 500 m

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3.3 FAUNA AND FAUNA HABITAT

Fauna results presented in this section relate only to the previously unsurveyed areas of the MB study area. Results for previously surveyed areas are presented in Phoenix (2015).

3.3.1 Fauna habitats

Five fauna habitat types were defined in the previously unsurveyed areas of the MB study area, including four habitats comprising remnant native vegetation (Figure 3-6):

- Succulent steppe/samphire² – 36.86 ha, 20.8%
- Cleared and revegetated non-native woodland³ – 12.21 ha, 6.9%
- Succulent steppe/samphire with woodland or shrubland² – 5.57 ha, 3.1%.
- Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet) – 2.10 ha, 1.2%
- Shrubland (thicket)⁴ – 1.87 ha, 1.1%.

The remainder (118.87 ha, 67.0%) represents cleared areas (agriculture, road, infrastructure). All of the habitat types were previously documented in MB study area (Phoenix 2015).

The shrubland and woodland habitats were of little value to fauna as native understory was largely absent. These areas of native remnant vegetation are also quite small (all less than 1.5 ha) and isolated from other remnants.

The succulent/steppe habitats are part of a more extensive network of drainage and were considered to have some potential value as a linkage and provide habitat for wading birds. However, they were typically low in vegetation cover and the types of vegetation that provide food sources and as such provide low habitat value to most fauna species.

3.3.2 Conservation significant fauna

No evidence of any conservation significant fauna species was identified in the additional surveys. The likelihood of occurrence assessment conducted for conservation significant fauna in the initial survey (Phoenix 2015) is considered applicable to the new parts of MB study area.

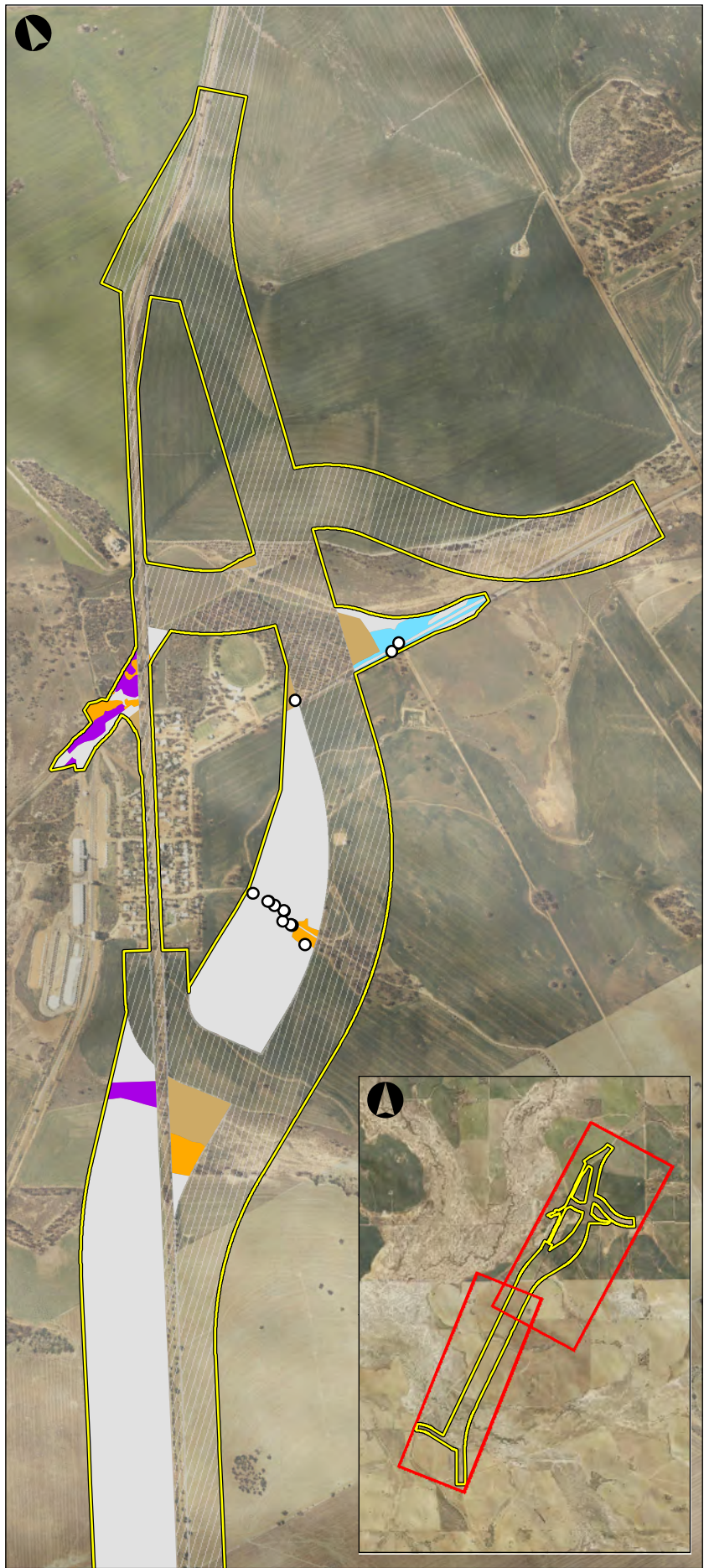
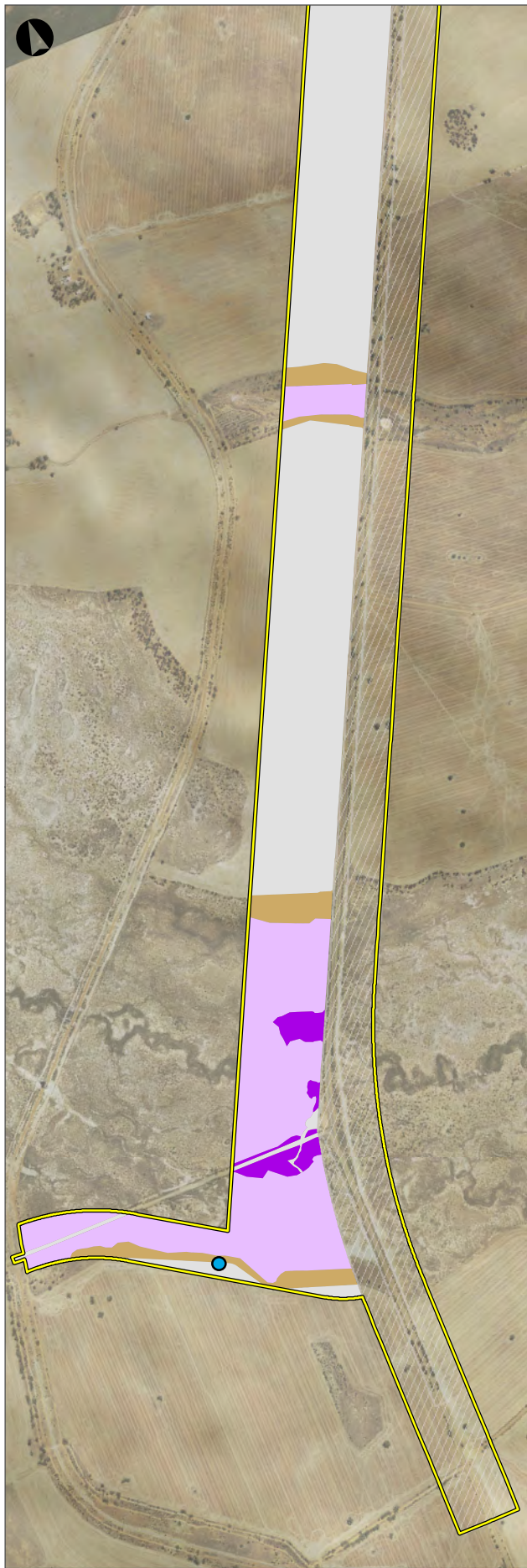
3.3.3 Introduced species

No introduced species were observed directly or indirectly during the survey.

² Referred to in Phoenix (2016) as ‘Samphire flat or samphire flat with low shrubland or woodland’.

³ Referred to in Phoenix (2016) as ‘Cleared and revegetated mosaic’.

⁴ Referred to in Phoenix (2016) as ‘Shrubland (Mallee and Casuarina thickets)’.



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Flora and fauna assessment for the Lyons East Road
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| Project No | 1024 |
| Date | 06-Dec-16 |
| Drawn by | KW |
| Map author | KC |

0 200 400 800
Metres

1:20,000 (at A4) GDA 1994 MGA Zone 50

- Miling Bypass study area
- Previously surveyed areas
- Potential breeding trees
- Potential breeding tree with hollows but not suitable for use by CBC
- Potential breeding tree with hollows

- Fauna Description
- Cleared (agriculture, road, infrastructure)
 - Cleared and revegetated non-native woodland mosaic
 - Shrubland (thicket)
 - Succulent steppe/samphire
 - Succulent steppe/samphire with woodland or shrubland
 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)

Figure 3-6
Fauna habitats and Carnaby's Black Cockatoo potential breeding trees



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3.3.4 Survey of black cockatoo species

Fourteen new potential breeding trees for Carnaby's Black Cockatoo were identified in the MB study area to those recorded in the initial surveys (Figure 3-6; Appendix 5). Only one tree contained hollows but was found to be currently unsuitable as a nesting tree for the species.

Spatial analysis of the extent of breeding habitat for Carnaby's Black Cockatoo in vegetation types representing remnant native vegetation identified an additional 1.74 ha to that previously recorded.

Approximately 0.3 ha of remnant vegetation was mapped as low value foraging habitat for Carnaby's Black Cockatoo; no quality habitat for the species was present. Similarly, no foraging habitat was identified for Forest Red-tailed Black Cockatoo. Succulent/samphire habitats of the MB study area do not support flora species that are food sources for the two black cockatoo species, and the woodland and shrubland habitats contained very few suitable food plants.

4 DISCUSSION

4.1 FLORA AND VEGETATION

The additional surveys of the MB study area did not identify any new significant environmental values to those recorded in the initial assessment of Lyons East Road to Gatti Road study area (Phoenix 2015).

Records of conservation significant flora within the MB study area from the additional surveys were confined to a single Priority 3 species, *Chamelaucium* sp. Wongan Hills, with the new records extending the distribution of a population identified in the initial surveys (Phoenix 2015). No new conservation significant flora populations were recorded in the MB study area.

Targeted transect searches carried out in accordance with EPBC Act orchid survey guidelines (Department of the Environment 2014) for *Caladenia drakeoides* in potential habitat within the study area did not locate any individuals. Considering the following, it is considered unlikely that this species occurs in the study area:

- potential habitat was generally considered marginal when considered in the broader context of suitable habitat for the target species across its known distribution (habitat within the MB study area was confined to four small areas associated with saline depressions or drainage lines)
- survey intensity was conducted at transect spacings of generally 5–10 m in accordance with the guidelines (Department of the Environment 2014), with exceptions to this being in areas that were considered too degraded to support the species
- surveys were completed at optimal times based on monitoring of an extant known population located within approximately 40 km of the MB study area
- surveys were directed by Dr Andrew Batty (orchid specialist) who has over 20 years' experience researching and working with native orchids including the target species. Dr Batty was involved in all targeted orchid transect searches, initial team familiarisation with the target species and inspection of orchids observed during searches
- seasonal rainfall conditions were above average across the study area resulting in one of the best spring flowering events for orchids for several years, based on anecdotal observations.

Of the six vegetation associations identified in the MB study area, associations: 631 Succulent steppe with woodland and thicket, 676 Succulent steppe; samphire and 1048 Mosaic: Shrublands; *Melaleuca* patchy scrub / succulent steppe; samphire may be considered significant as they contained vegetation in excellent condition and provided habitat for conservation significant species, *Chamelaucium* sp. Wongan Hills.

Based on the assessment for presence of the EPBC Act listed Eucalypt Woodlands of the Western Australian Wheatbelt TEC, it is concluded that the Eucalypt Woodlands of the Western Australian Wheatbelt TEC is not present in the MB study area.

The extrapolated remnant vegetation to 500 m either side of the MB study area indicates that the vegetation associations of the study area are representative of associations in the broader vicinity; however, the extrapolated vegetation mapping should be treated as a broad indication of vegetation extent and patterning only. In addition, three vegetation associations are anticipated to support conservation significant flora species. Field surveys are needed to confirm the accuracy of the extrapolated vegetation mapping and to search for conservation significant flora.

4.2 FAUNA AND FAUNA HABITAT

No new fauna values were identified in the additional areas of the MB study area to those already recorded in previous surveys (Phoenix 2015).

The additional survey marginally increased the number of potential breeding trees for Carnaby's Black Cockatoo recorded in the MB study area; however, none of these were considered suitable for current breeding by the species and the assessment did not identify any areas of quality foraging habitat for the species, consistent with the findings of the initial survey for the Lyons East Road to Gatti Road study area (Phoenix 2015).

5 REFERENCES

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Appendix 1 Quadrat data

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | GAP015 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 02/09/2016 | Position: | -30.531113, 116.339338 |
| Total vegetation cover (%): | 95 | Topography: | drainage line |
| Tree/shrub cover >2 m (%): | 0 | Soil colour: | red-brown |
| Shrub cover <2 m (%): | 80 | Soil: | sandy clay |
| Grass cover (%): | 40 | Rock type: | none |
| Herb cover (%): | 15 | Fire age: | not evident |
| Disturbance details: | Current operations, evidence of f.eral animals, grazing low, historic clearing, weed infestation | | |
| Vegetation condition: | good, Keighery (1994) | | |
| Vegetation description: | Mid sparse <i>Rhagodia drummondii</i> shrubland over low closed <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>T. pergranulata</i> subsp. <i>pergranulata</i> chenopod shrubland over low <i>Lolium rigidum</i> grassland. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Tecticornia indica</i> subsp. <i>bidens</i> | 65.0 | 00.50 | | |
| <i>Lolium rigidum</i> | 40.0 | 00.50 | * | |
| <i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> | 10.0 | 00.30 | | |
| <i>Cotula bipinnata</i> | 10.0 | 00.20 | * | |
| <i>Sonchus oleraceus</i> | 05.0 | 01.00 | * | |
| <i>Rhagodia drummondii</i> | 04.0 | 00.60 | | |
| <i>Austrostipa nitida</i> | 02.0 | 00.20 | | |
| <i>Atriplex amnicola</i> | 01.0 | 00.60 | | |
| <i>Mesembryanthemum nodiflorum</i> | 01.0 | 00.10 | * | |
| <i>Monoculus monstrosus</i> | 00.1 | 00.40 | * | |
| <i>Medicago polymorpha</i> | 00.1 | 00.30 | * | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | MBY001 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 23/03/2016 | Position: | -30.487659, 116.361748 |
| Total vegetation cover (%): | 40 | Topography: | plain |
| Tree/shrub cover >2 m (%): | 7 | Soil colour: | grey, whitish |
| Shrub cover <2 m (%): | 10 | Soil: | sandy clay, clay loam |
| Grass cover (%): | 10 | Rock type: | none |
| Herb cover (%): | 15 | Fire age: | not evident |
| Disturbance details: | erosion channels, evidence of feral animals, firebreak, grazing – high, historic clearing, large-scale clearing, litter, livestock tracks, vehicle tracks, weed infestation | | |
| Vegetation condition: | degraded, Keighery (1994) | | |
| Vegetation description: | Isolated low <i>Eucalyptus loxophleba</i> trees over isolated tall <i>Melaleuca acuminata</i> shrubs over sparse mid <i>Acacia ancistrophylla</i> var. <i>ancistrophylla</i> and <i>Rhagodia drummondii</i> shrubland over sparse low <i>Maireana brevifolia</i> and <i>Tecticornia undulata</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> tussock grasses and low open * <i>Mesembryanthemum nodiflorum</i> forbland. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|---------------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Arctotheca calendula</i> | 15.0 | 00.10 | * | |
| <i>Mesembryanthemum nodiflorum</i> | 15.0 | 00.10 | * | |
| <i>Didymanthus roei</i> | 10.0 | 00.15 | | |
| <i>Eucalyptus loxophleba</i> | 05.0 | 07.00 | | |
| <i>Melaleuca acuminata</i> | 05.0 | 03.00 | | |
| <i>Rhagodia drummondii</i> | 05.0 | 01.20 | | |
| <i>Bromus rubens</i> | 05.0 | 00.15 | * | |
| <i>Tecticornia undulata</i> | 03.0 | 00.50 | | |
| <i>Maireana brevifolia</i> | 02.0 | 00.50 | | |
| <i>Enchylaena tomentosa</i> | 02.0 | 00.25 | | |
| <i>Acacia ancistrophylla</i> var. <i>ancistrophylla</i> | 01.0 | 01.00 | | |
| <i>Austrostipa elegantissima</i> | 01.0 | 00.50 | | |
| <i>Hordeum leporinum</i> | 01.0 | 00.15 | * | |
| <i>Romulea rosea</i> | 01.0 | 00.15 | * | |
| <i>Avena barbata</i> | 00.1 | 00.40 | * | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------|------|-------|---|
| <i>Sonchus oleraceus</i> | 00.1 | 00.25 | * |
| <i>Lolium rigidum</i> | 00.1 | 00.20 | * |
| <i>Maireana carnososa</i> | 00.1 | 00.20 | |
| <i>Sclerolaena eurotioides</i> | 00.1 | 00.15 | |
| <i>Podolepis capillaris</i> | 00.1 | 00.10 | |
| <i>Sclerolaena diacantha</i> | 00.1 | 00.05 | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | MBY002 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 23/03/2016 | Position: | -30.487215, 116.363649 |
| Total vegetation cover (%): | 60 | Topography: | plain |
| Tree/shrub cover >2 m (%): | 40 | Soil colour: | grey, whitish |
| Shrub cover <2 m (%): | 25 | Soil: | sandy clay, clay loam |
| Grass cover (%): | 50 | Rock type: | none |
| Herb cover (%): | 1 | Fire age: | not evident |
| Disturbance details: | excavation, firebreak, grazing – high, historic clearing, historic operations, large-scale clearing, litter, livestock tracks, vehicle tracks, weed infestation | | |
| Vegetation condition: | degraded, Keighery (1994) | | |
| Vegetation description: | Mid <i>Eucalyptus loxophleba</i> open forest over mid <i>Santalum acuminatum</i> and <i>Melaleuca eleuterostachya</i> shrubland over low <i>Atriplex semibaccata</i> and <i>Maireana brevifolia</i> chenopod shrubland over low <i>*Avena barbata</i> and <i>*Bromus diandrus</i> tussock grassland. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|----------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Avena barbata</i> | 45.0 | 00.40 | * | |
| <i>Eucalyptus loxophleba</i> | 40.0 | 12.00 | | |
| <i>Maireana brevifolia</i> | 20.0 | 00.80 | | |
| <i>Santalum acuminatum</i> | 10.0 | 02.50 | | |
| <i>Atriplex semibaccata</i> | 10.0 | 00.20 | | |
| <i>Bromus diandrus</i> | 05.0 | 00.20 | * | |
| <i>Acacia ligulata</i> | 03.0 | 03.00 | | |
| <i>Melaleuca eleuterostachya</i> | 02.0 | 02.50 | | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchoa to Wubin Upgrade Stage 2 Project

Prepared for Muchoa to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | MBY003 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 24/03/2016 | Position: | -30.489346, 116.373832 |
| Total vegetation cover (%): | 35 | Topography: | undulating plain |
| Tree/shrub cover >2 m (%): | 10 | Soil colour: | brown |
| Shrub cover <2 m (%): | 20 | Soil: | sandy loam |
| Grass cover (%): | 0.5 | Rock type: | none |
| Herb cover (%): | 5 | Fire age: | not evident |
| Disturbance details: | current operations, firebreak, grazing – high, historic clearing, large-scale clearing, litter, livestock tracks, vehicle tracks, weed infestation | | |
| Vegetation condition: | degraded, Keighery (1994) | | |
| Vegetation description: | Low <i>Eucalyptus leptopoda</i> and <i>E. loxophleba</i> woodland over low open <i>Atriplex codonocarpa</i> , <i>A. semibaccata</i> and <i>Maireana brevifolia</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> and <i>*Bromus diandrus</i> tussock grasses and isolated low <i>*Mesembryanthemum nodiflorum</i> forbs. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Atriplex codonocarpa</i> | 10.0 | 00.20 | | |
| <i>Eucalyptus leptopoda</i> | 05.0 | 07.00 | | |
| <i>Eucalyptus loxophleba</i> | 05.0 | 06.00 | | |
| <i>Maireana brevifolia</i> | 05.0 | 00.50 | | |
| <i>Mesembryanthemum nodiflorum</i> | 05.0 | 00.20 | * | |
| <i>Atriplex semibaccata</i> | 05.0 | 00.20 | | |
| <i>Austrostipa elegantissima</i> | 00.1 | 00.50 | | |
| <i>Enchylaena tomentosa</i> | 00.1 | 00.20 | | |
| <i>Bromus rubens</i> | 00.1 | 00.10 | * | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|
| Site: | MBY009 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 05/04/2016 | Position: | -30.53159, 116.339498 |
| Total vegetation cover (%): | 40 | Topography: | salt lake (playa) |
| Tree/shrub cover >2 m (%): | 0 | Soil colour: | brown, whitish |
| Shrub cover <2 m (%): | 30 | Soil: | sandy clay, clay loam |
| Grass cover (%): | 3 | Rock type: | none |
| Herb cover (%): | 10 | Fire age: | not evident |
| Disturbance details: | historic operations, litter, weed infestation | | |
| Vegetation condition: | very Good, Keighery (1994) | | |
| Vegetation description: | Low open <i>Tecticornia</i> spp. and <i>Rhagodia drummondii</i> chenopod shrubland over isolated low <i>Avena barbata</i> , <i>Eragrostis curvula</i> and <i>Lolium rigidum</i> tussock grasses and low sparse <i>Mesembryanthemum nodiflorum</i> forbland. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Tecticornia indica</i> subsp. <i>bidens</i> | 25.0 | 00.60 | | |
| <i>Mesembryanthemum nodiflorum</i> | 10.0 | 00.10 | * | |
| <i>Rhagodia drummondii</i> | 03.0 | 00.60 | | |
| <i>Lolium rigidum</i> | 03.0 | 00.20 | * | |
| <i>Eragrostis curvula</i> | 01.0 | 00.30 | * | |
| <i>Tecticornia undulata</i> | 01.0 | 00.30 | | |
| <i>Austrostipa elegantissima</i> | 00.1 | 00.50 | | |
| <i>Atriplex amnicola</i> | 00.1 | 00.40 | | |
| <i>Maireana brevifolia</i> | 00.1 | 00.30 | | |
| <i>Tecticornia pergranulata</i> | 00.1 | 00.25 | | |
| <i>Avena barbata</i> | 00.1 | 00.20 | * | |
| <i>Atriplex nummularia</i> | 00.1 | 00.15 | | |
| <i>Maireana trichoptera</i> | 00.1 | 00.15 | | |
| <i>Oxalis pes-caprae</i> | 00.1 | 00.05 | * | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | MILMOO001 | Type: | Quadrat (20 m x 20 m) |
| Date(s): | 02/09/2016 | Position: | -30.534037, 116.332212 |
| Total vegetation cover (%): | 55 | Topography: | undulating plain |
| Tree/shrub cover >2 m (%): | 0 | Soil colour: | red-brown |
| Shrub cover <2 m (%): | 40 | Soil: | sandy clay |
| Grass cover (%): | 40 | Rock type: | |
| Herb cover (%): | 1 | Fire age: | not evident |
| Disturbance details: | Evidence of feral animals, grazing medium, historic clearing, livestock tracks, weed infestation. | | |
| Vegetation condition: | good, Keighery (1994) | | |
| Vegetation description: | Low <i>Tecticornia indica</i> subsp. <i>bidens</i> shrubland over low * <i>Lolium rigidum</i> , * <i>Bromus diandrus</i> and * <i>Vulpia myuros</i> forma <i>myuros</i> tussock grassland and isolated low <i>Didymanthus roei</i> , * <i>Arctotheca calendula</i> and <i>Trifolium arvense</i> forbs. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Tecticornia indica</i> subsp. <i>bidens</i> | 35.0 | 00.50 | | |
| <i>Lolium rigidum</i> | 30.0 | 00.40 | * | |
| <i>Bromus diandrus</i> | 05.0 | 00.20 | * | |
| <i>Vulpia myuros</i> forma <i>myuros</i> | 05.0 | 00.10 | * | |
| <i>Trifolium arvense</i> | 01.0 | 00.30 | * | |
| <i>Medicago polymorpha</i> | 01.0 | 00.30 | * | |
| <i>Didymanthus roei</i> | 01.0 | 00.20 | | |
| <i>Mesembryanthemum nodiflorum</i> | 00.5 | 00.05 | * | |
| <i>Monoculus monstrosus</i> | 00.1 | 00.40 | * | |
| <i>Podolepis capillaris</i> | 00.1 | 00.30 | | |
| <i>Romulea rosea</i> | 00.1 | 00.15 | * | |
| <i>Podolepis capillaris</i> | 00.1 | 00.10 | | |
| <i>Cotula bipinnata</i> | 00.1 | 00.10 | * | |
| <i>Arctotheca calendula</i> | 00.1 | 00.10 | * | |
| <i>Pogonolepis stricta</i> | 00.1 | 00.05 | | |
| <i>Crassula ? colorata</i> | 00.1 | 00.03 | | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|
| Site: | P5.09 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 31/10/2014, 15/06/2015 | Position: | -30.53045, 116.340228 |
| Total vegetation cover (%): | 45 | Topography: | undulating plain |
| Tree/shrub cover >2 m (%): | 30 | Soil colour: | red-orange |
| Shrub cover <2 m (%): | 18 | Soil: | sandy clay |
| Grass cover (%): | 3 | Rock type: | none |
| Herb cover (%): | 5 | Fire age: | >10 years |
| Disturbance details: | fenceline, weeds, rubbish | | |
| Vegetation condition: | excellent, Keighery (1994) | | |
| Vegetation description: | Tall <i>Hakea preissii</i> shrubland over low open <i>Rhagodia</i> sp. Watheroo and <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>T. lepidosperma</i> chenopod shrubland over isolated low <i>Austrostipa elegantissima</i> , <i>*Avena barbata</i> and <i>*Lolium rigidum</i> tussock grasses and low sparse <i>Pogonolepis muelleriana</i> and <i>Eriochiton sclerolaenoides</i> forbs and isolated <i>Comesperma integerrima</i> | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Hakea preissii</i> | 30.0 | 03.00 | | |
| <i>Rhagodia</i> sp. Watheroo (R.J. Cranfield & P.J. Spence 8183) | 15.0 | 01.00 | | |
| <i>Pogonolepis muelleriana</i> | 05.0 | 00.05 | | |
| <i>Tecticornia indica</i> subsp. <i>bidens</i> | 02.0 | 01.00 | | |
| <i>Lolium rigidum</i> | 02.0 | 00.10 | * | |
| <i>Austrostipa elegantissima</i> | 01.0 | 00.60 | | |
| <i>Comesperma integerrimum</i> | 00.1 | 00.50 | | |
| <i>Tecticornia lepidosperma</i> | 00.1 | 00.50 | | |
| <i>Avena barbata</i> | 00.1 | 00.40 | * | |
| <i>Ursinia anthemoides</i> | 00.1 | 00.20 | * | |
| <i>Eriochiton sclerolaenoides</i> | 00.1 | 00.10 | | |

Flora and fauna assessment for the Lyons East Road to Gatti Road study area – Report Addendum. Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

| | | | |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------|
| Site: | P5.16 | Type: | Quadrat (10 m x 10 m) |
| Date(s): | 30/10/2014, 15/06/2015 | Position: | -30.507883, 116.353022 |
| Total vegetation cover (%): | 50 | Topography: | undulating plain |
| Tree/shrub cover >2 m (%): | 55 | Soil colour: | red-orange |
| Shrub cover <2 m (%): | 2 | Soil: | sandy clay |
| Grass cover (%): | 2 | Rock type: | none |
| Herb cover (%): | 0 | Fire age: | >10 years |
| Disturbance details: | cleared, virtually no shrub layer, fenceline, rubbish | | |
| Vegetation condition: | degraded, Keighery (1994) | | |
| Vegetation description: | Isolated tall <i>Eucalyptus salmonophloia</i> trees over a low open <i>Eucalyptus ebbanoensis</i> subsp. <i>ebbanoensis</i> and <i>Eucalyptus ewartiana</i> mallee forest over isolated low <i>Maireana brevifolia</i> , <i>Enchylaena tomentosa</i> and <i>Rhagodia</i> sp. Watheroo shrubs over isolated low <i>*Ehrharta calycina</i> forbs. | | |



| Species | Cover (%) | Height (m) | Weeds | Conservation status |
|------------------------------------------------------------------|------------------|-------------------|--------------|----------------------------|
| <i>Eucalyptus ebbanoensis</i> subsp. <i>ebbanoensis</i> | 30.0 | 05.00 | | |
| <i>Eucalyptus ewartiana</i> | 20.0 | 05.00 | | |
| <i>Eucalyptus salmonophloia</i> | 05.0 | 20.00 | | |
| <i>Ehrharta calycina</i> | 02.0 | 00.30 | * | |
| <i>Ptilotus divaricatus</i> | 01.0 | 00.10 | | |
| <i>Maireana brevifolia</i> | 00.1 | 00.50 | | |
| <i>Rhagodia</i> sp. Watheroo (R.J. Cranfield & P.J. Spence 8183) | 00.1 | 00.30 | | |
| <i>Enchylaena tomentosa</i> | 00.1 | 00.20 | | |
| <i>Sclerolaena diacantha</i> | 00.1 | 00.20 | | |

Appendix 2 Key to determining presence of the EPBC Act listed TEC Eucalypt woodlands of the Western Australian Wheatbelt

Description based on (REF): The Eucalypt woodlands of the Western Australian Wheatbelt TEC is composed of eucalypt woodlands dominated by a complex mosaic of eucalypt species with a single tree or mallet form over an understorey that is highly variable in structure and composition. A mallet habit refers to a eucalypt with a single, slender trunk and steep-angled branches that give rise to a dense crown. Many eucalypt species are considered iconic within the Wheatbelt landscape, for example, *Eucalyptus salmonophloia* (salmon gum), *E. loxophleba* subsp. *loxophleba* (York gum), *Eucalyptus rudis* subsp. *rudis*, *E. salubris* (gimlet), *E. wandoo* (wandoo) and the mallet group of species. Associated species may include *Acacia acuminata* (jam), *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah). The understorey structures are often bare to sparse, herbaceous, shrub or heath, chenopod-dominated, thickets (*Melaleuca* spp.) and saline areas with *Tecticornia* spp. The main diagnostic features include location, minimum crown cover of the tree canopy of 10% in a mature woodland, presence of key species and a minimum condition according to scale of Keighery (1994) that depends on size of a patch, weed cover and presence of mature trees. A patch is defined as a discrete and mostly continuous area of the ecological community and may include small-scale variations and disturbances, such as tracks or breaks, watercourses/drainage lines or localised changes in vegetation that do not act as a permanent barrier or significantly alter its overall functionality. Each patch of the community includes a buffer zone, an area that lies immediately outside the edge of a patch but is not part of the ecological community. The buffer zone is designed to minimise this risk to the ecological community.

Woodland vegetation with a very sparse eucalypt tree canopy and woodlands dominated by mallee forms characterised by multiple stems of similar size arising at or near ground level are not part of the ecological community. The ecological community is not likely to be present if it is dominated by non-eucalypt species in the tree canopy, for instance *Acacia acuminata* (jam) or *Allocasuarina huegeliana* (rock sheoak) even though these species may be present as an understorey or minor canopy component.

The community occupies a transitional zone between the wetter forests associated with the Darling Range and the southwest coast, and the low woodlands and shrublands of the semi-arid to arid interior. The Wheatbelt region where the ecological community occurs mostly encompasses two IBRA2 subregions: Avon Wheatbelt subregion AVW01 Merredin and Avon Wheatbelt subregion AVW02 Katanning. Patches of the ecological community may extend into adjacent areas of the primary Wheatbelt bioregions, such as the easternmost parts of the Jarrah Forest bioregion forming an extension of the Avon Wheatbelt landscape in that they comprise areas subject to similar climate, landscape and threats. A third IBRA2 subregion includes Mallee subregion MAL02 Western Mallee and is located south of Perth. The ecological community is generally associated with the flatter, undulating relief, including drainage lines and saline areas.

The WA Wheatbelt woodlands ecological community potentially corresponds to 45 Beard (Shepherd *et al.* 2002) vegetation associations. The most likely equivalents are with the 37 associations that are dominant or unique within the Wheatbelt regions.

Diagnostic 1 Location

Survey location occurs within one of the following three regions:

- Avon Wheatbelt bioregion - subregions AVW01 Merredin and AVW02 Katanning
- Mallee bioregion - MAL02 Western Mallee only

- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt, and are effectively an extension of the Avon Wheatbelt landscape. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that fall below 600 mm mean annual rainfall (Figure 1), are off the Darling Range, associated with the Yilgarn Craton geology and are generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. The ecological community generally falls within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.

.....2

Survey location occurs within region:

- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that ARE ABOVE the 600 mm isohyet, are ON the Darling Range, NOT associated with the Yilgarn Craton geology and are NOT generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. It generally DOES NOT fall within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.

.....NOT TEC

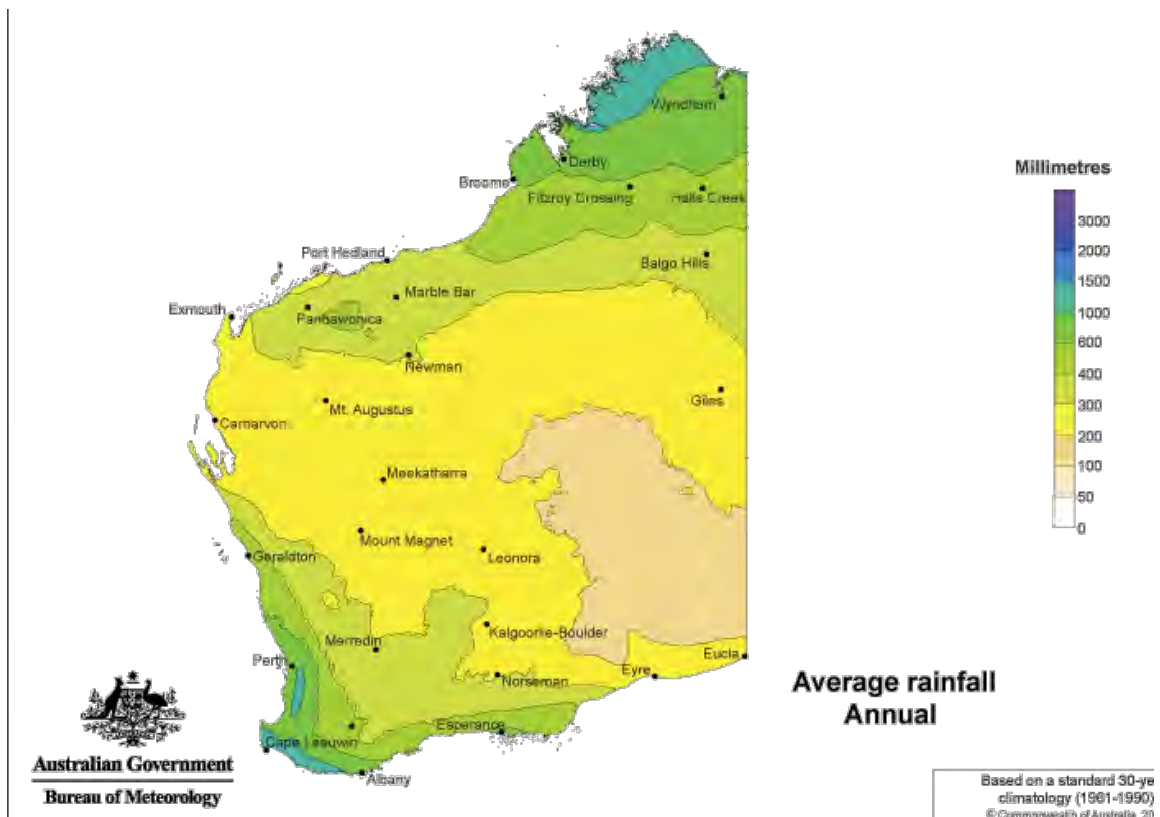


Figure 1 Isohyets of Western Australia (BoM 2016)

Diagnostic 2 Minimum crown canopy

The structure of the ecological community is a woodland in which the minimum crown cover of the tree canopy in a mature eucalypt woodland is 10% (crowns measured as if they are opaque). The maximum tree canopy cover usually is up to 40%. It may be higher in certain circumstances, for instance trees with a mallet growth form (multi-stemmed upper canopy) may be more densely spaced, or disturbances such as fire may result in an increased cover of canopy species during regeneration.

.....3

Crown cover of trees less than 10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings.

.....3

Crown cover of trees less than 10%, no evidence of recent disturbance, no presence of seedlings or saplings.

.....NOT TEC

Diagnostic 3 Dominant *Eucalyptus* tree canopy

One or more of the key tree species in Table 1 are dominant or co-dominant, the trees are predominantly single trunked, not mallee (multi-stemmed).

.....4

Other species are present in the tree canopy (e.g. species in Table 2 or other taxa) but these collectively do not occur as dominants in the tree canopy.

.....4

Dominant woodlands with a mallee subcanopy (lower tree layer of mallee or non-eucalypt tree species). Upper eucalypt tree canopy must be present dominated by key woodland species in Table 2 and have cover of 10% or more.

.....4

Other species are present in the tree canopy (e.g. species in Table 2 or other taxa) and these collectively do occur as dominants in the tree canopy.

.....NOT TEC

Table 1 Key eucalypt species. One or more of these species are dominant or co-dominant within a given patch of the ecological community

| Scientific name | Common name/s |
|-------------------------------------------------------|---------------------------------|
| <i>Eucalyptus accedens</i> | powder-bark; powder-bark wandoo |
| <i>Eucalyptus aequioperta</i> | Welcome Hill gum |
| <i>Eucalyptus alipes</i> | Hyden mallet |
| <i>Eucalyptus astringens</i> subsp. <i>astringens</i> | brown mallet |
| <i>Eucalyptus capillosa</i> | wheatbelt wandoo |
| <i>Eucalyptus densa</i> subsp. <i>densa</i> | narrow-leaved blue mallet |
| <i>Eucalyptus extensa</i> | yellow mallet |
| <i>Eucalyptus falcata</i> | silver mallet |
| <i>Eucalyptus gardneri</i> subsp. <i>gardneri</i> | blue mallet |

| Scientific name | Common name/s |
|-------------------------------------------------------|-----------------------------------------|
| <i>Eucalyptus goniocarpa</i> | Lake King mallet |
| <i>Eucalyptus kondininensis</i> | Kondinin blackbutt |
| <i>Eucalyptus longicornis</i> | red morrel |
| <i>Eucalyptus loxophleba</i> subsp. <i>loxophleba</i> | York gum |
| <i>Eucalyptus melanoxydon</i> | black morrel |
| <i>Eucalyptus mimica</i> subsp. <i>continens</i> | hooded mallet |
| <i>Eucalyptus mimica</i> subsp. <i>mimica</i> | Newdegate mallet |
| <i>Eucalyptus myriadena</i> | small-fruited gum; blackbutt |
| <i>Eucalyptus occidentalis</i> | flat-topped yate |
| <i>Eucalyptus ornata</i> | ornamental silver mallet; ornate mallet |
| <i>Eucalyptus recta</i> | Mt Yule silver mallet; Cadoux mallet |
| <i>Eucalyptus rudis</i> subsp. <i>rudis</i> | flooded gum |
| <i>Eucalyptus salicola</i> | salt gum; salt salmon gum |
| <i>Eucalyptus salmonophloia</i> | salmon gum |
| <i>Eucalyptus salubris</i> | gimlet |
| <i>Eucalyptus sargentii</i> subsp. <i>sargentii</i> | salt river gum |
| <i>Eucalyptus singularis</i> | ridge-top mallet |
| <i>Eucalyptus spathulata</i> subsp. <i>spathulata</i> | swamp mallet |
| <i>Eucalyptus spathulata</i> subsp. <i>salina</i> | Salt River mallet |
| <i>Eucalyptus urna</i> | merrit |
| <i>Eucalyptus wandoo</i> subsp. <i>pulverea</i> | wandoo |
| <i>Eucalyptus wandoo</i> subsp. <i>wandoo</i> | wandoo |

Table 2 Associated canopy species that may be present within the ecological community but are not dominant or co-dominant¹

| Scientific name | Common name/s |
|---------------------------------------------------------|-------------------------|
| <i>Acacia acuminata</i> | jam |
| <i>Allocasuarina huegeliana</i> | rock sheoak |
| <i>Corymbia calophylla</i> | marri |
| <i>Eucalyptus annulata</i> | prickly-fruited mallee |
| <i>Eucalyptus arachnaea</i> subsp. <i>arachnaea</i> | black-stemmed mallee |
| <i>Eucalyptus arachnaea</i> subsp. <i>arrecta</i> | black-stemmed mallet |
| <i>Eucalyptus armillata</i> | flanged mallee |
| <i>Eucalyptus calycogona</i> subsp. <i>calycogona</i> | square-fruited mallee |
| <i>Eucalyptus camaldulensis</i> subsp. <i>arida</i> | river red gum |
| <i>Eucalyptus celastroides</i> subsp. <i>virella</i> | wheatbelt mallee |
| <i>Eucalyptus cylindriflora</i> | Goldfields white mallee |
| <i>Eucalyptus decipiens</i> | redheart; moit |
| <i>Eucalyptus drummondii</i> | Drummond's mallee |
| <i>Eucalyptus eremophila</i> | sand mallee |
| <i>Eucalyptus erythronema</i> subsp. <i>erythronema</i> | red-flowered mallee |
| <i>Eucalyptus erythronema</i> subsp. <i>inornata</i> | yellow-flowered mallee |

| | |
|---------------------------------------------------------|--------------------------------|
| <i>Eucalyptus eudesmioides</i> | Kalbarri mallee |
| <i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i> | Flockton's mallee |
| <i>Eucalyptus gittinsii</i> subsp. <i>illucida</i> | northern sandplain mallee |
| <i>Eucalyptus incrassata</i> | ridge-fruited mallee |
| <i>Eucalyptus kochii</i> subsp. <i>plenissima</i> | Trayning mallee |
| <i>Eucalyptus leptopoda</i> subsp. <i>leptopoda</i> | Merredin mallee; Tammin mallee |
| <i>Eucalyptus loxophleba</i> subsp. <i>gratae</i> | Lake Grace mallee |
| <i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i> | smooth-barked York gum |
| <i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i> | blackbutt York gum |
| <i>Eucalyptus macrocarpa</i> | mottlecah |
| <i>Eucalyptus marginata</i> | jarrah |
| <i>Eucalyptus moderata</i> | redwood mallee |
| <i>Eucalyptus obtusiflora</i> | Dongara mallee |
| <i>Eucalyptus olivina</i> | olive-leaved mallee |
| <i>Eucalyptus orthostemon</i> | diverse mallee |
| <i>Eucalyptus perangusta</i> | fine-leaved mallee |
| <i>Eucalyptus phaenophylla</i> | common southern mallee |
| <i>Eucalyptus phenax</i> subsp. <i>phenax</i> | white mallee |
| <i>Eucalyptus pileata</i> | capped mallee |
| <i>Eucalyptus platypus</i> subsp. <i>platypus</i> | moort |
| <i>Eucalyptus polita</i> | Parker Range mallet |
| <i>Eucalyptus sheathiana</i> | ribbon-barked mallee |
| <i>Eucalyptus sporadica</i> | Burngup mallee |
| <i>Eucalyptus subangusta</i> subsp. <i>subangusta</i> | grey mallee |

¹The list is not comprehensive and presents the more common taxa encountered.

Diagnostic 4 Native understorey

A native understorey is present but is of variable composition, being a combination of grasses, other herbs and shrubs. A list of key species is summarised in Table 3. Any one of the structural understorey categories may or may not be present.

Bare to sparse understorey (e.g. under some mallet woodlands).

.....5

Herbaceous understorey – a ground layer of forbs and/or graminoids though a few, scattered shrubs may be present.

.....5

Scrub or heath understorey – comprises a mixture of diverse shrubs of variable height and cover. A ground layer of herbs and grasses is present to variable extent.

.....5

Chenopod-dominated understorey – a subset of the scrub category in which the prominent species present are saltbushes, bluebushes and related taxa (e.g. *Atriplex*, *Enchylaena*, *Maireana*, *Rhagodia* and *Sclerolaena*).

.....5

Thickets of taller shrub species understorey (e.g. *Melaleuca pauperiflora*, *M. acuminata*, *M. uncinata*, *M. lanceolata*, *M. sheathiana*, *M. adnata*, *M. cucullata* and/or *M. lateriflora*, *Allocasuarina campestris* with *Melaleuca hamata* or *M. scalena*). A range of other shrub and ground layer species may occur among or below the thickets.

.....5

Salt tolerant species understorey (e.g. samphire, *Tecticornia* spp.).

.....5

Shrublands or herblands in which the tree canopy layer is very sparse to absent, either naturally or maintained so through long-term disturbance. Native vegetation where a tree canopy was formerly present is often referred to as ‘derived’ or ‘secondary’ vegetation. These sites would fall below the 10 per cent minimum canopy cover threshold for a woodland.

.....NOT TEC

Table 3 Understorey species

| Scientific name | Common name/s |
|----------------------------------------------------|-----------------------|
| Shrubs | |
| <i>Acacia acuaria</i> | |
| <i>Acacia colletioides</i> | wait-a-while |
| <i>Acacia erinacea</i> | |
| <i>Acacia hemiteles</i> | |
| <i>Acacia lasiocalyx</i> | silver wattle |
| <i>Acacia lasiocarpa</i> | panjang |
| <i>Acacia leptospermoides</i> | |
| <i>Acacia mackeyana</i> | |
| <i>Acacia merrallii</i> | |
| <i>Acacia microbotrya.</i> | manna wattle |
| <i>Acacia pulchella</i> | prickly moses |
| <i>Allocasuarina acutivalvis</i> | |
| <i>Allocasuarina campestris</i> | |
| <i>Allocasuarina humilis</i> | dwarf sheoak |
| <i>Allocasuarina lehmanniana</i> | dune sheoak |
| <i>Allocasuarina microstachya</i> | |
| <i>Argyrolottis turbinata</i> | |
| <i>Astroloma epacridis</i> | |
| <i>Banksia armata</i> | prickly dryandra |
| <i>Banksia sessilis</i> | parrot bush |
| <i>Beyeria brevifolia</i> | |
| <i>Bossiaea divaricata</i> | |
| <i>Bossiaea eriocarpa</i> | common brown pea |
| <i>Bossiaea halophila</i> | |
| <i>Callistemon phoeniceus</i> | lesser bottlebrush |
| <i>Calothamnus quadrifidus</i> | one-sided bottlebrush |
| <i>Calothamnus quadrifidus</i> subsp. <i>asper</i> | one-sided bottlebrush |
| <i>Comesperma integerrimum</i> | |

| Scientific name | Common name/s |
|------------------------------------|----------------------------|
| <i>Conostylis setigera</i> | |
| <i>Dampiera lavandulacea</i> | |
| <i>Darwinia</i> sp. <i>Karonie</i> | |
| <i>Daviesia nematophylla</i> | |
| <i>Daviesia triflora</i> | |
| <i>Dodonaea bursariifolia</i> | |
| <i>Dodonaea inaequifolia</i> | |
| <i>Dodonaea pinifolia</i> | |
| <i>Dodonaea viscosa</i> | sticky hopbush |
| <i>Eremophila decipiens</i> | slender fuchsia |
| <i>Eremophila ionantha</i> | violet-flowered eremophila |
| <i>Eremophila oppositifolia</i> | weeooka |
| <i>Eremophila scoparia</i> | broom bush |
| <i>Exocarpos aphyllus</i> | leafless ballart |
| <i>Gastrolobium microcarpum</i> | sandplain poison |
| <i>Gastrolobium parviflorum</i> | |
| <i>Gastrolobium spinosum</i> | prickly poison |
| <i>Gastrolobium tricuspdatum</i> | |
| <i>Gastrolobium trilobum</i> | bullock poison |
| <i>Grevillea acuaria</i> | |
| <i>Grevillea huegelii</i> | |
| <i>Grevillea tenuiflora</i> | tassel grevillea |
| <i>Hakea laurina</i> | pincushion hakea |
| <i>Hakea lissocarpa</i> | honey bush |
| <i>Hakea multilineata</i> | grass-leaf hakea |
| <i>Hakea petiolaris</i> | sea urchin hakea |
| <i>Hakea preissii</i> | needle tree |
| <i>Hakea varia</i> | variable-leaved hakea |
| <i>Hibbertia commutata</i> | |
| <i>Hibbertia exasperata</i> | |
| <i>Hibbertia hypericoides</i> | yellow buttercups |
| <i>Hovea chorizemifolia</i> | holly-leaved hovea |
| <i>Hypocalymma angustifolium</i> | white myrtle |
| <i>Leptomeria preissiana</i> | |
| <i>Leptospermum erubescens</i> | roadside teatree |
| <i>Lycium australe</i> | |
| <i>Australian boxthorn</i> | |
| <i>Melaleuca acuminata</i> | |
| <i>Melaleuca adnata</i> | |
| <i>Melaleuca atroviridis</i> | |
| <i>Melaleuca brophyi</i> | |
| <i>Melaleuca cucullata</i> | |
| <i>Melaleuca cuticularis</i> | saltwater paperbark |
| <i>Melaleuca halmaturorum</i> | |

| Scientific name | Common name/s |
|------------------------------------|------------------------|
| <i>Melaleuca hamata</i> | |
| <i>Melaleuca hamulosa</i> | |
| <i>Melaleuca lanceolata</i> | |
| <i>Rottneest teatree</i> | |
| <i>Melaleuca lateriflora</i> | gorada |
| <i>Melaleuca marginata</i> | |
| <i>Melaleuca pauperiflora</i> | boree |
| <i>Melaleuca radula</i> | graceful honeymyrtle |
| <i>Melaleuca raphiophylla</i> | swamp paperbark |
| <i>Melaleuca scalena</i> | |
| <i>Melaleuca strobophylla</i> | |
| <i>Melaleuca teuthidoides</i> | |
| <i>Melaleuca thyoides</i> | |
| <i>Melaleuca uncinata group</i> | broom bush |
| <i>Melaleuca viminea</i> | mohan |
| <i>Olearia muelleri</i> | |
| <i>Goldfields daisy</i> | |
| <i>Olearia sp. Kennedy Range</i> | |
| <i>Petrophile divaricata</i> | |
| <i>Petrophile shuttleworthiana</i> | |
| <i>Petrophile squamata</i> | |
| <i>Petrophile striata</i> | |
| <i>Phebalium filifolium</i> | slender phebalium |
| <i>Phebalium lepidotum</i> | |
| <i>Phebalium microphyllum</i> | |
| <i>Phebalium tuberosum</i> | |
| <i>Pimelea argentea</i> | silvery-leaved pimelea |
| <i>Pittosporum angustifolium</i> | |
| <i>Platysace maxwellii</i> | karno |
| <i>Rhadinothamnus rudis</i> | |
| <i>Santalum acuminata</i> | quandong |
| <i>Santalum spicatum</i> | sandalwood |
| <i>Scaevola spinescens</i> | currant bush |
| <i>Senna artemisioides</i> | |
| <i>Styphelia tenuiflora</i> | common pinheath |
| <i>Templetonia sulcata</i> | centipede bush |
| <i>Trymalium elachophyllum</i> | |
| <i>Trymalium ledifolium</i> | |
| <i>Westringia cephalantha</i> | |
| <i>Xanthorrhoea drummondii</i> | |
| Chenopods | |
| <i>Atriplex acutibractea</i> | toothed saltbush |
| <i>Atriplex paludosa</i> | marsh saltbush |
| <i>Atriplex semibaccata</i> | berry saltbush |

| Scientific name | Common name/s |
|------------------------------------------------------------|----------------------|
| <i>Atriplex stipitata</i> | mallee saltbush |
| <i>Atriplex vesicaria</i> | bladder saltbush |
| <i>Enchylaena lanata / tomentosa complex</i> | barrier saltbush |
| <i>Maireana brevifolia</i> | small-leaf bluebush |
| <i>Maireana erioclada</i> | |
| <i>Maireana marginata</i> | |
| <i>Maireana trichoptera</i> | downy bluebush |
| <i>Rhagodia drummondii</i> | |
| <i>Rhagodia preissii</i> | |
| <i>Sclerolaena diacantha</i> | grey copperburr |
| <i>Tecticornia spp.</i> | samphire |
| <i>Threlkeldia diffusa</i> | coast bonefruit |
| Forbs | |
| <i>Actinobole uliginosum</i> | flannel cudweed |
| <i>Asteridea athrixioides</i> | |
| <i>Blennospora drummondii</i> | |
| <i>Borya nitida</i> | pincushions |
| <i>Borya sphaerocephala</i> | pincushions |
| <i>Brachyscome ciliaris</i> | |
| <i>Brachyscome lineariloba</i> | |
| <i>Caesia micrantha</i> | pale fringe-lily |
| <i>Caladenia flava</i> | cowslip orchid |
| <i>Calandrinia calyptрата</i> | pink purslane |
| <i>Calandrinia eremaea</i> | twining purslane |
| <i>Calotis hispidula</i> | bindy eye |
| <i>Carpobrotus modestus</i> | inland pigface |
| <i>Centipeda crateriformis</i> subsp. <i>crateriformis</i> | |
| <i>Chamaescilla corymbosa</i> | blue squill |
| <i>Chamaexeros serra</i> | little fringe-leaf |
| <i>Cotula coronopifolia</i> | waterbuttons |
| <i>Crassula colorata</i> | dense stonecrop |
| <i>Crassula exserta</i> | |
| <i>Dampiera juncea</i> | rush-like dampiera |
| <i>Dampiera lindleyi</i> | |
| <i>Daucus glochidiatus</i> | Australian carrot |
| <i>Dianella brevicaulis</i> | |
| <i>Dichopogon capillipes</i> | |
| <i>Disphyma crassifolium</i> | round-leaved pigface |
| <i>Drosera macrantha</i> | bridal rainbow |
| <i>Erodium cygnorum</i> | blue heronsbill |
| <i>Gilberta tenuifolia</i> | |
| <i>Gnephosis drummondii</i> | |
| <i>Gnephosis tenuissima</i> | |
| <i>Gnephosis tridens</i> | |

| Scientific name | Common name/s |
|------------------------------------------------|---------------------|
| <i>Gonocarpus nodulosus</i> | |
| <i>Goodenia berardiana</i> | |
| <i>Helichrysum leucopsideum</i> | |
| <i>Helichrysum luteoalbum</i> | Jersey cudweed |
| <i>Lagenophora huegelii</i> | |
| <i>Lawrencella rosea</i> | |
| <i>Lepidium rotundum</i> | veined peppergrass |
| <i>Podolepis capillaris</i> | wiry podolepis |
| <i>Podolepis lessonii</i> | |
| <i>Podotheca angustifolia</i> | sticky longheads |
| <i>Poranthera microphylla</i> | small poranthera |
| <i>Pterostylis sanguinea</i> | |
| <i>Ptilotus spathulatus</i> | |
| <i>Rhodanthe laevis</i> | |
| <i>Senecio glossanthus</i> | slender groundsel |
| <i>Spergularia marina</i> | |
| <i>Stylidium calcaratum</i> | book triggerplant |
| <i>Thysanotus patersonii</i> | |
| <i>Trachymene cyanopetala</i> | |
| <i>Trachymene ornata</i> | spongefruit |
| <i>Trachymene pilosa</i> | native parsnip |
| <i>Velleia cycnopotamica</i> | |
| <i>Waitzia acuminata</i> | orange immortelle |
| <i>Zygophyllum ovatum</i> | dwarf twinleaf |
| Graminoids | |
| <i>Amphipogon caricinus - strictus complex</i> | greybeard grass |
| <i>Austrostipa elegantissima</i> | |
| <i>Austrostipa hemipogon</i> | |
| <i>Austrostipa nitida</i> | |
| <i>Austrostipa trichophylla</i> | |
| <i>Centrolepis polygyna</i> | wiry centrolepis |
| <i>Desmocladus asper</i> | |
| <i>Desmocladus flexuosus</i> | |
| <i>Gahnia ancistrophylla</i> | hook-leaf saw sedge |
| <i>Gahnia australis</i> | |
| <i>Harperia lateriflora</i> | |
| <i>Juncus bufonius</i> | toad rush |
| <i>Lachnagrostis filiformis</i> | blowngrass |
| <i>Lepidosperma leptostachyum</i> | |
| <i>Lepidosperma resinosum</i> | |
| <i>Lepidosperma sp. aff. tenue</i> | |
| <i>Lepidosperma tenue</i> | |
| <i>Lepidosperma viscidum</i> | sticky sword sedge |
| <i>Lomandra effusa</i> | scented matrush |

| Scientific name | Common name/s |
|---------------------------------------------------|----------------------|
| <i>Lomandra micrantha</i> subsp. <i>micrantha</i> | small-flower matrush |
| <i>Lomandra nutans</i> | |
| <i>Meeboldina coangustata</i> | |
| <i>Mesomelaena preissii</i> | |
| <i>Neurachne alopecuroides</i> | foxtail mulga grass |
| <i>Rytidosperma caespitosum</i> | |
| <i>Rytidosperma setaceum</i> group | |
| <i>Schoenus nanus</i> | tiny bog-rush |
| <i>Schoenus sculptus</i> | gimlet bog-rush |
| <i>Schoenus subfascicularis</i> | |

Diagnostic 5 Vegetation condition

Minimum condition for patches of the WA Wheatbelt Woodlands ecological community. For each category, both the weed cover and mature tree presence criteria must apply plus one of either patch size or patch width, depending on whether the patch is a roadside remnant or not.

Category A:

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

.....TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more.

.....TEC

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) less than 2 ha.

.....NOT TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) less than 5 m.

.....NOT TEC

Category B:

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014).

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

.....TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more.

.....TEC

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Patch size (non-roadside) less than 2 ha.

.....NOT TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) less than 5 m.

.....NOT TEC

Category C:

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

Minimum patch size (non-roadside) 5 ha or more.

.....TEC

Patch size (non- roadside) less than 5 ha

.....NOT TEC

Category D:

Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-Low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Minimum patch size (non-roadside) 5 ha or more.

.....TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more

.....TEC

Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

.....NOT TEC

Appendix 3 Flora species inventory for additional survey of MB study area

| Family | Taxon |
|----------------|---------------------------------------------------------------|
| Aizoaceae | <i>*Mesembryanthemum nodiflorum</i> |
| Asteraceae | <i>*Arctotheca calendula</i> |
| Asteraceae | <i>*Cotula bipinnata</i> |
| Asteraceae | <i>*Hypochaeris glabra</i> |
| Asteraceae | <i>*Monoculus monstrosus</i> |
| Asteraceae | <i>*Sonchus oleraceus</i> |
| Asteraceae | <i>*Ursinia anthemoides</i> |
| Asteraceae | <i>Podolepis capillaris</i> |
| Asteraceae | <i>Pogonolepis muelleriana</i> |
| Asteraceae | <i>Pogonolepis stricta</i> |
| Boraginaceae | <i>*Echium plantagineum</i> |
| Cactaceae | <i>*Opuntia monachantha</i> |
| Chenopodiaceae | <i>Atriplex amnicola</i> |
| Chenopodiaceae | <i>Atriplex codonocarpa</i> |
| Chenopodiaceae | <i>Atriplex hymenotheca</i> |
| Chenopodiaceae | <i>Atriplex nummularia</i> |
| Chenopodiaceae | <i>Atriplex semibaccata</i> |
| Chenopodiaceae | <i>Didymanthus roei</i> |
| Chenopodiaceae | <i>Enchylaena tomentosa</i> |
| Chenopodiaceae | <i>Eriochiton sclerolaenoides</i> |
| Chenopodiaceae | <i>Maireana brevifolia</i> |
| Chenopodiaceae | <i>Maireana carnosa</i> |
| Chenopodiaceae | <i>Maireana trichoptera</i> |
| Chenopodiaceae | <i>Rhagodia drummondii</i> |
| Chenopodiaceae | <i>Rhagodia sp. Watheroo (R.J. Cranfield & P.J. Spenc</i> |
| Chenopodiaceae | <i>Sclerolaena diacantha</i> |
| Chenopodiaceae | <i>Sclerolaena eurotioides</i> |
| Chenopodiaceae | <i>Tecticornia indica</i> subsp. <i>bidens</i> |
| Chenopodiaceae | <i>Tecticornia lepidosperma</i> |
| Chenopodiaceae | <i>Tecticornia pergranulata</i> |
| Chenopodiaceae | <i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> |
| Chenopodiaceae | <i>Tecticornia undulata</i> |
| Crassulaceae | <i>Crassula ? colorata</i> |
| Fabaceae | <i>*Medicago polymorpha</i> |
| Fabaceae | <i>*Trifolium arvense</i> |
| Fabaceae | <i>Acacia ancistrophylla</i> var. <i>ancistrophylla</i> |
| Fabaceae | <i>Acacia ligulata</i> |
| Iridaceae | <i>*Romulea rosea</i> |
| Myrtaceae | <i>Chamelaucium</i> sp. <i>Wongan Hills</i> |
| Myrtaceae | <i>Eucalyptus loxophleba</i> |
| Myrtaceae | <i>Melaleuca acuminata</i> |

| Family | Taxon |
|--------------|-------------------------------------|
| Myrtaeae | <i>Eucalyptus aequioperta</i> |
| Myrtaeae | <i>Eucalyptus leptopoda</i> |
| Myrtaeae | <i>Melaleuca eleuterostachya</i> |
| Myrtaeae | <i>Melaleuca stereophloia</i> |
| Oxalidae | * <i>Oxalis pes-caprae</i> |
| Poaceae | * <i>Avena barbata</i> |
| Poaceae | * <i>Bromus diandrus</i> |
| Poaceae | * <i>Bromus rubens</i> |
| Poaceae | * <i>Eragrostis curvula</i> |
| Poaceae | * <i>Hordeum leporinum</i> |
| Poaceae | * <i>Lolium rigidum</i> |
| Poaceae | * <i>Vulpia myuros forma myuros</i> |
| Poaceae | <i>Austrostipa elegantissima</i> |
| Poaceae | <i>Austrostipa nitida</i> |
| Polygalaceae | <i>Comesperma integerrimum</i> |
| Proteaceae | <i>Hakea preissii</i> |
| Santalaceae | <i>Santalum acuminatum</i> |

Appendix 4 Eucalypt woodlands of the Western Australian wheatbelt TEC – site assessment

| Quadrat | Vegetation association | Diagnostic features | | | | |
|-----------|------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------|----------------------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Diagnostic 1 - Location | Diagnostic 2 - Minimum crown canopy | Diagnostic 3 - Dominant tree canopy | Diagnostic 4 - Native understorey | Diagnostic 5 - Vegetation condition |
| GAP015 | 676 Succulent steppe; samphire NOT TEC | | | | | |
| MBY001 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 5% NOT TEC | | | |
| MBY002 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 40% | Dominant species: <i>Eucalyptus loxophleba</i> | Herbaceous understorey of Chenopod species | Patch type: non- roadside, <5 ha NOT TEC Category: D Vegetation condition is degraded. Mature trees not present at 5 trees per 0.5 ha. Exotic plant species account for 50–70% (66%) of total vegetation cover in the understorey. NOT TEC |
| MBY003 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 5% NOT TEC | | | |
| MBY009 | 676 Succulent steppe; samphire NOT TEC | | | | | |
| MILMOO001 | 676 Succulent steppe; samphire NOT TEC | | | | | |
| P5.5 | 631 Succulent steppe with woodland and thicket; York gum over <i>Melaleuca thyoides</i> and samphire | Location: AVW02 | Crown cover: 10% | Dominant species: <i>Eucalyptus aequioperta</i> | Herbaceous understorey of Chenopod species | Patch type: non-roadside, <2 ha NOT TEC Condition: very good Category: A Vegetation condition is excellent. Exotic |

| Quadrat | Vegetation association | Diagnostic features | | | | |
|---------|--------------------------------------------------|-------------------------|-------------------------------------|-----------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Diagnostic 1 - Location | Diagnostic 2 - Minimum crown canopy | Diagnostic 3 - Dominant tree canopy | Diagnostic 4 - Native understorey | Diagnostic 5 - Vegetation condition |
| | | | | | | plant species account for 0–30% of total vegetation cover in the understorey layers. |
| P5.4 | 676 Succulent steppe; samphire NOT TEC | | | | | |
| P5.10 | 676 Succulent steppe; samphire NOT TEC | | | | | |
| P5.12 | Cleared and planted NOT TEC | | | | | |
| P5.13 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 30% | Dominant species: <i>Eucalyptus loxophleba</i> , | Herbaceous understorey of Chenopod species | Patch type: roadside, <5 m wide NOT TEC Category: D Vegetation condition is degraded. Mature trees not present at 5 trees per 0.5 ha. NOT TEC |
| P5.18 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 20% | Dominant species: <i>Eucalyptus loxophleba</i> , | Herbaceous understorey of Chenopod species | Patch type: non-roadside, <5 ha NOT TEC Category: D Vegetation condition is degraded. Mature trees not present at 5 trees per 0.5 ha. Exotic plant species account for 50–70% (88%) of total vegetation cover in the understorey. NOT TEC |
| P5.19 | 352 Medium woodland; York Gum | Location: AVW02 | Crown cover: 70% | Dominant species: <i>Eucalyptus loxophleba</i> , Other tree canopy | Herbaceous understorey of Chenopod species | Patch type: roadside, <5 m wide NOT TEC Category: D Vegetation condition is degraded. Mature |

| Quadrat | Vegetation association | Diagnostic features | | | | |
|---------|------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------|-------------------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------|
| | | Diagnostic 1 - Location | Diagnostic 2 - Minimum crown canopy | Diagnostic 3 - Dominant tree canopy | Diagnostic 4 - Native understorey | Diagnostic 5 - Vegetation condition |
| | | | | species: none present | | trees ($\geq 30\text{cm DBH}$) ³ not present at 5 trees per 0.5 ha. NOT TEC |
| P5.88 | Cleared and planted NOT TEC | | | | | |
| P5.86 | Cleared and planted NOT TEC | | | | | |
| P5.15a | 676 Succulent steppe; samphire NOT TEC | | | | | |
| P5.16 | 142 Medium woodland; York Gum and Salmon Gum | Location: AVW02 | Crown cover: 5% NOT TEC | | | |
| P5.07 | 1048 Mosaic: Shrublands; melaleuca patchy scrub / succulent steppe; samphire NOT TEC | | | | | |
| P5.09 | 1048 Mosaic: Shrublands; melaleuca patchy scrub / succulent steppe; samphire NOT TEC | | | | | |

Appendix 5 Carnaby's Black Cockatoo potential breeding tree records

| Name | Latitude | Longitude | Tree species | DBH (mm) | Hollows present | Suitable for Carnaby's | Evidence of use by Carnaby's | Description |
|---------|------------|------------|---------------------------------|----------|-----------------|------------------------|------------------------------|------------------------------------------------------------------|
| HT04891 | -30.495789 | 116.365396 | <i>Eucalyptus salmonophloia</i> | 440 | No | No | No | |
| HT04894 | -30.489554 | 116.36894 | <i>Eucalyptus salmonophloia</i> | 600 | No | No | No | |
| HT12657 | -30.489517 | 116.372847 | <i>Eucalyptus loxophleba</i> | 540 | No | No | No | |
| HT12658 | -30.489646 | 116.372511 | <i>Eucalyptus loxophleba</i> | 520 | No | No | No | |
| HT12659 | -30.494691 | 116.365327 | <i>Eucalyptus salmonophloia</i> | 540 | No | No | No | |
| HT12660 | -30.494671 | 116.365327 | <i>Eucalyptus salmonophloia</i> | 920 | No | No | No | |
| HT12661 | -30.494396 | 116.365122 | <i>Eucalyptus salmonophloia</i> | 800 | No | No | No | |
| HT12662 | -30.494239 | 116.365031 | <i>Eucalyptus salmonophloia</i> | 900 | No | No | No | |
| HT12663 | -30.494219 | 116.365008 | <i>Eucalyptus salmonophloia</i> | 660 | No | No | No | |
| HT12664 | -30.493807 | 116.364689 | <i>Eucalyptus salmonophloia</i> | 800 | No | No | No | |
| HT12665 | -30.49491 | 116.365122 | <i>Eucalyptus salmonophloia</i> | 640 | No | No | No | |
| HT12666 | -30.495111 | 116.365304 | <i>Eucalyptus salmonophloia</i> | 600 | No | No | No | |
| HT12667 | -30.495133 | 116.36533 | <i>Eucalyptus salmonophloia</i> | 940 | No | No | No | |
| HT12851 | -30.535612 | 116.334058 | <i>Eucalyptus wandoo</i> | 750 | Yes | No | No | Hollow at 2.5 m, unsuitable for Carnaby's Black Cockatoo nesting |

