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ENVIRONMENTAL SCIENCES

Supplementary flora and vegetation survey and terrestrial fauna survey for the Balla Balla Infrastructure Project

Prepared for Preston Consulting Pty Ltd on behalf of Balla Balla Infrastructure Group Ltd

July 2018

Final Report

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Final Report

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EXECUTIVE SUMMARY

Balla Balla Infrastructure Group Ltd (BBIG) are seeking to develop the Balla Balla Infrastructure (BBI) Project (the Project). The Project will provide new rail and port, located approximately 70 km NW of Tom Price in the Pilbara region of WA.

In May 2017, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Preston Consulting Pty Ltd, on behalf of BBIG, to undertake a supplementary flora and vegetation survey and terrestrial fauna survey for the Project. The study area for the survey was defined by the final potential disturbance area for the Project and was 3,497.85 ha. Of this, 447.81 ha was located outside the study area for the initial baseline flora and vegetation surveys conducted for the Project by Ecoscape in 2014 and 354.8 ha outside of the initial fauna surveys conducted by Phoenix Environmental Sciences in 2014. The current study area is located mostly within the Approved Development Envelope for the Project, with a small area extending outside this.

The scope of works included a desktop study to collate and contemporise all existing survey information to inform the additional field studies. The field surveys included systematic sampling of flora and vegetation, opportunistic collections of any previously undescribed flora species, assessment and mapping of vegetation type, vegetation condition and fauna habitat within any areas that had not been previously surveyed. Targeted searches were undertaken for significant flora and vertebrate fauna focusing on Threatened Fauna species specifically Northern Quoll (*Dasyurus hallucatus*, Endangered), Pilbara Olive Python (*Liasis olivaceus barroni*, Vulnerable), Bilby (*Macrotis lagotis*, Bilby), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* – Pilbara form, Vulnerable) and Ghost Bat (*Macroderma gigas*, Vulnerable). An assessment for the presence and extent of previously recorded Priority Ecological Communities (PECs) was also undertaken.

The field surveys were undertaken from 7–17 June 2017 for flora and vegetation and over two trips, 6–9 June and 17–21 June 2017, for fauna. A total of 17 50x50 m quadrats and 11 relevés were surveyed for flora and vegetation. Seventeen sites with two camera traps per site were surveyed for the Northern Quoll, fourteen 2 ha plots were surveyed for the Bilby, two sites with acoustic surveys were sampled for Pilbara leaf-nosed Bat and Ghost Bat, and 17 sites were surveyed for the Pilbara Olive Python. The surveys were conducted in accordance with Environmental Protection Authority (EPA) guidelines for the environmental factors 'flora and vegetation' and 'terrestrial fauna'.

A total of 221 flora species and subspecies representing 36 families and 97 genera were recorded during the field surveys. This included 131 perennial species, 82 annual or short-lived species and eight unknown (taxa not identified to species level).

The desktop study identified 83 significant flora species as potentially occurring in the study area; of these nine were previously recorded in the initial baseline surveys conducted for the Project. In the current survey, seven Priority flora species were recorded in the study area, including four that were also recorded in the initial survey – *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1), *Goodenia nuda* (P4), *Heliotropium muticum* (P3), *Rhynchosia bungarensis* (P4) – and three that were not previously recorded – *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (P1), *Acacia fecunda* (P3), and *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3).

A total of 15 vegetation types were mapped in the previously unsurveyed portion of the study area comprising eight open to sparse woodlands, seven open to sparse shrublands over hummock and/or tussock grasslands, and one tussock grassland. All of this vegetation was rated as Excellent to Very Good condition. All but one of the mapped vegetation types (AaAsTw) were matched with those described by Ecoscape in the initial baseline survey for the Project.

Two PECs recorded in the initial baseline survey for the Project were confirmed as present in the study area. The initial baseline survey by Ecoscape identified the presence of the P1–P3 'Four plant assemblages of the Wona Land System' in the Approved Development Envelope, defined as Sb vegetation type. The current survey confirmed the presence and mapped extent of the PEC in the study area and the wider Approved Development Envelope as aligning with the mapped Sb vegetation type.

The P3 'Horseflat Land System of the Roebourne Plains' PEC was mapped in the northern part of the study area and wider Approved Development Envelope in the initial baseline survey by Ecoscape. The current survey identified additional occurrence of the PEC in the previously unsurveyed portion of the study area.

Three fauna habitats were mapped in the previously unsurveyed portion of the study area comprising hummock and tussock grassland, open and closed shrubland, and minor creek and drainage line. All of the habitat types were previously recorded in the initial fauna surveys for the Project. The current study area therefore does not contain any restricted fauna habitat types; with all well represented in the wider Approved Development Envelope.

Two of the five target fauna species were recorded during the survey: Northern Quoll and Bilby. The Northern Quoll was recorded on eight camera traps at three sites, and once from secondary evidence (scat) during the field survey. Two of the sites, a creekline/rocky slope and a gully, were close to the location of previous records and within areas previously mapped as critical Northern Quoll habitat; the third was further south along the creekline from the creekline/rocky slope site, where the species was not recorded previously.

Additional suitable habitat for the Bilby was recorded in the previously unsurveyed portion of the study area and a single defunct Bilby burrow was recorded from a Bilby plot site in this habitat. No suitable habitat was recorded for Northern Quoll, Pilbara Olive Python or the two bat species in the previously unsurveyed portion of the study area.

1 INTRODUCTION

Balla Balla Infrastructure Group Ltd (BBIG) are seeking to develop the Balla Balla Infrastructure (BBI) Project (the Project). The Project will provide new rail and port, located approximately 70 km NW of Tom Price in the Pilbara region of WA (Figure 1-1). In May 2017, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Preston Consulting Pty Ltd, on behalf of BBIG, to undertake a supplementary flora and vegetation survey and terrestrial fauna survey for the Project.

1.1 BACKGROUND

The Project consists of a new transhipment port located mid-way between Port Hedland and Karratha, a 160 km railway and 40 km conveyor connection to the Pilbara Iron Ore Project (PIOP). All aspects of the Project have been approved under Part IV of the *Environmental Protection Act 1986* (EP Act), and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Relevant environmental approvals for the Project are:

- EP Act, MS 945 – port approval
- EP Act, MS 1006 – rail and conveyor
- EPBC Act, EPBC 2015/7420 – rail and conveyor.

The port was 'not assessed' under the EPBC Act.

The relevant EP Act and EPBC Act approval conditions requiring additional ecological surveys for the Project prior to construction are outlined in Table 1-1.

Table 1-1 Relevant approval conditions and required works

Condition	Required works
MS 1006: 6-2	
(1) when implemented, determine the presence of conservation significant flora for the final alignment in 6-5(1)(a), including the presence of the Priority Ecological Community (PEC) 'Cracking Clays of the Chichester and Mungaroona Range', identify any previously undescribed flora species within the proposed disturbance areas and map the vegetation within the proposed disturbance areas that has not been previously surveyed.	Conduct a survey of 3,000 ha (the final potential disturbance areas) to: 1. Identify the presence (or absence) of: a) Any conservation significant flora b) The 'Cracking Clays of the Chichester and Mungaroona Range' PEC c) Any previously undescribed flora species. 2. Map the vegetation within any areas that have not been previously surveyed.
7-2. The Conservation Significant Fauna Management Plan shall include: (1) details of a survey to be undertaken prior to ground-disturbing activities, to confirm the presence of conservation significant fauna and their dens/shelter from previous surveys and identify any conservation significant fauna that may have moved into disturbance areas prior to construction;	Conduct a conservation significant fauna survey of 3,000 ha (the final potential disturbance areas) to confirm the presence of conservation significant fauna and their dens/shelter from previous surveys and identify any conservation significant fauna that may have moved into disturbance areas.

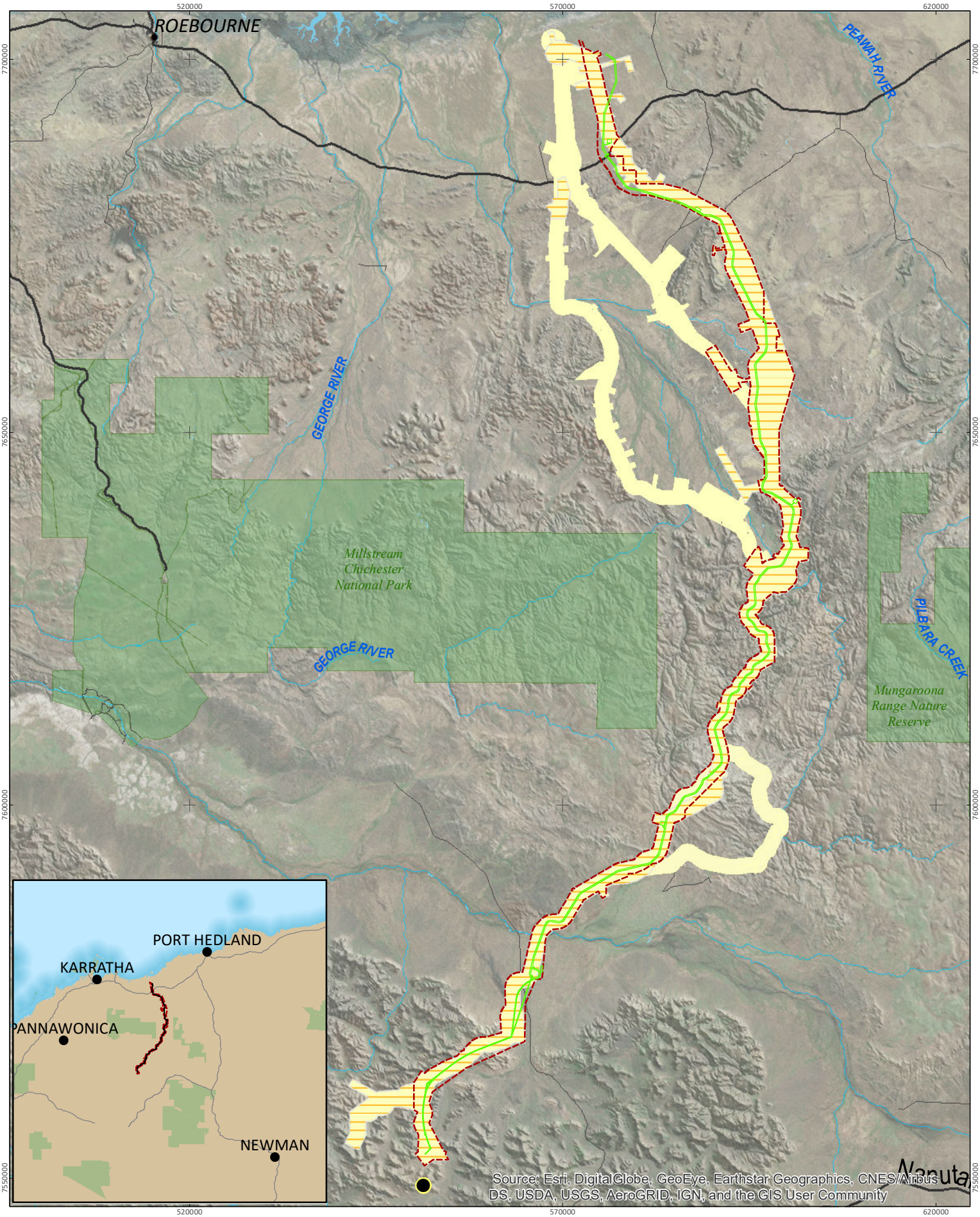
1.2 SURVEY OBJECTIVE AND SCOPE

The objective of the survey was to define the flora and vegetation, and terrestrial fauna values of the study area to complete the ecological surveys to ensure timely project commencement. The scope of work for the BBI Project included:

- desktop study of all existing flora, vegetation and terrestrial fauna information to define the key biological values
- field survey of final potential disturbance areas including:
    - targeted searches for conservation significant flora
    - assessment for presence of Priority Ecological Communities (PECs) that were previously identified as potentially present in the Approved Development Envelope
    - any previously undescribed flora species (opportunistic records only)
    - map the vegetation and fauna habitats within any areas that have not been previously surveyed
    - targeted conservation significant fauna survey focusing on Threatened Fauna Species, specifically Northern Quoll (*Dasyurus hallucatus*, Endangered), Pilbara Olive Python (*Liasis olivaceus barroni*, Vulnerable), Bilby (*Macrotis lagotis*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* – Pilbara form, Vulnerable) and Ghost Bat (*Macroderma gigas*, Vulnerable).
- data analyses, sample processing and species identifications for samples collected during the field surveys
- preparation of maps showing significant species records, vegetation units and fauna habitats in the study area
- preparation of a clear and concise technical report detailing the findings of the survey and providing sufficient information to meet the requirements outlined in Table 1-1.

1.3 STUDY AREA

The study area for the survey was defined by the final potential disturbance area for the Project and was 3,497.85 ha (Figure 1-1). Of this, 447.81 ha was located outside the study area for the initial baseline flora and vegetation surveys conducted for the Project (Ecoscape 2014) and 354.8 outside of the initial fauna surveys (Phoenix 2014) (Figure 1-1).



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Balla Balla Infrastructure Project

Project No	1155
Date	18-Oct-17
Drawn by	AL
Map author	JC

0 5 10 20
Kilometres

1:650,000 (at A4) GDA 1994 MGA Zone 50

- Pilbara Iron Ore Project
- Study area (final potential disturbance area)
- Approved development envelope
- Previous Ecoscape (2014) study area
- Previous Phoenix (2014) study area

Figure 1-1

Project location and study area

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P:\GIS\Projects\PIOPBalla\1155-PIO-BBI ECO\Mapping\MapDocuments\Figures\1155_BBI_Location.mxd

1.4 EXISTING ENVIRONMENT

The study area traverses all four subregions (Roebourne, Chichester, Fortescue and Hamersley) of the Interim Biogeographic Regionalisation of Australia (IBRA) Pilbara bioregion (Department of the Environment 2014; Thackway & Cresswell 1995). The study area intersects 21 land systems (Table 1-2) (Payne & Leighton 2004; van Vreeswyk *et al.* 2004), of which all are represented in areas previously surveyed (Ecoscape 2014; Phoenix 2014). The dominant land systems of the study area are Boolgeeda, Uaroo and Rocklea land systems which cover approximately 21.6%, 16.1% and 15.4% respectively (Table 1-2).

Table 1-2 Landsystems of the study area

Land system	Area (ha)	% of study area
Black	9.20	0.3%
Boolaloo	51.93	1.5%
Boolgeeda	756.15	21.6%
Calcrete	10.60	0.3%
Capricorn	43.17	1.2%
Coolibah	16.85	0.5%
Granitic	129.20	3.7%
Gregory	34.29	1.0%
Horseflat	51.63	1.5%
Jurrawarrina	21.96	0.6%
Macroy	178.29	5.1%
Mallina	224.36	6.4%
McKay	97.43	2.8%
Newman	86.84	2.5%
River	137.99	3.9%
Rocklea	538.81	15.4%
Ruth	189.48	5.4%
Satirist	46.68	1.3%
Uaroo	563.51	16.1%
Urandy	288.32	8.2%
Wona	21.15	0.6%
Total	**3497.85**	**100.0%**

The Pilbara bioregion has a semi-desert to tropical climate with highly variable rainfall, often occurring predominantly over summer (Leighton 2004; McKenzie et al. 2009). Rainfall across the region is largely driven by highly variable year-to-year cyclonic activity moving southwards from northern Australian waters which accounts for the majority of annual precipitation recorded (McKenzie et al. 2009). The nearest Bureau of Meteorology (BoM) weather stations with comprehensive data collection and historic climate data are located at Karratha Aero (no. 004083, Latitude: 20.71 °S Longitude: 116.77 °E) approximately 92 km west of the northernmost point of the study area and Wittenoom (no. 005026, Latitude: 22.24 °S Longitude: 116.77 °E) approximately 88 km east of the southernmost point of the study area.

Karratha records the highest mean maximum monthly temperature (36.1°C) in March and lowest (26.2°C) in July with highest mean minimum (26.7°C) recorded in January and February and lowest (13.8°C) in July (BoM 2017) (Figure 1-2). Average annual rainfall is 296.7 mm with January, February and March recording the highest monthly averages (49.1, 78.0 and 47.8 mm respectively). Tropical rain-bearing depressions moving southwards from northern Australian waters often cause cyclonic activity and heavy rainfall events during the summer months (BoM 2017) (Figure 1-2).

Wittenoom records the highest mean maximum monthly temperature (39.7°C) in December and lowest (24.2°C) in July with lowest mean minimum (26.0°C) recorded in January and lowest (11.5°C) in July (BoM 2017) (Figure 1-3). Average annual rainfall is 462.5 mm with January, February and March recording the highest monthly averages (114.4, 105.1 and 69.8 mm respectively) during summer months as a result of cyclonic activity and heavy rainfall events caused by tropical rain-bearing depressions moving southwards from northern Australian waters (BoM 2017) (Figure 1-3).

Daily mean temperatures preceding the survey from April 2016 to March 2017 fluctuated above and below the long-term annual averages for both Karratha Aero and Wittenoom (Figure 1-2; Figure 1-3). Mean minimum temperatures were above annual averages for Karratha and Wittenoom from June to July 2016 but remained close to annual averages for the remainder of the 12 months preceding the field survey. Mean maximum temperatures recorded were close to equal with annual averages for the majority of the 12 months preceding the field survey for both Karratha and Wittenoom with below average temperatures recorded between January and February (Figure 1-2; Figure 1-3).

Records from Karratha Aero weather station show variable amounts of rainfall in the 12 months preceding the field survey compared with the long-term annual average with above average rainfall recorded in June to July 2016 and January, February and April of 2017 (Figure 1-2). Wittenoom weather station also showed variable amounts of rainfall in the 12 months preceding the field survey compared to long-term annual averages with above average rainfall recorded in June to July 2016 and January to March 2017. Above average rainfall recorded in the 12 months preceding the field survey occurred as a result heavy winter rainfall events in June 2016 and cyclonic activity in the northwest of WA in the summer months of early 2017 (Figure 1-3).

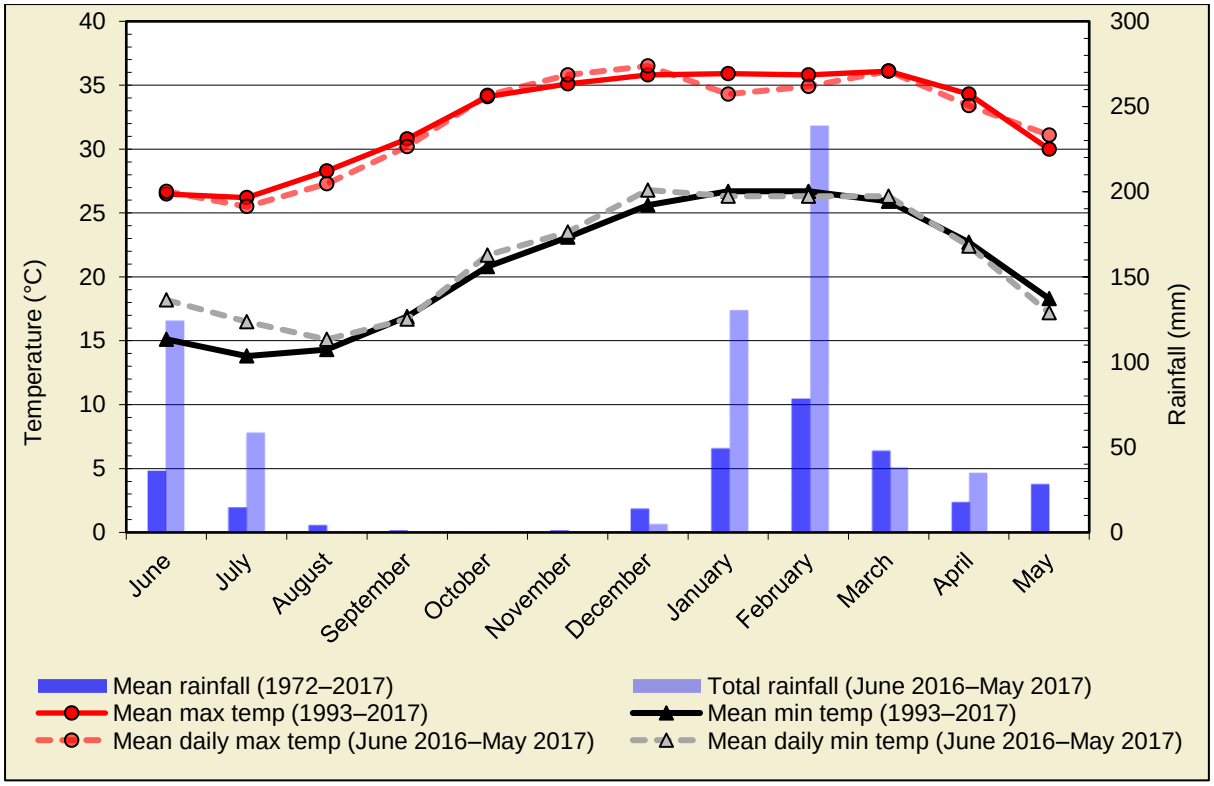


Figure 1-2 **Annual climate and weather data for Karratha Aero (no. 004083) (BoM 2017) and mean monthly data for the 12 months preceding the field survey**

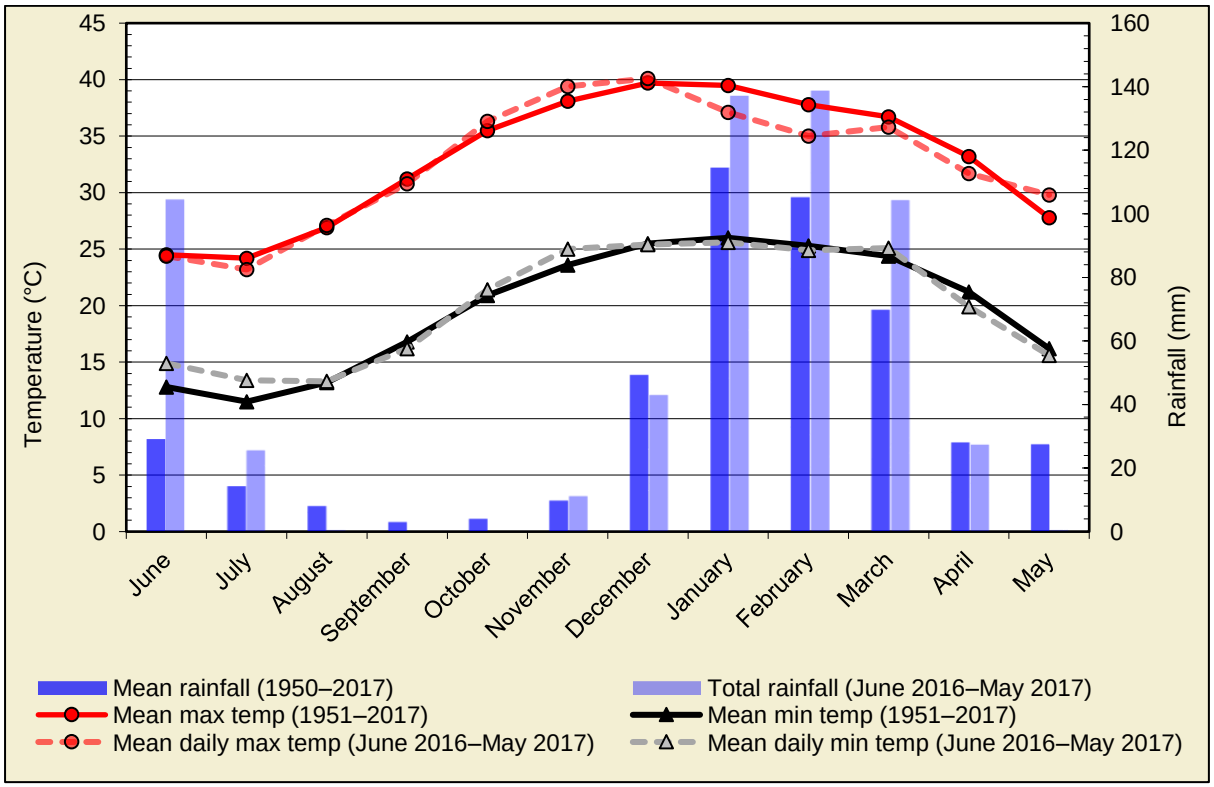


Figure 1-3 **Annual climate and weather data for Wittenoom (no. 005026) (BoM 2017) and mean monthly data for the 12 months preceding the field survey**

2 METHODS

Survey design, methodology and report-writing adhered to relevant principles and guidelines, including:

- Statement of Environmental Principles, Factors and Objectives (EPA 2016)
- EPA Environmental Factor Guideline: Flora and vegetation (EPA 2016)
- EPA Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment (EPA 2016)
- EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016)
- EPA Technical Guidance: Terrestrial fauna surveys (EPA 2016)
- Technical Guidance. Sampling methods for terrestrial vertebrate fauna (EPA 2016).

2.1 DESKTOP STUDY

2.1.1 Database searches and literature review

Two previous biological surveys were conducted to support environmental approvals for the Project and form the basis of the desktop review information for the current survey:

- Ecoscape (2014) *Rutila Resources railway corridor flora and vegetation assessment*. Unpublished report prepared for Preston Consulting and Rutila Resources Pty Ltd. Survey scope comprised desktop review, reconnaissance survey in May 2014 and single season Level 2 flora and vegetation survey in July–August 2014. The study area for the assessment covered the majority of the Approved Development Envelope (Figure 1-1).
- Phoenix Environmental Sciences (2014) *Terrestrial fauna surveys for the Balla Balla Railway Project* and Addendum. Unpublished report prepared for Preston Consulting on behalf of Rutila Resources Ltd. Survey scope comprised a desktop review, Level 1 vertebrate fauna survey, Level 2 short range endemic (SRE) invertebrate fauna survey and a targeted vertebrate fauna survey. The surveys were undertaken in June, July, August/September and October 2014. The study area for the surveys covered the majority of the Approved Development Envelope (Figure 1-1).

Previous records of significant flora, vegetation and fauna were collated from spatial data for the previous surveys. To supplement the previous survey data and identify potential records in previously unsurveyed areas, new database searches were also conducted (Table 2-1).

Table 2-1 Database searches undertaken for the desktop review

Database	Search extent
Threatened Flora, Fauna and Ecological Community database searches (DPaW 2014)	40 km buffer of the Approved Development Envelope
Threatened Flora, Fauna and Ecological Community database searches (DBCA 2017)	40 km buffer of study area (WA Herbarium and TPFL spatial data)
NatureMap (2014)	25 km buffer of the study area surveyed by Ecoscape
Protected Matters Search Tool (Department of the Environment 2014)	25 km buffer of the study area surveyed by Ecoscape

2.1.2 Preliminary site selection

Preliminary quadrat locations were pre-selected in previously unsurveyed areas using high quality aerial photography; with selection based on apparent changes in the vegetation visible in the aerial imagery. Previous vegetation mapping, significant flora records (DBCA 2017; Ecoscape 2014) and aerial photography were used to identify areas requiring targeted surveys for conservation significant flora.

Preliminary fauna survey site locations were selected based on previous habitat mapping and significant fauna records (DBCA 2017; Phoenix 2014). In previously unsurveyed areas, initial characterisation of habitats was undertaken using aerial photography, land system maps and topographic maps.

2.2 FIELD SURVEY

A flora and vegetation field survey was undertaken on 7–17 June 2017. The targeted conservation significant fauna survey was undertaken over two field trips, the first 6–9 June and the second 17–21 June 2017.

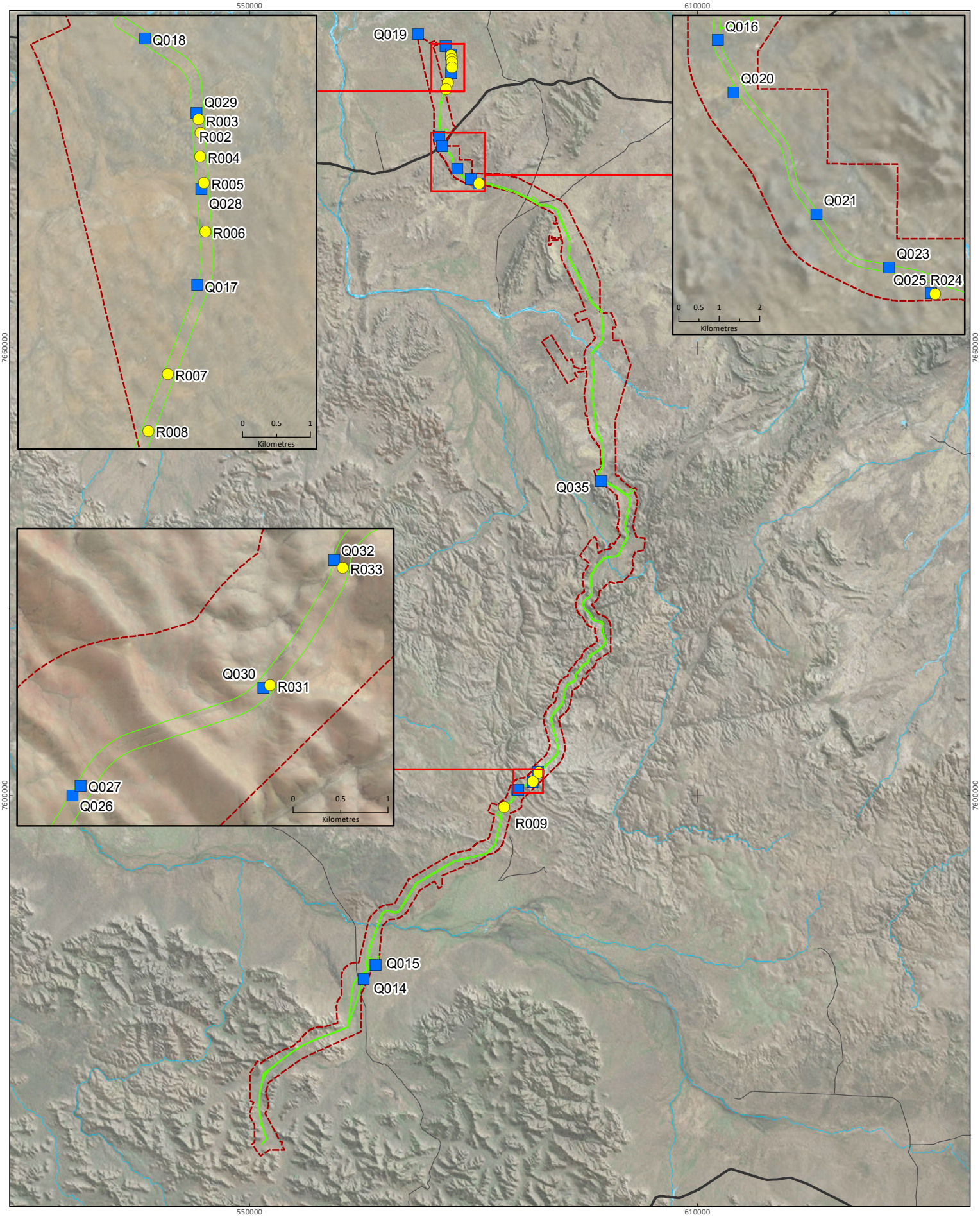
2.2.1 Flora and vegetation

A detailed field survey was undertaken within the study area in accordance with current EPA guidelines (EPA 2016) with additional targeted searches conducted for conservation significant species. Field methods included:

- surveying of quadrats and relevés (see 0)
- targeted flora searches (see 2.2.1.2)
- targeted Priority Ecological Community (PEC) searches (see 2.2.1.3)
- vegetation association mapping (see 2.2.1.4)
- vegetation condition mapping (see 2.2.1.5).

2.2.1.1 Quadrats and relevés

Quadrat locations were selected to ensure that an accurate representation of the major vegetation types within the study area were sampled adequately. Two methods were used for the selection of quadrat placement within the study area. Preliminary quadrat locations were pre-selected using high quality aerial photography; with selection based on apparent changes in the vegetation visible in the aerial imagery. The preliminary quadrat locations were re-assessed during the site visit, while ground-truthing the study area on foot. Some preliminary quadrats were moved to locations which better represented vegetation types and some quadrats were changed to relevés, where only dominant vegetation was recorded for the purposes of accurate vegetation mapping. In total, 17 quadrats and 11 relevés were surveyed across the study area (Figure 2-1; Appendix 1).



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Project No	1155
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Map author	JC

0 5 10 20
Kilometres

1:650,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Flora survey sites
Quadrat
Relevé

Figure 2-1

Flora and vegetation survey sites

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Co-ordinates of all corners of each quadrat were recorded on a hand-held Garmin GPS. A single GPS co-ordinate was recorded for each relevé.

The following information was recorded for each quadrat:

- location – the geographic coordinates of all four corners of the quadrat in WGS84 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (ESCAVI 2003) and in accordance with EPA (2016) (Appendix 2)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity
- vegetation condition – the condition of the vegetation was recorded utilising the condition scale of Trudgen (1988 in EPA 2016) (Table 2-2)
- height and percentage foliage cover (PFC) – a visual estimate of the canopy cover of each species present within the 50 m x 50 m quadrat was recorded as a percentage, as was the total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover.
- photograph – a colour photograph of the vegetation within each quadrat in a south-easterly direction from the north-west corner of the quadrat
- flora species list – a list including the name of every flora species present within the quadrat; to ensure accurate taxonomic identification of flora species present within the study area, collections were made of each specimen at least once and each collection was pressed and documented for identification using the WA Herbarium resources.

2.2.1.2 Targeted flora searches

Targeted flora searches were undertaken simultaneously with the flora and vegetation survey to determine whether any of the conservation significant species identified from the desktop and literature review occurred in the study area. The searches focused on habitats considered likely to support conservation significant flora, in addition to previously recorded locations of conservation significant plants or populations in close proximity to the study area.

If a flora species was considered to potentially be conservation significant (i.e. similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable
- description of the habitat and floristic community in which the potential conservation significant species was located
- population size estimate (i.e. estimated number of individual plants) where applicable
- specimen collection for taxonomic identification and lodgement at the WA Herbarium
- photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

2.2.1.3 Priority Ecological Community assessment

Targeted searches were undertaken for two PECs within the study area that were previously identified as potentially present in the Approved Development Envelope by Ecoscape (2014):

- Four plant assemblages of the Wona Land System (Priority 1 – Priority 3), previously known as 'Cracking Clays of the Chichester and Mungaroona Range'
- Horseflat Land System of the Roebourne Plains (Priority 3).

Quadrat and relevé sampling was conducted in mapped locations of the PECs (DBCA 2017) to characterise the communities. In addition, the entire area of vegetation type Sb considered to be the 'Four plant assemblages of the Wona Land System' PEC (Ecoscape (2014) was traversed on foot as the follow up assessment to confirm presence and the boundary of the PEC.

Searches were undertaken in unmapped areas where suitable habitat matched the descriptions of the two PECs. Where either PEC was considered to potentially occur (i.e. similar floristic characteristics from the site data and occurring within suitable habitat), species inventory data was collected from quadrats or relevés (see 2.2.1.1).

2.2.1.4 Vegetation mapping

The vegetation descriptions from quadrats and relevés from the survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and combination of species and the prevalent community structure (i.e. woodland, shrubland, etc.). The vegetation boundaries were mapped utilising high-quality colour aerial photography and from vegetation boundaries recorded on GPS during the field survey.

To support delineation of vegetation types, a cluster analysis was conducted based on species cover in each quadrat. The fusion strategy for the site classification was flexible UPGMA with a beta value of -0.1 and Bray Curtis association measure in the software package PATN (Belbin 2003). A dendrogram was produced to illustrate the similarities between the vegetation units identified. Statistically distinct vegetation units (the floristic group) classified the vegetation at a local scale. Local scale vegetation units were described at NVIS Level V – Association (ESCAVI 2003). The term 'vegetation type' was used for local scale vegetation units in accordance with the technical guidance (EPA 2016).

2.2.1.5 Condition mapping

The condition of vegetation was mapped across the study area based on the Trudgen (1988 in EPA 2016) scale, an appropriate condition rating scale for the Eremaean Botanical Province where the Project is located (EPA 2016).

The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranges from Excellent being the highest rating to Completely Degraded as the lowest (Table 2-2).

Table 2-2 Vegetation condition rating scale (Trudgen 1988, in EPA 2016)

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

2.2.2 Fauna and fauna habitat

2.2.2.1 Site selection

Preliminary survey sites identified prior to the field survey, were refined during the field survey.

2.2.2.2 Northern Quoll

Northern Quoll were targeted within the study using camera trapping to determine presence and relative importance of populations within critical habitat. The camera traps were deployed to facilitate individual recognition of quolls due to their unique spot pattern, following methods adopted from Hohnen *et al.* (2013) and Smith and Coulson (2012). Sites targeted denning/shelter habitat and foraging/dispersal habitat, both considered critical to the survival of the species as defined by DoE Northern Quoll referral guidelines (Department of the Environment 2016).

A pair of cameras was established at each site, aligned vertically and horizontally, trained on a single deposition of universal bait (peanut butter, sardines and rolled oats) (Figure 2-2). The date and time of each pair was synchronised prior to arming, in order that vertical and horizontal trigger events could be compared. This arrangement was implemented so that if one camera didn't capture suitable images to achieve individual recognition, the second hopefully would.

Figure 2-2 Example of the Northern Quoll camera trap system deployed

Two brands of camera were used, with the settings being identical for each type across the sites. The same camera brand was used at each site to ensure consistent results. Camera traps were deployed at 17 camera trap sites, with two cameras at each site, resulting in a total of 34 cameras deployed (Figure 2-3). Site descriptions were recorded at each camera trap site (Appendix 3).

Table 2-3 Camera trap settings

Setting	Reconyx Hyperfire 600	Bushnell Trophy Cam
Format	Photo	Photo
Photos per trigger	10	3
Flash	Auto	Low
Trigger delay	0	1

The metadata for each resultant image was tagged in various ways using Adobe Lightroom 6.0 to facilitate comparison of paired camera trigger events and between closely positioned sites and most importantly, to analyse spot patterns. The following summary data was also determined for each camera at each site:

- total number of images
- number of useful images
- number of images in each trigger event
- start time/date of each trigger event

- end time/date of each trigger event.

Each individual recorded was given a unique identification number to apply the DoE metrics concerning population density and importance (Department of the Environment 2016):

- high density – numerous camera triggers of multiple individuals across multiple cameras at a site
- low density – infrequent camera triggers of one or two individuals confined to one or more cameras and sites.

2.2.2.3 Bilby

Targeted Bilby plot surveys were undertaken to search for evidence of occurrence using standardised 2 ha plots adopted from Southgate *et al.* (2005) and Southgate and Moseby (2008). Prior to undertaking each plot series, the area was flown at approximately 30–50 m above ground level at a rate of 15–20 knots using an R44 helicopters with an observer on each side of the aircraft looking primarily for burrows and active movement pathways.

Fourteen 2 ha plots (100 m x 200 m) were undertaken within the study area (Figure 2-3), covering approximately 28 ha as a systematic grid-search. Each plot was surveyed for evidence of Bilby presence, incuding tracks, scats, foraging diggings and/or burrows. Habitat descriptions were recorded at each plot site (Appendix 3). Approximately 1 person hour was spent searching each site. In addition, observers walked between each plot conducting further searches for evidence of the species.

2.2.2.4 Pilbara leaf-nosed Bat and Ghost Bat

Acoustic surveys were undertaken at two sites where possible disturbance to roost sites or water sources were present. The resultant ultrasonic recordings were analysed using Wildlife Acoustics' Kaleidoscope 4.0 software package in Bat Analysis mode. The data was processed separately for each species as follows:

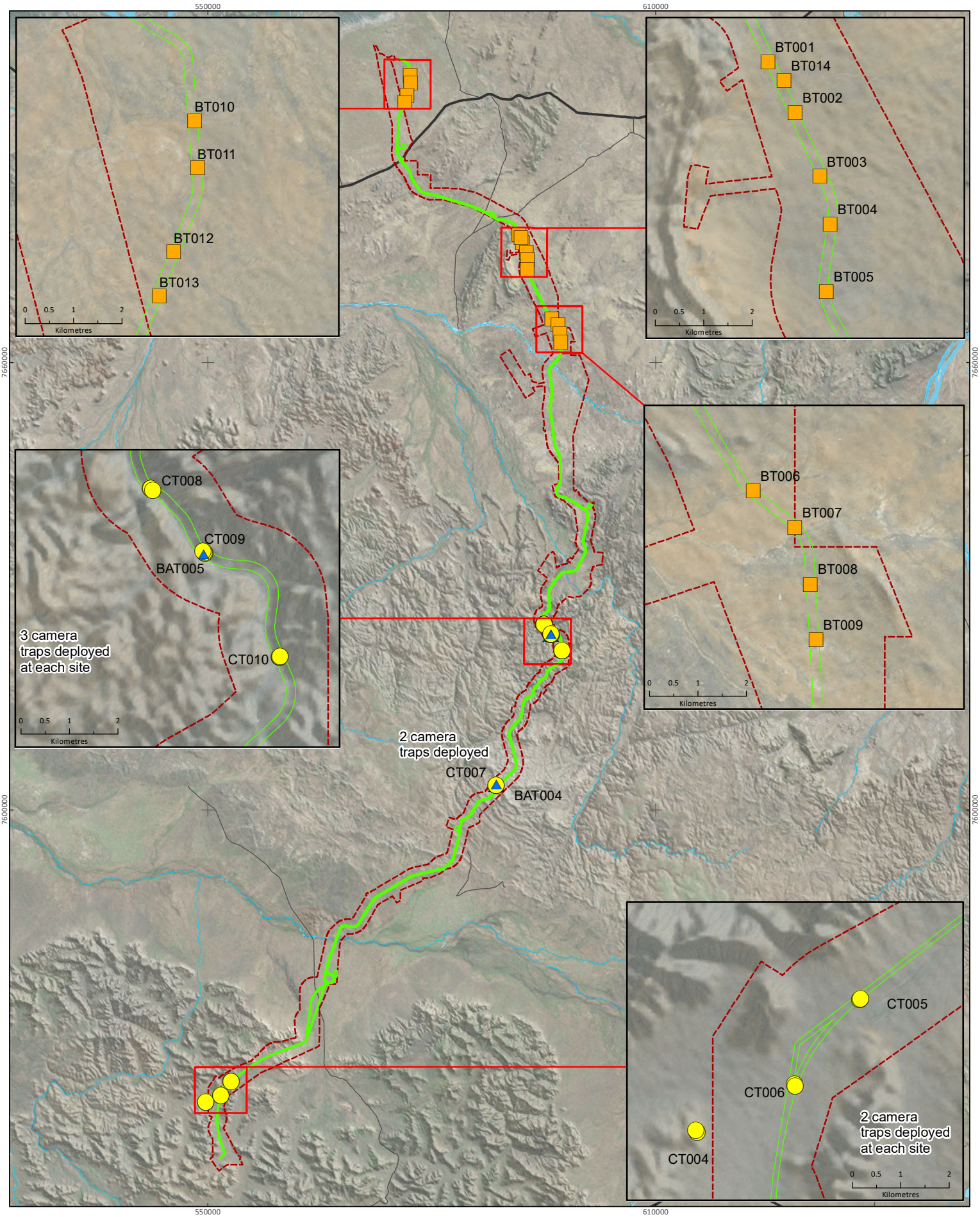
- echolocation pulse: 8-90 kHz (Ghost Bat)
- echolocation pulse: 90 -130 kHz (Pilbara Leaf-nosed Bat).

Cluster analyses was then undertaken for the Ghost Bat data batch only (8-90 KHz), because no calls above 90 KHz were recorded.

The resultant data for both species was compared to the echolocation call specifications described in McKenzie & Bullen (2009) within each resultant cluster.

2.2.2.5 Pilbara Olive Python

Diurnal searches for individuals and secondary evidence including scats and sloughs (shed skins) were undertaken for Pilbara Olive Python at 17 sites (Figure 2-3). Due to access constraints, no night surveys could be undertaken for the species. A total of 17 person hours of targeted searches was completed, concurrent with searches for other species.



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Project No	1155
Date	20-Oct-17
Drawn by	KW
Map author	JC

0 5 10 20
Kilometres

1:650,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Aprpoved development envelope
Survey site
Bat acoustic survey
Bilby plot
Northern Quoll camera traps and Pilbara

Figure 2-3

Terrestrial fauna survey sites

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2.2.1 Taxonomy and nomenclature

Plant species were identified using local and regional flora keys, and comparisons with named species held at the WA Herbarium. Nomenclature for flora and vegetation and terrestrial fauna used in this report follows that used by FloraBase (DBCA 2017) and the DBCA/WA Herbarium. The conservation status of all recorded species was compared against the current lists available on FloraBase (DBCA 2017), Threatened and Priority fauna list (DPaW 2017) and the EPBC Act Threatened species database (DoEE 2017).

2.2.2 Survey personnel

The personnel involved in the survey are presented in Table 2-4.

Table 2-4 Project team

	Name	Qualifications	Role/s
Project management, GIS	Mrs Karen Crews	BSc. (Env. Biol.) (Hons)	Project manager, report review
	Mrs Kathryn Wyatt	BIS. (GIS) Grad. Cert. (GIS)	GIS
Botany	Dr Grant Wells	PhD (Botany)	Taxonomy, data analysis and report review
	Dr Grace Wells	PhD (Plant Conservation)	Logistics, GIS and vegetation mapping, reporting
	Mrs Catherine Krens	BSc (Env. Sci.)	Desktop review, field survey and data analysis
	Ms Gabriela Martinez	BSc. (Env Sci. & Cons. Biol.)	Field survey
	Ms Anna Leung	BSc. (Env. Sci.) (Hons)	Reporting
	Frank Obbens (WA Herbarium)	BSc. (Env. Biol.) (Hons)	Taxonomy
Zoology	Mr Jarrad Clark	BSc. (Env. Mgmt.)	Field surveys, data analysis, reporting
	Mr Mike Brown	BSc. (App. Sci.)	Field surveys
	Ryan Ellis	BESc (Wildlife Cons. Biol.)	Reporting

3 RESULTS

3.1 DESKTOP STUDY

3.1.1 Flora and vegetation

3.1.1.1 Conservation significant flora

Eighty-three conservation significant flora species were identified from the desktop study as previously recorded in or near the study area (Table 3-1; Figure 3-1):

- One Threatened species, listed as Vulnerable under the EPBC act
- 22 Priority 1 species
- 15 Priority 2 species
- 39 Priority 3 species
- Seven Priority 4 species.

One additional species, *Vigna* sp. Hamersley Clay (A.A. Mitchell PRP 113), previously known as *Vigna* sp. central (M.E. Trudgen 1626) and listed as Priority 2 at the time of the initial desktop review by Ecoscape (2014) is no longer listed as a Priority Flora (DBCA 2017).

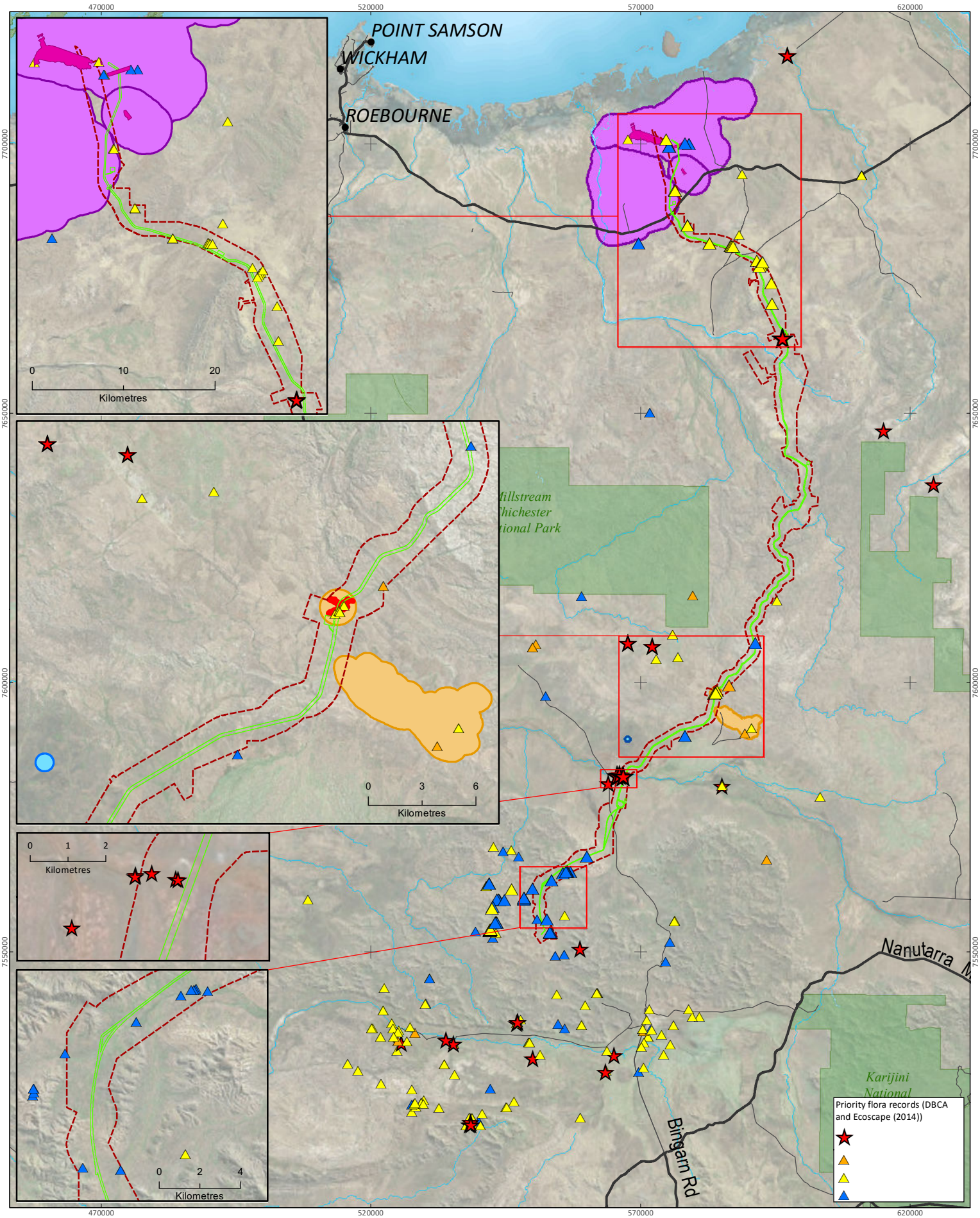
Table 3-1 Desktop records for conservation significant flora species

Species	DPaW Priority list	Nearest record to study area	Source
Abutilon sp. Pritzelianum (S. van Leeuwen 5095)	P1	Recorded in four locations in Approved Development Envelope, 180 individuals in total	Ecoscape (2014)
Acacia bromilowiana	P4	Approx. 35 km south of study area	DPaW (2014), DBCA (2017)
Acacia daweana	P3	Approx. 7 km west of study area	DPaW (2014), DBCA (2017), Naturemap (2014)
Acacia glaucocaesia	P3	Approx. 25 km east of study area	DBCA (2017)
Acacia leeuweniana	P1	Approx. 21 km east of study area	DPaW (2014), DBCA (2017)
Acacia subtiliformis	P3	Within 40 km of study area	DPaW (2014)
Adiantum capillus-veneris	P2	Within 40 km of study area	DPaW (2014)
Aristida jerichoensis var. *subspinulifera*	P3	Approx. 30 km south of study area	DBCA (2017)
Astrebla lappacea	P3	Approx. 18 km south of study area	DPaW (2014), DBCA (2017), Naturemap (2014)
Bothriochloa decipiens var. *cloncurrensis*	P1	Within 40 km of study area	DPaW (2014)
Calotis latiuscula	P3	Approx. 25 km south-east of study area	DPaW (2014), DBCA (2017)
Calotis squamigera	P1	Within 40 km of study area	DPaW (2014)
Cladium procerum	P2	Approx. 11 km west of Study area	DPaW (2014), DBCA (2017), Naturemap (2014)

Species	DPaW Priority list	Nearest record to study area	Source
Dampiera anonyma	P3	Approx. 13 km south-east of study area	DBCA (2017)
Dampiera metallorum	P3	Within 25 km of study area	DPaW (2014), Naturemap (2014)
Dipteracanthus chichesterensis	P1	Approx. 13 km west of study area	DBCA (2017)
Eragrostis crateriformis	P3	Within 40 km of study area	DPaW (2014)
Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)	P1	Within 40 km of study area	DPaW (2014)
Eragrostis surreyana	P3	Approx. 15 km east of study area	DBCA (2017)
Eremophila pusilliflora (Previously *Eremophila forrestii* subsp. Pingandy (M.E. Trudgen 2662))	P2	Within 40 km of study area	DPaW (2014)
Eremophila magnifica subsp. *magnifica*	P4	Approx. 15 km south of study area	DPaW (2014), DBCA (2017), Naturemap (2014)
Eremophila magnifica subsp. *velutina*	P3	Approx. 17 km south of study area	EPBC (2014), DPaW (2014), DBCA (2017), Naturemap (2014)
Eremophila sp. Hamersley Range (K. Walker KW 136)	P1	Within 40 km of study area	DPaW (2014)
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	P1	Within 40 km of study area	DPaW (2014)
Eremophila sp. West Angelas (S. van Leeuwen 4068)	P1	Within 40 km of study area	DPaW (2014)
Eremophila spongiocarpa	P1	Within 40 km of study area	DPaW (2014)
Eucalyptus lucens	P1	Within 40 km of study area	DPaW (2014)
Euphorbia australis var. *glabra*	P2	Approx. 24 km south-east of study area	DPaW (2014), DBCA (2017)
Euphorbia inappendiculata var. *inappendiculata*	P2	Approx. 28 km south-west of study area	DPaW (2014), DBCA (2017)
Euphorbia inappendiculata var. *queenslandica*	P1	Approx. 24 km south-west of study area	DPaW (2014)
Fimbristylis sieberiana	P3	Within 40 km of study area	DPaW (2014)
Geijera salicifolia	P3	Within 40 km of study area	DPaW (2014)
Glycine falcata	P3	Approx. 31 km south-west of study area	DPaW (2014), DBCA (2017)
Gompholobium karijini	P2	Approx. 29 km east of study area	WA Herb (2017)
Goodenia nuda	P4	Within Approved Development Envelope from 23 records, with 145 individuals	DPaW (2014), DBCA (2017), Ecoscape (2014), Naturemap (2014)
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Approx. 23 km south-east of study area	DPaW (2014), DBCA (2017)
Gymnanthera cunninghamii	P3	Approx. 32 km south-east of study area	DPaW (2014), DBCA (2017)

Species	DPaW Priority list	Nearest record to study area	Source
Helichrysum oligochaetum	P1	Within Approved Development Envelope from five records, with over 55 individuals.	DPaW (2014), DBCA (2017), Ecoscape 2014, Naturemap (2014)
Heliotropium muticum	P3 (formerly P1)	Within Approved Development Envelope from 20 records, with over 583 individuals	DPaW (2014), DBCA (2017), Ecoscape 2014
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2	Within 40 km of study area	DPaW (2014)
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	P1	Approx. 25 km south-east of study area	DPaW (2014), DBCA (2017)
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	Approx. 4 km west of study area	DPaW (2014), DBCA (2017)
Indigofera sp. Gilesii (M.E. Trudgen 15869)	P3	Within 40 km of study area	DPaW (2014)
Iotasperma sessilifolium	P3	Approx. 19 km south of study area	DPaW (2014), DBCA (2017)
Ipomoea racemigera	P2	Within 40 km of study area	DPaW (2014)
Josephinia sp. Marandoo (M.E. Trudgen 1554)	P1	Approx. 21 km south of study area	WA Herb (2017), Naturemap (2014)
Lepidium catapycnon	P4 (formerly T)	Within 25 km of study area	EPBC (2014), DPaW (2014)
Livistona alfredii	P4	Approx. 30 km west of study area	DPaW (2014), DBCA (2017)
Nicotiana heterantha	P1	Approx. 11 km east of study area	DPaW (2014), DBCA (2017), Naturemap (2014)
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Within Approved Development Envelope and BBI study area from 5 records, with over 140 individuals	DPaW (2014), DBCA (2017), Ecoscape 2014, Naturemap (2014)
Olearia mucronata	P3	Within 40 km of study area	DPaW (2014)
Owenia acidula	P3	Within 40 km of study area	DPaW (2014)
Oxalis sp. Pilbara (M.E. Trudgen 12725)	P2	Within 40 km of study area	DPaW (2014)
Paspalidium retiglume	P2	Approx. 6 km east of study area	DPaW (2014), DBCA (2017), NatureMap (2014)
Pentalepis trichodesmoides subsp. *hispida*	P2	Within Approved Development Envelope from one record, with only one individual	Ecoscape (2014), DPaW (2014)
Pilbara trudgenii	P3 (formerly P2)	Within 40 km of study area	DPaW (2014)
Pleurocarpaea gracilis	P3	Within 40 km of study area	DPaW (2014)
Polymeria distigma	P3	Within 40 km of study area	DPaW (2014)
Ptilotus mollis	P4	Approx. 38 km south-west of study area	WA Herb (2017)
Ptilotus subspinescens	P3	Approx. 29 km south-west of	DPaW (2014), DBCA (2017)

Species	DPaW Priority list	Nearest record to study area	Source
		study area	
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3	Approx. 21 km south of study area	DPaW (2014), DBCA (2017)
Rhynchosia bungarensis	P4	Approx. 2 km west of study area	DPaW (2014), DBCA (2017), Ecoscape 2014, Naturemap (2014)
Rostellularia adscendens var. *latifolia*	P3	Approx. 5 km south-west of study area	DPaW (2014), DBCA (2017), Naturemap (2014)
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675*)*	P2	Within 40 km of study area	DPaW (2014)
Sida sp. Barlee Range (S. van Leeuwen 1642)	P3	Approx. 7 km west of study area	DPaW (2014), DBCA (2017), Ecoscape 2014, Naturemap (2014)
Sida sp. Hamersley Range (K. Newbey 10692)	P1	Approx. 5 km south-east of study area	DPaW (2014), DBCA (2017), NatureMap (2014)
Solanum albostellatum	P3	Within 40 km of study area	DPaW (2014)
Solanum kentrocaule	P3	Within 40 km of study area	DPaW (2014)
Sporobolus pulchellus	P1	Within 40 km of study area	DPaW (2014)
Stackhousia clementii	P3	Approx. 17 km east of study area	DPaW (2014), DBCA (2017)
Swainsona thompsoniana	P3	Approx. 14 km east of study area	DPaW (2014), DBCA (2017)
Tephrosia rosea var. Port Hedland (A.S. George 1114)	P1	Approx. 16 km east of study area	DPaW (2014), DBCA (2017). Naturemap (2014)
Tetratheca fordiana	P1	Within 40 km of study area	DPaW (2014)
Teucrium pilbaranum	P2 (formerly P1)	Approx. 32 km south-west of study area	DPaW (2014), DBCA (2017)
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	Approx. 0.5 km of study area	DPaW (2014), DBCA (2017)
Thryptomene wittweri	T	Within 40 km of study area	DPaW (2014)
Trianthema sp. Python Pool (G.R. Guerin & M.E. Trudgen GG 1023)	P2	Within 40 km of study area	DPaW (2014)
Triodia basitricha	P3	Approx. 3 km east of study area	DBCA (2017)
Triodia sp. Karijini (S. van Leeuwen 4111)	P1	Within 40 km of study area	DPaW (2014)
Triodia sp. Mt Ella (M.E. Trudgen 12739)	P3	Within 40 km of study area	DPaW (2014)
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	P3	Within 40 km of study area	DPaW (2014)
Vigna triodiophylla (*Previously Vigna* sp. rockpiles (R. Butcher et al. RB 1400))	P3	Within 40 km of study area	DPaW (2014)
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	P1	Within 40 km of study area	DPaW (2014)



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Project No	1155
Date	31-Jul-18
Drawn by	AL
Map author	JC

0 5 10 20 30
Kilometres

1:900,000 (at A4) GDA 1994 MGA Zone 50

Approved development envelope
Study area (final potential disturbance area)

Ecological communities (Ecoscape 2014)
- Sb vegetation unit – potentially representative of the Four plant assemblages of the Wona Land System PEC
- Horseflat Land System of the Roebourne Plains (P3)

Ecological communities (DPaW)
- Four plant assemblages of the Wona Land System (previously 'Cracking clays of the Chichester and Mungaroona Range') (P1)
- Kumina Land System (P3)
- Horseflat Land System of the Roebourne Plains (P3)

Figure 3-1

Desktop records of conservation significant flora and ecological communities

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3.1.1.2 Introduced flora

Ecoscape (2014) recorded 16 weed species during their baseline flora and vegetation survey for the Project (Table 3-2). None of these species are a declared pest or weed of national significance.

Table 3-2 Weed species recorded by the desktop assessment near the study area

Family	Name
Polygonaceae	*Rumex vesicarius*[1]
Amaranthaceae	*Aerva javanica*
Papaveraceae	*Argemone ochroleuca* subsp. *ochroleuca*
Asteraceae	*Bidens bipinnata*
Poaceae	*Cenchrus ciliaris*
Poaceae	*Cenchrus setiger*
Cucurbitaceae	*Cucumis melo*
Poaceae	*Cynodon dactylon*
Asteraceae	*Flaveria trinervia*
Malvaceae	*Malvastrum americanum*
Malvaceae	*Melochia pyramidata*
Passifloraceae	*Passiflora foetida* var. *hispida*
Poaceae	*Setaria verticillata*
Asteraceae	*Sigesbeckia orientalis*
Asteraceae	*Sonchus oleraceus*
Fabaceae	*Vachellia farnesiana*

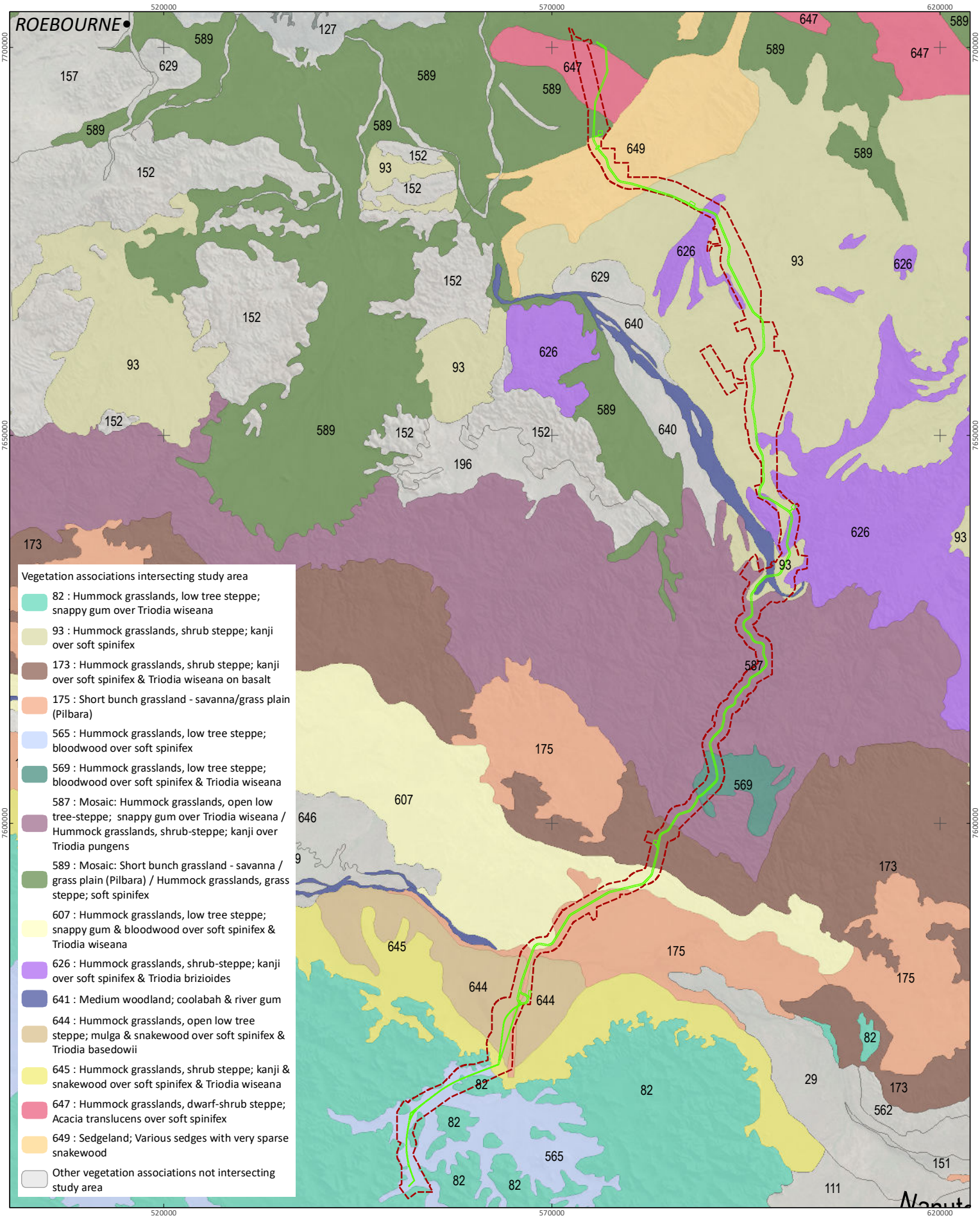
[1] formerly *Acetosa vesicaria.*

3.1.1.3 Vegetation associations

Regional scale vegetation mapping by Shepherd *et al.* (2002, after Beard) defined 15 vegetation associations in the study area (Figure 3-2):

- Association 82 Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*
- Association 93 Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp
- Association 173 Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp
- Association 175 Annual grasses *Enneapogon* spp. *Aristida* spp. etc. on dry plains and salt water grasses *Sporobolus virginicus* on the coast

- Association 565 Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*
- Association 569 Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*
- 587 Mosaic: Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana* / Hummock grasslands, shrub-steppe; kanji over *Triodia pungens*
- 589 Mosaic: Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft spinifex
- Association 607 Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*
- Association 626 Hummock grassland with sparse shrubs *Triodia* spp. *Acacia* spp.
- Association 641 Wheatbelt; York gum, salmon gum etc. *Eucalyptus loxophleba*, *E. salmonophloia*. Goldfields; gimlet, redwood etc. *E. salubris*, *E. oleosa*. Riverine; rivergum *E. camaldulensis*. Tropical; messmate, woolybush
- Association 644 Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*
- Association 645 Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp
- Association 647 Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp
- Association 649 Hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp.



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Project No	1155
Date	20-Oct-17
Drawn by	AL
Map author	JC

0 2.5 5 10 15 20 25
Kilometres

1:625,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope

Figure 3-2
Shepherd et al. (2002) vegetation associations of the study area

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Ecoscape (2014) previously completed vegetation type mapping in 87.8% of the current study area. They mapped 58 vegetation types plus two mosaics of two vegetation types each in total, of which 51 intersect the current study area (Table 3-3).

Table 3-3 Previously mapped vegetation types (Ecoscape 2014) and presence in current study area

Vegetation code	Vegetation description	Mapped in current study area?
Aa3Te	*Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia arida* tall-mid open to scattered shrubland over *Triodia epactia* and *Triodia wiseana* mid-low open hummock grassland	Yes
Aa3Tl	*Acacia ancistrocarpa*, *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera*, *Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* and *Corymbia deserticola* subsp. *deserticola* low scattered trees	Yes
Aa3Tl/Ts	Mosaic of: *Acacia ancistrocarpa*, *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera*, *Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* and *Corymbia deserticola* subsp. *deserticola* low scattered trees and *Triodia secunda*, *Triodia wiseana*	Yes
Aa4As3	*Acacia arida* mid sparse shrubland over *Acacia stellaticeps*, *Triodia epactia* and *Bonamia erecta* low shrubland/hummock grassland with *Corymbia hamersleyana* scattered low trees	No
Aa4Tl	*Acacia arida* and *Acacia ancistrocarpa* mid open shrubland over *Triodia lanigera*, *Acacia spondylophylla* and *Triodia epactia* mid (low) hummock grassland/shrubland	Yes
Aa5Tw	*Acacia atkinsiana*, *Hakea chordophylla* and *Acacia ancistrocarpa* tall-mid sparse shrubland over *Triodia wiseana* and *Triodia epactia* low hummock grassland with *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* low scattered trees	Yes
Ac1ApTe	*Acacia citrinoviridis* low woodland or tall to mid shrubland over *Acacia pyrifolia* var. *pyrifolia*, *Acacia trachycarpa* and *Acacia pruinocarpa* tall-mid shrubland over *Triodia epactia* mid hummock grassland	Yes
Ac1Te	*Acacia citrinoviridis* and *Corymbia hamersleyana* low woodland over *Triodia epactia*, *Themeda triandra* and *Chrysopogon fallax* mid-low hummock grassland/tussock grassland	Yes
AiTe(1)	*Acacia inaequilatera* and *Acacia acradenia* tall sparse shrubland over *Triodia epactia* and *Triodia wiseana* mid tussock grassland	Yes
AiTe(2)	*Acacia inaequilatera* and *Acacia ancistrocarpa* tall-mid sparse-scattered shrubland over *Triodia epactia* mid hummock grassland	Yes
AiTe(3)	*Acacia inaequilatera* and *Acacia trachycarpa* mid sparse shrubland over *Triodia epactia* and *Pluchea tetranthera* mid(low) hummock grassland/shrubland with *Corymbia hamersleyana* low scattered trees	Yes
AiTw(1)	*Acacia inaequilatera* tall sparse or scattered shrubland over *Triodia wiseana* and *Triodia epactia* mid-low hummock grassland	Yes
AiTw(2)	*Acacia inaequilatera*, *Acacia pyrifolia* var. *pyrifolia* and *Hakea lorea* subsp. *lorea* tall	Yes

Vegetation code	Vegetation description	Mapped in current study area?
	sparse shrubland over *Triodia wiseana*, *Triodia epactia* and *Triodia brizoides* mid-low hummock grassland	
AiTw(3)	*Acacia inaequilatera*, *Grevillea pyramidalis* subsp. *leucadendron* and *Acacia* sp. tall sparse shrubland over *Triodia wiseana*, *Triodia epactia* and *Triodia* aff. *melvillei hummock* grassland with *Corymbia hamersleyana* low scattered trees	Yes
AmEe	*Acacia melleodora* tall open shrubland over *Eragrostis eriopoda* and *Aristida holathera* var. *holathera* mid open tussock grassland	Yes
AoTe	*Acacia orthocarpa* and *Acacia pyrifolia* var. *pyrifolia* tall open shrubland over *Triodia epactia*, *Indigofera monophylla* and *Triodia wiseana* mid hummock grassland/shrubland	Yes
ApTe	*Acacia pyrifolia* var. *pyrifolia*, *Acacia trachycarpa* and *Petalostylis labicheoides* tall-mid open shrubland over *Triodia epactia*, **Cenchrus ciliaris* and **Aerva javanica* mid-low tussock grassland/hummock grassland/shrubland	Yes
ApTw	*Acacia pyrifolia* var. *pyrifolia*, *Acacia ancistrocarpa* and *Acacia inaequilatera* tall sparse shrubland over *Triodia wiseana* and *Triodia epactia* mid hummock grassland	Yes
As1Cf	*Acacia sclerosperma* subsp. *sclerosperma* and *Carissa lanceolata* tall shrubland over *Chrysopogon fallax*, *Eragrostis xerophila* and **Cenchrus ciliaris* mid tussock grassland	No
As3	*Acacia stellaticeps* and *Triodia schinzii* low shrubland/mid hummock grassland	Yes
AxSb	*Acacia xiphophylla* tall shrubland over *Streptoglossa bubakii*, *Stemodia kingii* and *Triodia wiseana* low open shrubland/hummock grassland	Yes
Cc2AbBe	*Corymbia candida* mid woodland over *Acacia bivenosa* and *Acacia elachantha* tall open shrubland over *Bothriochloa ewartiana*, *Themeda triandra* and *Chrysopogon fallax* low sparse tussock grassland	Yes
Cc2Eb	*Corymbia candida* low open woodland over *Eriachne benthamii*, *Triodia epactia* and *Chrysopogon fallax* mid tussock grassland/hummock grassland with *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall scattered shrubs	No
CdAa5Te	*Corymbia deserticola* subsp. *deserticola*, *Corymbia hamersleyana* and *Eucalyptus xerothermica* low open woodland over *Acacia atkinsiana* and *Grevillea wickhamii* tall open shrubland over *Triodia epactia* mid hummock grassland	Yes
ChAa1Ta	*Corymbia hamersleyana* low open woodland over *Acacia acradenia*, *Acacia ancistrocarpa* and *Acacia inaequilatera* tall sparse shrubland over *Triodia angusta* and *Triodia epactia* low hummock grassland	Yes
ChAa5Te	*Corymbia hamersleyana*, *Eucalyptus gamophylla* and *Eucalyptus xerothermica* low open woodland over *Acacia atkinsiana*, *Grevillea wickhamii* and *Acacia ancistrocarpa* mid open-sparse shrubland over *Triodia epactia* and *Eulalia aurea* mid-low hummock grassland	Yes
ChAbTw	*Corymbia hamersleyana* and *Grevillea pyramidalis* subsp. *leucadendron* low open woodland or scattered trees over *Acacia bivenosa* and *Acacia arida* tall-mid sparse shrubland over *Triodia wiseana*, *Triodia epactia* and *Triodia angusta* mid open tussock grassland	Yes

Vegetation code	Vegetation description	Mapped in current study area?
ChAeTt	*Corymbia hamersleyana* and *Eucalyptus xerothermica* low open woodland over *Acacia elachantha* and *Maytenus* sp. Mt Windell (S. van Leeuwen 846) mid sparse shrubland over *Themeda triandra*, *Eulalia aurea* and *Chrysopogon fallax* mid tussock grassland	Yes
ChAiCf	*Corymbia hamersleyana* low open woodland over *Acacia inaequilatera*, *Acacia pyrifolia* var. *pyrifolia* and *Eremophila longifolia* tall open shrubland over *Chrysopogon fallax*, *Triodia epactia* and *Themeda triandra* mid tussock grassland/hummock grassland	Yes
ChAt2Te	*Corymbia hamersleyana* low open woodland over *Acacia tumida* var. *pilbarensis* and *Acacia pyrifolia* var. *pyrifolia* tall-mid sparse shrubland over *Triodia epactia*, *Themeda triandra* and *Paraneurachne muelleri* mid hummock grassland/tussock grassland	Yes
EgAa5Te	*Eucalyptus gamophylla* and *Corymbia hamersleyana* low open mallee shrubland/woodland over *Acacia atkinsiana*, *Acacia inaequilatera* and *Acacia trachycarpa* (dwarf variant) tall-mid open-sparse shrubland over *Triodia epactia*, *Paraneurachne muelleri* and *Triodia wiseana* mid-low hummock grassland/tussock grassland	Yes
ElAa3Tm	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia deserticola* subsp. *deserticola* low open woodland over *Acacia ancistrocarpa* mid sparse shrubland over *Triodia* aff. *melvillei* and *Amphipogon sericeus* mid-low hummock grassland/tussock grassland	No
ElAs2Te	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland or scattered trees over *Acacia* sp., *Acacia inaequilatera* and *Acacia tumida* subsp. *pilbarensis* tall sparse shrubland over *Triodia epactia* low hummock grassland	Yes
ElEgTw	*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Eucalyptus gamophylla*, *Acacia pyrifolia* var. *pyrifolia* and *Acacia maitlandii* low open mallee shrubland/tall open shrubland over *Triodia wiseana* and *Waltheria virgata* low hummock grassland	No
ElTe	*Eucalyptus leucophloia* subsp. *leucophloia* mid open woodland to scattered trees over *Triodia epactia*, *Triodia brizoides* and *Triodia wiseana* hummock grassland	Yes
ElTw(1)	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Triodia wiseana* and *Eriachne mucronata* mid-low hummock grassland/tussock grassland with *Grevillea wickhamii* and *Hakea chordophylla* tall-mid scattered shrubs	Yes
ElTw(2)	*Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Triodia wiseana* and *Triodia epactia* mid-low hummock grassland	Yes
EvApCc1	*Eucalyptus victrix*, *Corymbia hamersleyana* and *Acacia coriacea* subsp. *pendens* mid-low open woodland over *Acacia pyrifolia* var. *pyrifolia* tall sparse shrubland over **Cenchrus ciliaris*, *Triodia angusta* and *Triodia epactia* low tussock grassland/hummock grassland	Yes
EvApTe	*Eucalyptus victrix* and *Corymbia hamersleyana* mid open woodland-scattered trees over *Acacia pyrifolia* var. *pyrifolia* and *Acacia tumida* var. *pilbarensis* tall shrubland-scattered shrubs over *Triodia epactia*, *Tephrosia rosea* var. Fortescue creeks (M.I.H Brooker 2186) and **Cenchrus ciliaris* mid-low open hummock	Yes

Vegetation code	Vegetation description	Mapped in current study area?
	grassland/shrubland/tussock grassland	
EvAt1Te	*Eucalyptus victrix* mid woodland-open woodland over *Acacia trachycarpa*, *Acacia ampliceps* and *Acacia pyrifolia* var. *pyrifolia* tall shrubland-sparse shrubland over *Triodia epactia* and **Cenchrus ciliaris* mid open hummock grassland/tussock grassland	Yes
EvCb	*Eucalyptus victrix* low open woodland over *Cyperus bifax* and *Eriachne benthamii* low sedgeland/tussock grassland with **Vachellia farnesiana* tall scattered shrubs	Yes
EvMgEb	*Eucalyptus victrix* and *Acacia citrinoviridis* mid woodland over *Melaleuca glomerata* and **Vachellia farnesiana* tall sparse shrubland over *Eriachne benthamii* and *Cyperus bifax* low open tussock grassland/sedgeland	
EvMlCv	*Eucalyptus victrix*, *Eucalyptus camaldulensis* subsp. *refulgens* and *Acacia coriacea* subsp. *pendens* mid-low woodland over *Melaleuca linophylla*, *Melaleuca glomerata* and *Acacia trachycarpa* tall open shrubland over *Cyperus vaginatus*, *Triodia epactia* and **Cenchrus* ciliaris mid open sedgeland/hummock grassland/tussock grassland	Yes
Ex1	*Eragrostis xerophila*, *Dichanthium sericeum* subsp. *humilius* and *Vigna* sp. Hamersley Clay (A.A. Mitchell PRP 113) low tussock grassland/vineland	Yes
FbGpEm	*Ficus brachypoda* low open woodland over *Grevillea pyramidalis* subsp. *leucadendron* and *Tephrosia rosea* var. *clementii* mid sparse shrubland over *Eriachne mucronata*, *Triodia wiseana* and *Triodia epactia* mid open tussock grassland/hummock grassland	Yes
FPg1 (Mattiske)	*Triodia epactia*, *Eragrostis xerophila* and *Eriachne benthamii* mid-low hummock grassland with tall *Acacia inaequilatera* and *Carissa lanceolata* scattered clumps of shrubs	No
HcTe	*Hakea chordophylla* and *Grevillea pyramidalis* subsp. *leucadendron* tall sparse shrubland over *Triodia epactia* and **Cenchrus ciliaris* mid hummock grassland/tussock grassland	No
MaMgCv	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* mid open forest-open woodland over *Melaleuca glomerata*, *Acacia ampliceps* and *Acacia coriacea* subsp. *pendens* tall sparse shrubland-scattered shrubs over *Cyperus vaginatus* and *Stemodia grossa* mid open sedgeland/forbland	Yes
MaMlCi	*Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* low open woodland over *Melaleuca linophylla* tall open shrubland over *Cyperus ixiocarpus* mid sparse sedgeland	Yes
Rock	Rock outcrop (not vegetated)	Yes
Sb	*Streptoglossa bubakii*, *Sida fibulifera* and *Stemodia kingii* low open shrubland/herbland	Yes
Ta	*Triodia angusta* and *Triodia epactia* mid hummock grassland	Yes
Tb	*Triodia brizoides* and *Triodia epactia* mid-low hummock grassland with *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low scattered trees	Yes
Te(1)	*Triodia epactia* and *Triodia secunda* low hummock grassland	Yes
Te(2)	*Triodia epactia* and *Triodia wiseana* low hummock grassland with *Corymbia*	Yes

Vegetation code	Vegetation description	Mapped in current study area?
	hamersleyana low scattered trees over *Acacia elachantha* tall scattered shrubs	
Te(3)	*Triodia epactia*, *Sclerolaena hostilis* and *Triodia angusta* mid-low open hummock grassland/chenopod shrubland with occasional low *Acacia xiphophylla* scattered trees	No
Te(4)	*Triodia epactia*, *Triodia angusta* and *Triodia lanigera* mid hummock grassland with scattered low *Acacia xiphophylla* trees	Yes
Ts	*Triodia secunda*, *Triodia wiseana* and *Triodia epactia* mid hummock grassland	No
Tw(1)	*Triodia wiseana* and *Eragrostis xerophila* mid hummock grassland/tussock grassland	No
Tw(2)	*Triodia wiseana* and *Triodia epactia* low open hummock grass with *Corymbia hamersleyana* low scattered trees over *Acacia inaequilatera* mid scattered shrubs	Yes

3.1.1.4 Threatened and Priority Ecological Communities

The DBCA threatened and priority ecological community database did not return any records of TECs within the search extent. An earlier database search conducted for the Project by Ecoscape (2014) returned the TEC '*Themeda* grasslands on cracking clays (Hamersley Station, Pilbara)' as occurring within their search buffer area, but the study area was determined to be outside the administrative buffer associated with the TEC. Ecoscape (2014) did not identify any TECs as present in the Approved Development Envelope during their survey.

The database search results show two DBCA listed PECs intersecting the study area, 'Four plant assemblages of the Wona Land System' (Priority 1–3) and 'Horseflat Land System of the Roebourne Plains' (Priority 3). One additional Priority 3 PEC is located within 10 km, 'Kumina Land System' (Table 3-4; Figure 3-1).

Ecoscape (2014) identified that the mapped vegetation unit Sb, described as *Streptoglossa bubakii*, *Sida fibulifera* and *Stemodia kingii* low open shrubland/herbland, may be representative of one of the four community types that form the P1–P3 'Four plant assemblages of the Wona Land System'. As the DPaW Ecological Communities database search reported in the desktop review for the previous survey (Ecoscape 2014) did not include the area of the Sb vegetation unit mapped as the PEC, the authors recommended additional survey following the wet season, and consultation with relevant DBCA authorities to confirm presence of the PEC. The DBCA database search conducted 06 June 2017 for the current survey identified the potential PEC area mapped by Ecoscape (2014) as the PEC, including a 1 km buffer (Figure 3-1).

Ecoscape (2014) identified the likely presence of the 'Horseflat Land System of the Roebourne Plains' in the northern portion of the study area (Figure 3-1). Vegetation type Ex1 was considered to represent the PEC subtype 3; vegetation types Te(1) and Tw(1) were considered most likely to represent uncommon variations of subtype 5. Vegetation type Cc2Eb, in drainage depressions was considered to potentially represent subtype 7. The vegetation types mostly occurred on the Horseflat land system with a small proportion associated with the Mallina land system (Ecoscape 2014).

Table 3-4 Priority ecological communities identified in the desktop review

Community name	Cons. status	Proximity and relevance to study area	Description
Four plant assemblages of the Wona Land System	P1 - P3	DBCA mapped PEC boundary intersects the study area. The Wona Land System is present within study area. Tentatively mapped in the study area by Ecoscape (2014) as Sb vegetation type.	Four plant assemblages of the Wona Land System. A system of basalt upland gilgai plains with tussock grasslands throughout the Chichester Range. There are a series of community types identified within the Wona Land System gilgai plains that are considered susceptible to known threats such as grazing or have constituent rare/restricted species, as follows: - Cracking clays of the Chichester and Mungaroona Range (P1). This grassless plain of stony gibber community occurs on the tablelands with very little vegetative cover during the dry season, however during the wet a suite of ephemerals/annuals and short - lived perennials emerge, many of which are poorly known and range - end taxa. - Annual *Sorghum* grasslands on self mulching clays (P1). This community appears very rare and restricted to the Pannawonica - Robe valley end of Chichester Range. - Mitchell grass plains (*Astrebela* spp.) on gilgai (P3). - Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai (typical type, heavily grazed (P3).
Kumina Land System	P3	PEC is located 4 km from study area. The Kumina Land System is not present within the study area.	Ferricrete duricrust plains, uplands and plateaux remnants, relief up to 15 m. Duricrust plains and plateau remnants support hard spinifex grasslands.
Horseflat Land System of the Roebourne Plains	P3	DBCA mapped PEC boundary intersects the study area. The Horseflat Land System is present within the study area. Ecoscape (2014) recorded in northern section of the Approved Development Envelope.	The Horseflat Land System of the Roebourne Plains are extensive, weakly gilgaied clay plains dominated by tussock grasslands on mostly alluvial non – gilgaied, red clay loams or heavy clay loams. Perennial tussock grasses include *Eragrostis xerophila* (Roebourne Plains grass) and other *Eragrosti*s spp, *Eriachne* spp. and *Dichanthium* spp. The community also supports a suite of annual grasses including *Sorghum* spp. and rare *Astrebela* spp. The community extends from Cape Preston to Balla Balla surrounding the towns of Karratha and Roebourne.

3.1.2 Fauna and fauna habitat

Eight broad fauna habitats were mapped within the Approved Development Envelope during the baseline fauna surveys for the Project (Phoenix 2014) and of these, seven occur within the mapped extent of the current study area (Table 3-5).

A summary of previous records for each of the target conservation significant fauna species identified from the desktop review is provided in Table 3-6.

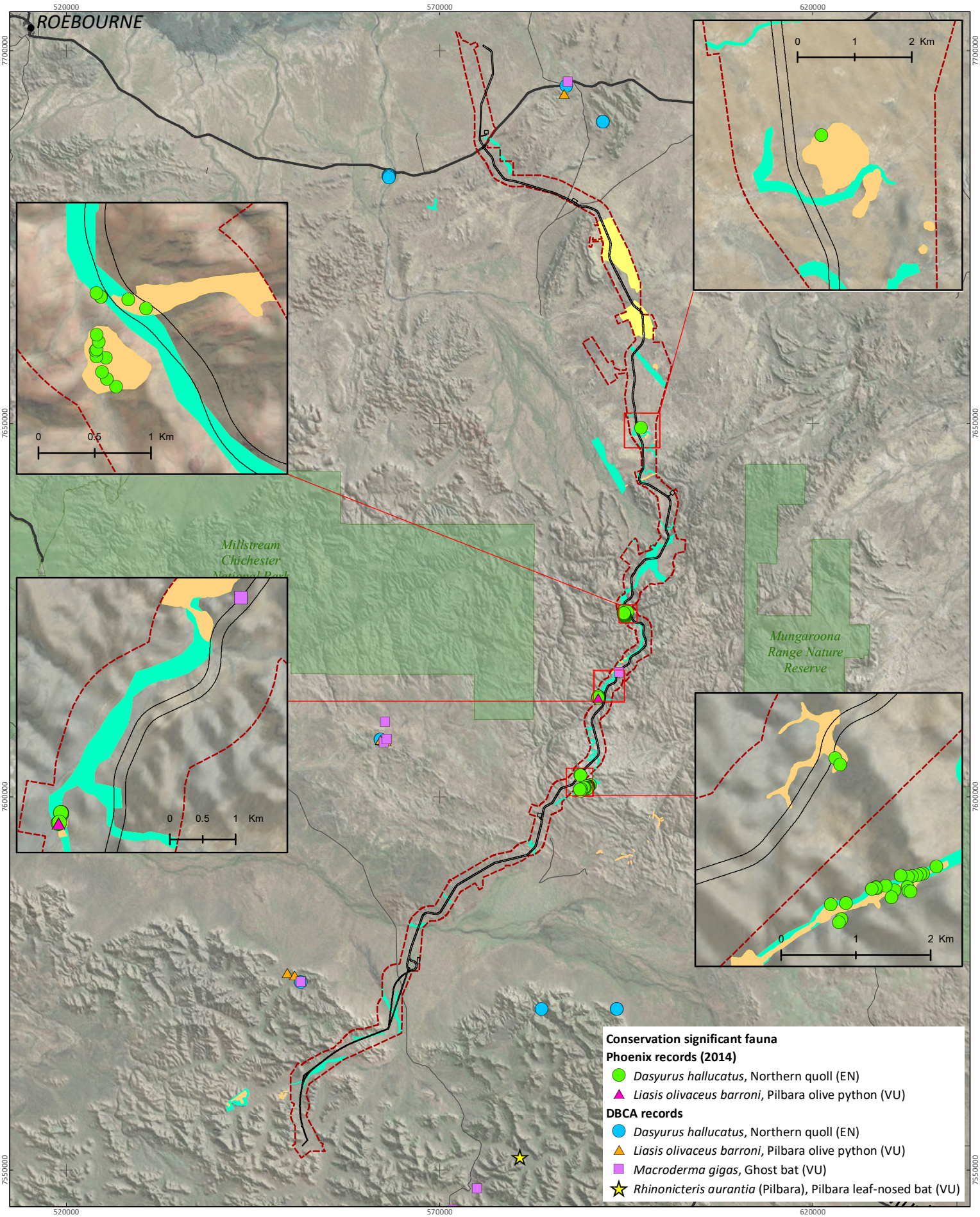
Table 3-5 Previously mapped fauna habitat types (Phoenix 2014) and presence in current study area

Fauna habitat type	Current study area
Hummock and tussock grassland	Yes
Minor creek and drainage line	Yes
Open and closed shrubland	Yes
Rocky hill slope	Yes
Woodland	Yes
Gully	Yes
Sandplain	Yes
Isolated sand dune	No

Table 3-6 Previous records of target fauna species

Species	Previous records
Northern Quoll (*Dasyurus hallucatus)*	Previously recorded multiple times by Phoenix (2014) from 45 captures of 21 individuals (eight female, 12 male and one undetermined) at five trapping sites and nine times from secondary evidence, eight scat records and once from skeletal remains (Figure 3-3). The species was also recorded on multiple occasions at seven camera trap sites (Figure 3-3). Of the previous records of Northern Quoll by Phoenix (2014), two occur within the current study area, one from a trapped individual and the second from a camera trap capture. Of the remaining records occurring outside of the current study area, many occur in areas of continuous habitat adjacent to the study area that intersects parts of it in some areas (Figure 3-3). A total of 14 records of Northern Quoll within the desktop search area were returned in the DBCA Threatened Fauna Database search, none of which occurred within the current study area (Figure 3-3). A total of 767.4 ha of suitable Northern Quoll denning and shelter habitat was mapped during the Phoenix (2014) survey, of which 11.5 ha intersects the current study area.
Pilbara Olive Python (*Liasis olivaceus barrni*)	The Pilbara Olive Python was recorded once from secondary evidence by Phoenix (2014). A single scat was recorded at one site outside the current study area (Figure 3-3). A snake resembling a Pilbara Olive Python was recorded at site Q4 from a remote camera trap (Figure 3-3); however, conclusive identification was not possible due to the position of the individual in the photo. DCBA Threatened Fauna Database results revealed eight records of the Pilbara Olive Python within the desktop search area, none of which occurred within the current study area, with the nearest record located approximately 10 km east of the northern quarter of the study area (Figure 3-3). A total of 4, 107.06 ha of suitable Pilbara Olive Python habitat comprising of guly and minor creek and drainage line habitats was mapped during the Phoenix (2014) survey, of which 175.03 ha intersects the current study area.
Bilby (*Macrotis lagotis*)	No Bilby have been recorded during previous surveys undertaken for the project (Phoenix 2014). No records of Bilby within the desktop search area were returned in the DBCA Threatened Fauna Database search.

Species	Previous records
	A total of 3,634.1 ha of suitable Bilby habitat was mapped during the Phoenix (2014) survey, of which 192.8 ha intersects the current study area.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* – Pilbara form)	No records of the Pilbara Leaf-nosed Bat have been collected during previous surveys for the Project (Phoenix 2014). Seven records of the species were returned in the DBCA Threatened Fauna Database search within the desktop search area, the closest of which occurred approximately 19 km southeast of the southern quarter of the study area (Figure 3-3). Habitat not previously mapped for the species for the Project.
Ghost Bat (*Macroderma gigas*)	The Ghost Bat was not recorded during previous surveys undertaken for the project; however, potential roost caves were identified within gully habitat in the southern third of the study area (Phoenix 2014). DCBA Threatened Faun Database results revealed 14 records of the Ghost Bat within the desktop search area, including one within the current study area, approximately half the length of the study area (Figure 3-3). Habitat not previously mapped for the species for the Project.



Balla Balla Infrastructure Group Ltd
Pilbara Iron Ore Project and
Balla Balla Infrastructure Project

Project No	1155
Date	25-Aug-17
Drawn by	AL
Map author	JC

0 5 10 20
Kilometres

(at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope

Species habitat mapped by Phoenix (2014)

Bilby
Northern Quoll and Pilbara Olive Python
Pilbara Olive Python

Figure 3-3

Previous records of target fauna species

PHOENIX ENVIRONMENTAL SCIENCES

3.2 FIELD SURVEY

3.2.1 Flora and vegetation

A total of 221 flora species and subspecies representing 36 families and 97 genera were recorded during the field surveys (Appendix 4). Species richness ranged from 13–42 species between sites with more than 20 species recorded in 66% of quadrat surveys (Appendix 1). The assemblage included 131 perennial species, 82 annual or short-lived species and eight unknown (taxa not identified to species level). The most prominent families recorded were Fabaceae (50 species), Poaceae (37), Malvaceae (23) and Amaranthaceae (18).

3.2.1.1 Conservation significant flora

No Commonwealth or State listed Threatened flora were recorded in the study area during the survey. Seven Priority flora were recorded (Figure 3-4):

- *Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1)
- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (P1)
- *Acacia fecunda* (P3)
- *Heliotropium muticum* (P3)
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3)
- *Goodenia nuda* (P4)
- *Rhynchosia bungarensis* (P4).

3.2.1.1.1 ***Abutilon* sp. Pritzelianum**

Status: Priority 1

Description: Perennial, erect open shrub up to 1.8 m high and 1.6 m wide (Plate 1). Yellow-orange flowers and fruits in August.

Plate 1 *Abutilon* sp. Pritzelianum – Atlas of Living Australia (ALA 2017)

Distribution and ecology: Occurs in the Carnarvon, Murchison and Pilbara bioregions (DBCA 2017). This species is known from 38 records (ALA 2017), with habitat descriptions including:

- *Eucalyptus camaldulensis* subsp. *obtuse* sparse open trees over sparse or open *Corchorus incanus* subsp. *incanus*, *Cullen martini* over *Aristida contorta* sparse or open tussock grass and *Triodia lanigera* hummock grassland
- *Acacia ancistrocarpa* and *A. inaequilatera* tall open shrubland over shrubland *A. stellaticeps* over *Triodia epactia* hummock grassland and *Triodia lanigera* hummock grassland
- emergent trees of *Corymbia zygophylla* over *Triodia* ? *lanigera* and *T. epactia*
- *Eragrostis eriopoda* tussock grassland with *Aristida hygrometrica*, *Corchorus incanus*, *Triumfetta chaetocarpa* and *Aerva javanica*
- *Acacia* spp. with *Eremophila* spp., *Thryptomene* spp. and *Triumfetta chaetocarpa*
- low shrubland with *Sida clementii*, *S. rohlenae*, *S. pilbarensis*, *Corchorus walcottii*, *Ipomoea muelleri*, *Acacia tumida*, *Abutilon otocarpum*, *Waltheria indica* and *Cajanus pubescens*
- open *Melaleuca* shrubland with *Acacia* shrubland over *Chenopodium* spp. and *Sida* spp.
- *Verticordia* and *Grevillea stenobotrya* with scattered emergent *Corymbia hamersleyana* over dwarf scrub of *Sida* sp., *Acacia stellaticeps* and *A. adsurgens* over open forbland of *Ptilotus polystachyus* and *Calandrinia* sp. over mid-dense hummock grass of *Triodia* sp.
- *Acacia tetragonophylla* and *A. sclerosperma* open scrub over *Scholtzia* sp., *Rhagodia preissii* and *Pityrodia loxocarpa* open dwarf scrub over *Eragrostis lanipes* open dwarf scrub over mixed very open forbland.

Population sizes provided in records for the species (DBCA 2017) range from a solitary plant to in excess of 50 plants, with some comments of the species being frequent or common.

Records and distribution in study area: Over 44 plants were recorded from four locations (ranging from 3 to >20 individuals) and two populations in the study area (Figure 3-4). *Abutilon* sp. Pritzelianum was recorded in one habitat type: *Acacia ancistrocarpa*, *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera*, *Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* (vegetation type Aa3TI).

3.2.1.1.2 ***Hibiscus* sp. Mt Brockman**

Status: Priority 1

Description: Spindly erect shrub to 3.5 m with mauve flowers.

Distribution and ecology: according to DBCA (2017), the species is confined to the Hamersley subregion in the Pilbara bioregion and is known from 14 records with habitat including:

- steep drainage gullies with scattered *Corymbia ferriticola* and *Eucalyptus leucophloia* low trees over scattered *A*cacia *pruinocarpa* and *Gossypium robinsonii* tall shrubland over mixed open shrubland of *Dodonaea pachyneura*, *Eremophila latrobeii* and *Stylobasium spathulatum*
- scattered low trees of *Eucalyptus leucophloia* over open shrubland of *Astrotricha hamptonii*, *Senna glutinosa* var. *glutonosa*, *Acacia monticola* over open hummock grassland of *Triodia epactia* and *Eriachne mucronata* and *Cymbopogon ambiguous* very open tussock grassland

- steep rocky gorge on ironstone outcropping and boulders *Corymbia ferriticola*, *Acacia citrinoviridis*, *A. pruinocarpa* and *Ficus brachypoda* low woodland over *Dodonaea pachyneura*, *Petalostylis labicheoides* scattered tall shrubland over *Aristida burbidgeae*, *Eriachne mucronata*, *Cymbopogon ambiguus*, *Eriachne tenuiculmis*, *Themeda triandra* very open tussock grassland and *Triodia pungens* scattered hummock grasses.

Population sizes provided in records for the species (DBCA 2017) range from four to in excess of 200 plants, with some comments of the species being common.

Records and distribution in study area: A solitary plant was located during the current survey in vegetation type Aa3TE, *Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia arida* tall-mid open to scattered shrubland over *Triodia epactia* and *Triodia wiseana* mid-low open hummock grassland. The record is located outside the current study area but within the Approved Development Envelope (Figure 3-4).

3.2.1.1.3 *Acacia fecunda*

Status: Priority 3

Description: Erect obconic shrub up to 3 m high with yellow flowers in May or August.

Distribution and ecology: according to DBCA (2017), the species is confined to the Chichester subregion in the Pilbara and is known from 12 records with habitat of grey silty loam over colluvial gravel over bedrock with scattered tall shrubs of *Acacia* sp. Over shrubland of *Acacia* sp., *Melaleuca* sp. and *Scaevola acacioides* over low shrubland of *Acacia* sp. And *Senna* ?*stricta* over hummock grassland of *Triodia longiceps* and *Triodia* sp. Over very open herbland of *Lepidium* sp. And *Atriplex* sp. The species is known from a series of disjunct populations east of Nullagine (Maslin & van Leeuwen 2008) with maps in ALA (2017) indicating the records of the species represent five distinct populations.

Records and distribution in study area: *Acacia fecunda* was recorded in one location in the study area with *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland or scattered trees over *Acacia* sp., *Acacia inaequilatera* and *Acacia tumida* subsp. *pilbarensis* tall sparse shrubland over *Triodia epactia* low hummock grassland (vegetation type ElAs2Te) (Figure 3-4). This record represents an approximately 250 km range extension.

3.2.1.1.4 *Heliotropium muticum*

Status: Priority 3

Description: Ascending to spreading perennial herb up to 0.3 m high.

Distribution and ecology: according to DBCA (2017), the species is confined to the Chichester and Roebourne subregions in the Pilbara and is known from 25 records with habitat including:

- on sandplain in mixed sparse *Acacia bivenosa*, *A. stellaticeps*, *A. inaequilatera* shrubs over sparse medium *Triodia epactia* and *Pluchea tetranthera* hummock grassland
- scattered low trees of *Corymbia candida* subsp. *lautifolia* over open shrubland of *Acacia colei*, *A. ancistrocarpa*, *A.* ?*sericophylla*, *A. tumida* var. *pilbarensis* over low open shrubland of *Acacia stellaticeps* over open hummock grassland of *Triodia lanigera*, *T. epactia*, *T. schinzii*
- *Acacia inaequilatera*, *A. acradenia* and *Grevillea wickhamii* sparse shrubland over *Triodia basedowii* and *T. wiseana* hummock grassland
- *Indigofera monophyla* and *Solanum phlomoides* sparse shrubland over *Triodia pungens* and *T. basedowii* open hummock grassland

- *Corymbia hamersleyana* and *C. flavescens* open woodland over *Acacia tumida* var. *pilbarensis* open shrubland over *A. stellaticeps* low open shrubland over *Triodia epactia* hummock grassland
- on alluvial stream bed and banks in open woodland of *Eucalyptus camaldulensis* and *Eucalyptus victrix* over tall shrubland of *Acacia arida*, *Acacia pyrifolia* and *Grevillea wickhamii* over low open heath of *Cajanus* sp., *Corchorus* sp. And *Acacia trachycarpa* over hummock grassland of *Triodia* spp. With open tussock grassland of *Sorghum* sp. And *Chrysopogon fallax* over very open grassland of *Sporobolus australasicus* over very open sedgeland of *Cyperus* sp. Over scattered forbland of *Ptilotus axillaris*.

Population sizes provided in records for the species (DBCA 2017) typically range from a solitary plant to up to five plants and comments of the species include rare. A single record identified a population of in excess of 100 plants.

Records and distribution in study area: *Heliotropium muticum* was recorded from 35 locations within and outside the study area in numbers ranging from 1 to 25 plants with a total of 214 individuals recorded (Figure 3-4). The species was recorded in three habitats:

- *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* low open woodland over *Triodia wiseana* and *Triodia epactia* mid-low hummock grassland (vegetation type ElTw(2)
- *Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia arida* tall-mid open to scattered shrubland over *Triodia epactia* and *Triodia wiseana* mid-low open hummock grassland (vegetation type Aa3Te)
- *Acacia ancistrocarpa*, *Acacia inaequilatera* and *Acacia pyrifolia* var. *pyrifolia* tall-mid open-sparse shrubland over *Triodia lanigera*, *Triodia epactia* and *Acacia stellaticeps* mid-low hummock grassland/shrubland with occasional *Corymbia hamersleyana* (vegetation type Aa3TI).

3.2.1.1.5 *Themeda* sp. Hamersley Station

Status: Priority 3

Description: Tussock grass up to 2 m high flowers in August (DBCA 2017).

Distribution and ecology: according to DBCA (DBCA 2017), the species is confined to the Pilbara bioregion and is known from 42 records with habitat including:

- plain with orange sandy clay in *Acacia aptaneura* tall sparse shrubland over *Aristida holathera* var. *holathera*, *Aristida jerichoensis* var. *subspinulifera*, *Cenchrus ciliaris*, *Chrysopogon fallax*, *Dichanthium sericeum* subsp. *Humilis*, *Enneapogon polyphyllus*, *Eriachne flaccida* and *Eulalia aurea* open grassland
- *Acacia ancistrocarpa* and *A. pachyacra* tall scattered shrubs over *Triodia basedowii*, *T. longiceps* and *Paraneurachne muelleri* mid-low open hummock grassland and tussock grassland
- red-brown alluvial sand over ironstone in low open woodland of *Acacia aneura* var. *aneura*, *A. pruinocarpa*, *A. xiphophylla*, *A. victoriae* over *A. tetragonophylla*, *Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* and mixed species of *Maireana* and *Sclerolaena*
- drainage line with dry red and brown clay loam with *Eucalyptus victrix* and *Acacia aptaneura* low open woodland over *Acacia synchronicia* tall open shrubland over *Atriplex bunburyana*, *Maireana pyramidata* and *Eremophila spongiocarpa* low shrubland over *Cenchrus ciliaris*, *C. setiger* and *Eragrostis tenellula* tussock grassland with mixed very open herbs

- *Astrebla* sp. Tussock grassland on broad flat plain, intersected by shallow drainage lines with red-brown silty clay ironstone pebbles and surface gravel
- *Corymbia hamersleyana*, *Acacia pyrifolia* and *A. bivenosa* over *Cenchrus ciliaris*, *Triodia epactia*, *Hybanthus aurantiacus* and *Triumfetta clementii*
- red sandy loam along creek over dolerite in *Acacia inaequiloba*, *Trioda wiseana*, *Hakea lorea*, *Rhagodia eremaea*, *Senna glutinosa*, *Eremophila forrestii*, *Trichodesma zeylanicum*, *Sida echinocarpa*, *Triodia epactia*, *Maireana villosa* and *Acacia orthocarpa*.

Population sizes provided in records for the species (DBCA 2017) range from solitary plants to a population of ca.1 000 000 plants and comments of the species being common.

Records and distribution in study area: Three individuals of *Themeda* sp. Hamersley Station were recorded on the boundary of the study area and a second population of two individuals was recorded outside the Approved Development Envelope (Figure 3-4). The population in the study area was recorded in *Acacia inaequilatera*, *Acacia pyrifolia* var. *pyrifolia* and *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Triodia wiseana*, *Triodia epactia* and *Triodia brizoides* mid-low hummock grassland (vegetation type AiTw(2)).

3.2.1.1.6 ***Goodenia nuda***

Status: Priority 4

Description: Erect to ascending herb up to 0.5 m high, yellow flowers between April to August.

Distribution and ecology: according to DBCA (2017), the species is located in the Gascoyne, Little Sandy Desert and Pilbara bioregions and is known from 92 records with habitat including:

- red-brown sandy loam over ironstone in drainage line with low woodland of *Eucalyptus victrix* and *Acacia distans* over mixed *Acacia tetragonophylla*, *A. synchronicia* and *A. sclerosperma* subsp. *sclerosperma* over *Eriachne benthamii* tussock grassland
- low woodland of *Acacia aptaneura* and *Corymbia aspera* over open tussock grassland of *Aristida inaequilatera*, *Enneapogon polyphyllus* and *Aristida contorta* with low open shrubland of *Ptilotus obovatus*, *Mariana villosa* and *Eremophila lanceolata*
- red brown light clay in floodplain with *Eucalyptus leucophloia*, *Corymbia hamersleyana* and *C. deserticola* low open woodland over *Hakea lorea* subsp. *Lorea*, *Acacia elachantha* and *A. tumida* var. *pilbarensis* scattered tall shrubs over *A. atkinsiana*, *Senna glutinosa* open shrubland over *Isotropis atropurpurea* scattered low shrub over *Triodia* sp. Millstream and *T. wiseana* hummock grassland.

Population sizes provided in records for the species (DBCA 2017) were typically 20 plants or below with occasional records of up to 50 plants.

Records and distribution in study area: *Goodenia nuda* was recorded from one location inside the Approved Development Envelope but outside the current study area (Figure 3-4) in vegetation type EvApTe, *Eucalyptus victrix* and *Corymbia hamersleyana* mid open woodland-scattered trees over *Acacia pyrifolia* var. *pyrifolia* and *Acacia tumida* var. *pilbarensis* tall shrubland-scattered shrubs over *Triodia epactia*, *Tephrosia rosea* var. Fortescue creeks (M.I.H Brooker 2186) and **Cenchrus ciliaris* mid-low open hummock grassland/shrubland/tussock grassland. The species was identified post-field and subsequently the size of the population was not recorded.

3.2.1.1.7 ***Rhynchosia bungarensis***

Status: Priority 4

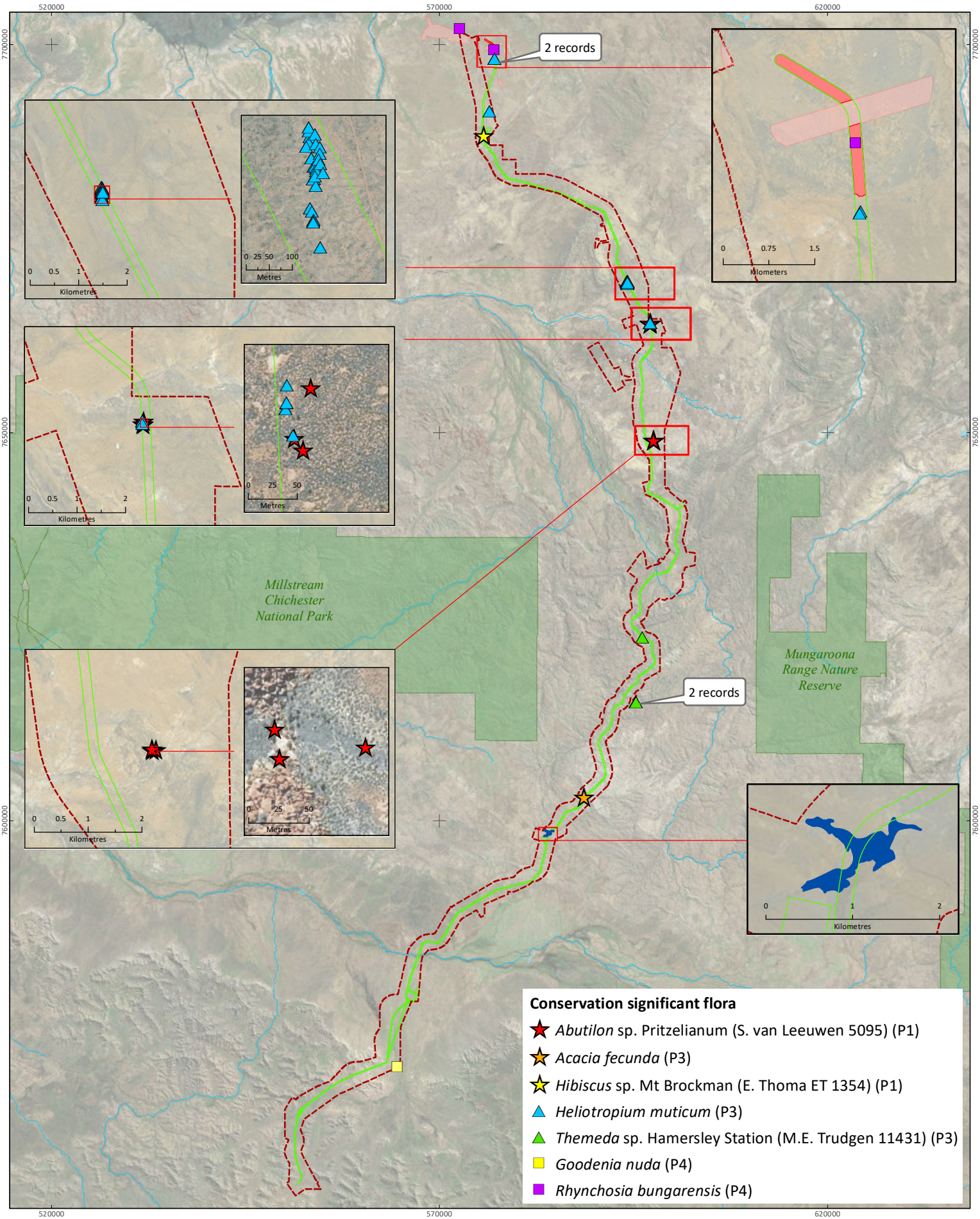
Description: Compact, prostrate shrub to 0.5 m high with yellow flowers.

Distribution and ecology: according to DBCA (DBCA 2017), the species is located in the Carnarvon, Gascoyne and Pilbara bioregions and is known from 76 records with habitat including:

- red brown alluvial sandy clay loam along drainage line with *Corymbia hamersleyana* and/or *Eucalyptus xerothermica* low open woodland over *Acacia tumida* var. *pilbarensis* tall open shrubland over *A*. *monticola* and *Gossypium robinsonii* shrubland over *Themeda* sp. Mt Barricade, *Triodia wiseana* and *T*. *epactia*
- low open woodland of *Eucalyptus camaldulensis* over *Gossypium robinsonii* over mixed low shrubs over open sedgeland of *Cyperus vaginatus*
- *Vachelia farnesiana* and *Petalostylis labicheioides* scattered shrubs, *Cenchrus ciliaris* tussock grassland and *Rhynchosia bungarensis*
- *Triodia wiseana* hummock grassland with *Triumfetta propinqua*, *Tephrosia supina*, *Indigofera monophylla*, *Vigna* sp. Rockpiles (R. Butcher et al. RB 1400), *Rhynchosia minima* and *Brachychiton acuminatus*
- brown, gravelly clayey sand in wetland with rock pools above waterfall *Triodia angusta* with *Eucalytpus victrix* and scattered *Acacia ampliceps*, *A*. *coriacea* and *Brachychiton acuminatus*, over herbland of *Pluchea rubelliflora* and *Fimbristylis*
- *Terminalia canescens* low open woodland over *Acacia coriacea* subsp. *Coriacea*, *Flueggia virosa* subsp. *Melanthesoides* high open shrubland over *Scaevola spinescens*, *Rhagodia eremaea* scattered shrubs over *Triodia epactia*, *Triodia angusta* scattered hummock grasses with *Rhynchosia* sp. Burrup and *Dicliptera armata* very open annual herbland.

Population sizes provided in records for the species (DBCA 2017) were frequently below 10 plants with a few records where frequency was described as common.

Records and distribution in study area: Two single plants of *Rhynchosia bungarensis* were recorded from two locations, one within the current study area, the other outside it at the northern tip of the Approved Development Envelope (Figure 3-4). The species was recorded in one habitat type, *Eragrostis xerophila*, *Dichanthium sericeum* subsp. *humilius* and *Vigna* sp. Hamersley Clay (A.A. Mitchell PRP 113) low tussock grassland/vineland (vegetation type Ex1).



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Project No	1155
Date	27-Oct-17
Drawn by	AL
Map author	JC

0 3 6 12 18 24
Kilometres

1:625,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Horseflat land system of the Roebourne Plains (P3)
Phoenix 2017
Previously mapped by Ecoscape (2014)
Four plant assemblages of the Wona Land System (P1-3)
Previously mapped by Ecoscape (2014)

Figure 3-4
Conservation significant flora records and Priority ecological community records from survey

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3.2.1.2 Introduced flora

Most of the vegetation in the study area was observed to be free of introduced flora; however, six introduced flora species were recorded during the survey (Table 3-7).

Table 3-7 Introduced flora species recorded during the field survey

Genus and species	No. of survey locations
**Flaveria trinervia*	3
**Cenchrus ciliaris*	2
**Aerva javanica*	2
**Portulaca pilosa*	2
**Setaria verticillata*	1
**Vachellia farnesiana*	1

3.2.1.3 Range extensions

Based on available distribution data, survey records for *Acacia fecunda* represent a large range extension of 255 km north-west.

3.2.1.4 Unidentified flora

23 taxa collected could not be identified definitively to species level due to a lack of reproductive structures. The remaining taxa (89.6% of all collected) were identified to species level (Table 3-8).

Table 3-8 Unidentified flora taxa recorded during the field survey

Specimens	Reason specimen not identified
Abutilon ?sp. dioicum	Sterile
Acacia ?*bivenosa*	Sterile
Acacia ?*coriacea* subsp. *pondens*	Sterile
Bonamia ?*linearis*	Sterile
Bonamia ?*pilbarensis*	Sterile
Cyperus sp.	Sterile
Goodenia sp.	Sterile
Goodenia ?*forrestii*	Sterile
Polygala ?*isingii*	Sterile
Rubiaceae sp.	Sterile
Sclerolaena ?*lanicuspis*	Sterile
Seringia ?*elliptica*	Sterile
Sida ?*arsiniata*	Sterile
Streptoglossa ?*liatroides*	Sterile
Streptoglossa ?*tenuiflora*	Sterile
Streptoglossa sp.	Sterile

Specimens	Reason specimen not identified
Swainsona ?*stenodonta*	Sterile
Triodia ?*basedowii*	Sterile
Triodia ?*brizoides*	Sterile
Triodia ?*epactia*	Sterile
Triodia ?*wiseana*	Sterile
Triodia sp. (resinous)	Sterile
Triodia sp. sterile	Sterile

3.2.1.5 Vegetation types

A total of 15 vegetation types were mapped in the previously unsurveyed portion of the study area (Table 3-9; Figure 3-5). The vegetation types comprised eight open to sparse woodlands, seven open to sparse shrublands over hummock and/or tussock grasslands, and one tussock grassland. Woodlands were dominated by *Eucalyptus victrix* or *Corymbia hamersleyana* with occasional *Eucalyptus leucophloia* over shrublands of *Grevillea* and *Acacia* species. Shrublands were dominated by mixed *Acacia* species over hummock grasslands of *Triodia* species. The tussock grassland was dominated by *Eragrostis xerophila*, *Sorghum timorense* and *Chrysopogon fallax*.

Vegetation types Ac1ApTe, AiTw(3) and AA3Ti were most prevalent with 14.04%, 13.57% and 12.36% mapped respectively (Table 3-10). The remainder of the vegetation types comprised between 0.97% and 8.32% of the unmapped portion of the study area. All but one of the mapped vegetation types (AaAsTw) were matched with those described by Ecoscape (2014).

Table 3-9 Vegetation types recorded in previously unmapped portion of study area

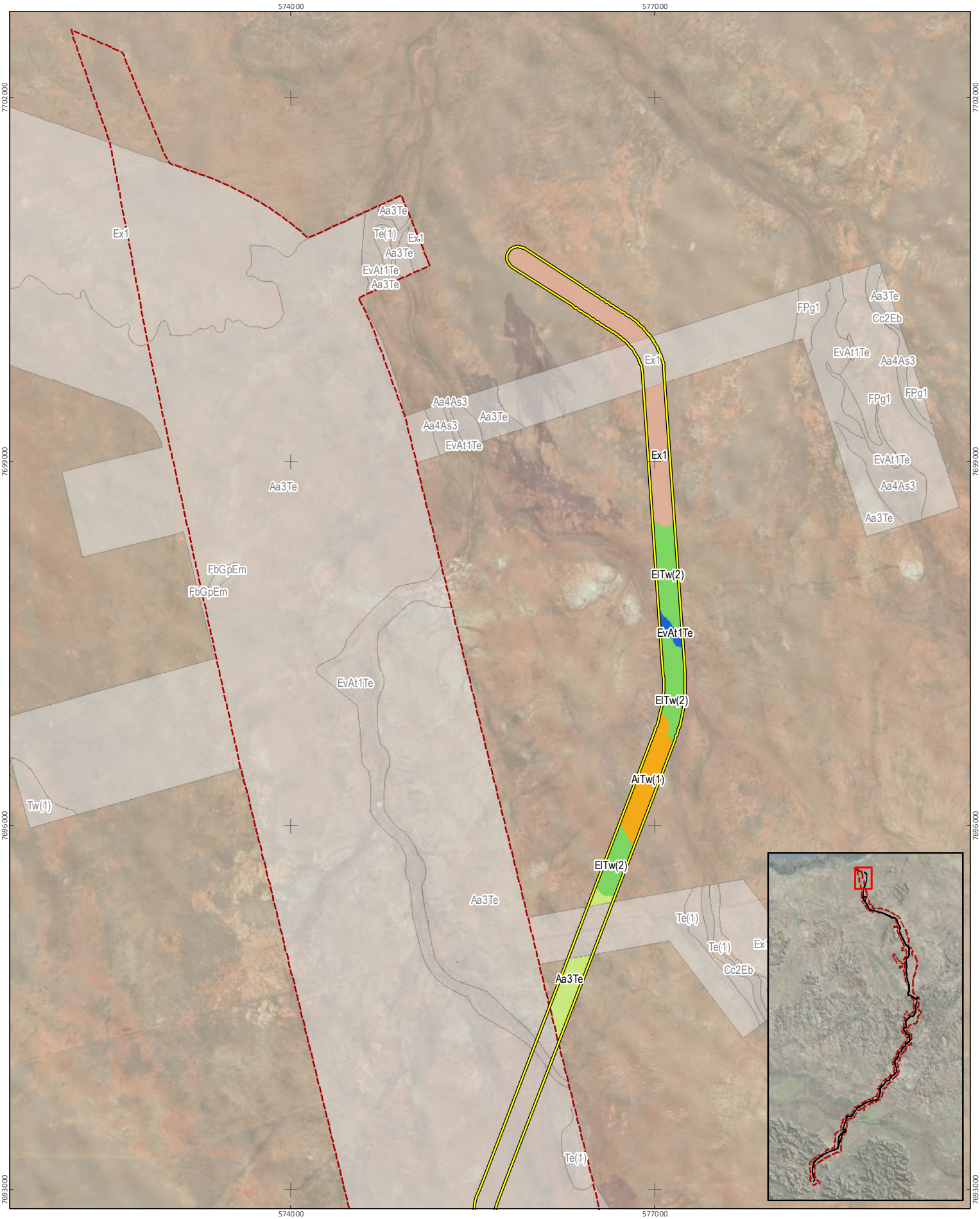
Vegetation code	Site name/s	Field description	Photo
Ac1ApTe	Q014 Q015	Tall open *Acacia citrinoviridis* and *Acacia pruinocarpa, A. dictyophleba* over *A. ancistrocarpa* shrubland with scattered *Grevillea wickhamii* over a low isolated *Acacia monticola x trachycarpa* shrubs over mid *Triodia epactia* and *T. wiseana* hummock grassland on stony soils (flats/plain).	
EvAt1Te	Q016 R06	Mid *Eucalyptus victrix* woodland over a tall open *Acacia monticola x trachycarpa* shrubland over low *Cenchrus ciliaris* tussock grassland with scattered *Triodia epactia* and *T. lanigera* hummock grasses on edges of river banks.	
AiTw(1)	Q017 Q023	Open mid *Acacia bivenosa, A. inaequilatera* and *A. pyrifolia* shrubland over mid *Triodia wiseana* hummock grassland on quartz stony plains.	

Vegetation code	Site name/s	Field description	Photo
Ex1	Q018 Q029 R02, R03, R04	Low *Eragrostis xerophila*, *Sorghum timorense* and *Chrysopogon fallax* tussock grassland over low sparse *Rhynchosia minima* forbland on horseshoe flat plains (Gilgaied clay plains supporting Roebourne Plains grass grasslands and minor grassy snakewood shrublands) Contained areas of possible PEC 'Horseflat Land System of the Roebourne Plains' (P3).	
AaAsTw	Q020	Isolated tall *Acacia ancistrocarpa* and *A. pyrifolia* shrubs over isolated mid *Acacia stellaticeps* shrubs over mid *Triodia wiseana* with *T. basedowii* hummock grassland on quartz stony flat plains.	
ChAa1Ta	Q021	Isolated low *Corymbia hamersleyana* trees over isolated tall *Acacia ancistrocarpa* and *Acacia pyrifolia* shrubs over mid *Triodia epactia* hummock grassland on stony soils (foothills).	

Vegetation code	Site name/s	Field description	Photo
Aa3Ti	Q025 R024	Isolated tall *Grevillea pyramidalis* shrubs over isolated mid *Acacia inaequilatera*, *A. pyrifolia* shrubs over mid *Triodia* ?*brizoides* hummock grassland on stony hillslopes	
ElTw(2)	Q028 R05 R07	Isolated low *Corymbia hamersleyana* and *Eucalyptus leucophloia* trees over sparse mid *Acacia bivenosa*, *A. tenuissima* and *A. pyrifolia* shrubland over mid *Triodia wiseana* hummock grassland on flat plain.	
AiTw(3)	Q026 Q030 Q032	Isolated low *Corymbia hamersleyana* trees over sparse tall *Acacia inaequilatera* shrubland occasionally with tall *Grevillea pyramidalis* and *G. wickhamii* shrubs over mid *Triodia* ?*wiseana* and *T. epactia* hummock grassland on rocky hillslopes	

Vegetation code	Site name/s	Field description	Photo
ElAs2Te	Q027 R031 R033	Open woodland of *Corymbia hamersleyana* occasionally with *Eucalyptus leucophloia, Terminalia circumalata* and *Melaleuca linophylla* over tall shrubland of *Acacia tumida* var. *pilbarensis* and *A. elachantha* over low sparse shrubland of *Acacia monticola* over grassland of *Setaria verticillata* and *Triodia* sp.	
ApTw	Q035	Low sparse woodland of *Corymbia hamersleyana* over a tall sparse shrubland of *Acacia pyrifolia, Acacia inaequilatera* and *Acacia acradenia* over a hummock grassland of *Triodia wiseana* on stony soils on plains.	
Aa3Te	R08	Tall open *Acacia ancistrocarpa*, *A. pyrifolia* and *Grevillea pyramidalis* shrubland over low open *Acacia bivenosa* and *A. stellaticeps* shrubland over mid *Triodia* spp. hummock grassland on plain in brown red silty sand soils.	

Vegetation code	Site name/s	Field description	Photo
ChAbTw	Matched with adjacent vegetation of Ecoscape (2014).	*Corymbia hamersleyana* and *Grevillea pyramidalis* subsp. *leucadendron* low open woodland or scattered trees over *Acacia bivenosa* and *A. arida* tall-mid sparse shrubland over *Triodia wiseana, T. epactia* and *T. angusta* mid open hummock grassland	N/A
AiTw(2)	Matched with adjacent vegetation of Ecoscape (2014).	*Acacia inaequilatera*, *A. pyrifolia* var. *pyrifolia* and *Hakea lorea* subsp. *lorea* tall sparse shrubland over *Triodia wiseana, T. epactia* and *T. brizoides* mid-low hummock grassland	N/A
AiTe(2)	Matched with adjacent vegetation of Ecoscape (2014).	*Acacia inaequilatera* and *A. ancistrocarpa* tall-mid sparse-scattered shrubland over *Triodia epactia* mid hummock grassland	N/A



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Project No	1155
Date	19/10/2017
Drawn by	KW
Map author	JC

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Kilometres

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

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Study area (final potential disturbance area)

Approved development

Vegetation type from previous survey (Ecoscape 2014)

Vegetation

Ex1

Figure 3-5.1

Vegetation types in the study area

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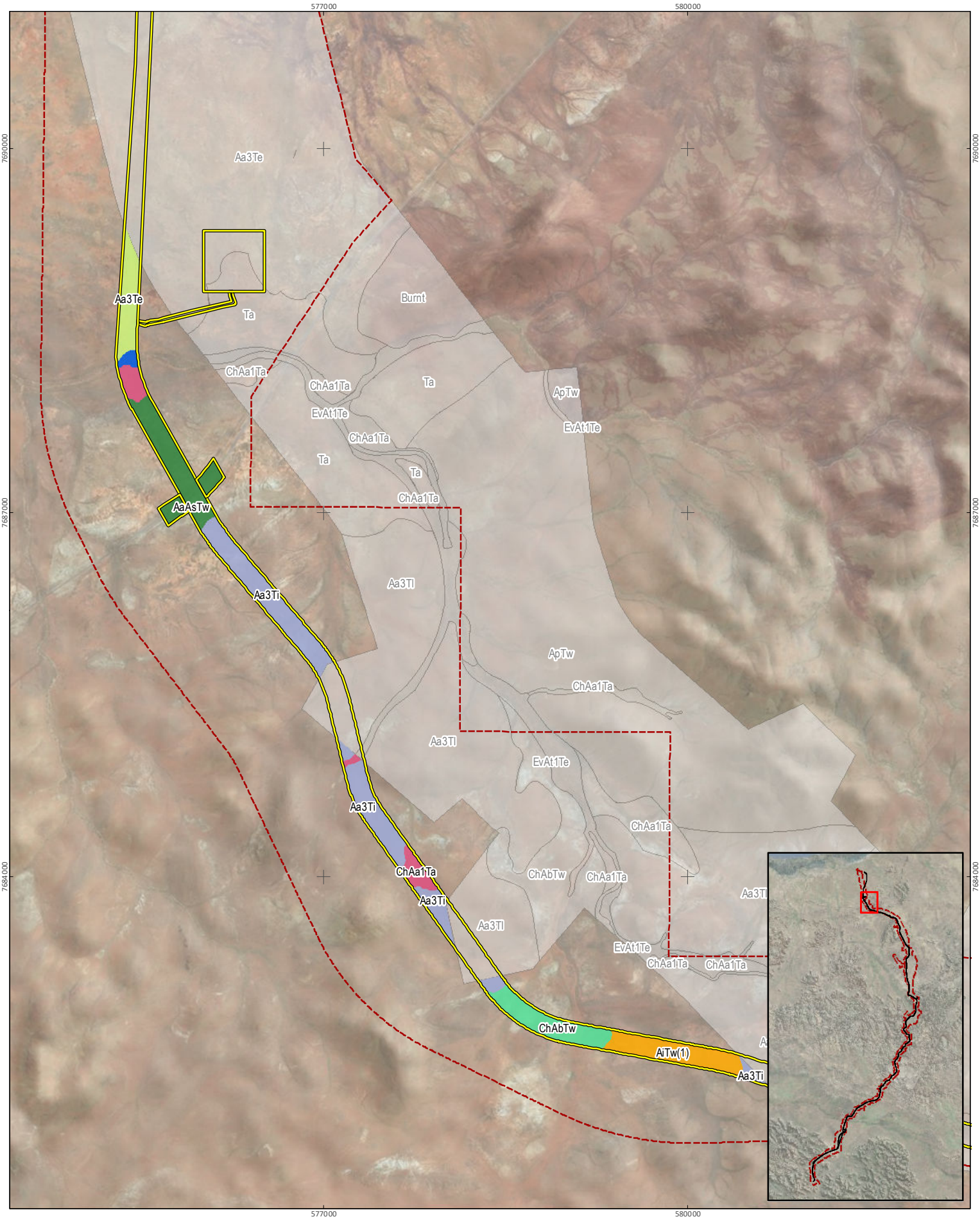

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Study area (final potential disturbance area)

Approved development

Vegetation type from previous survey (Ecoscape 2014)

Vegetation

Aa3Ti

Figure 3-5.2

Vegetation types in the study area

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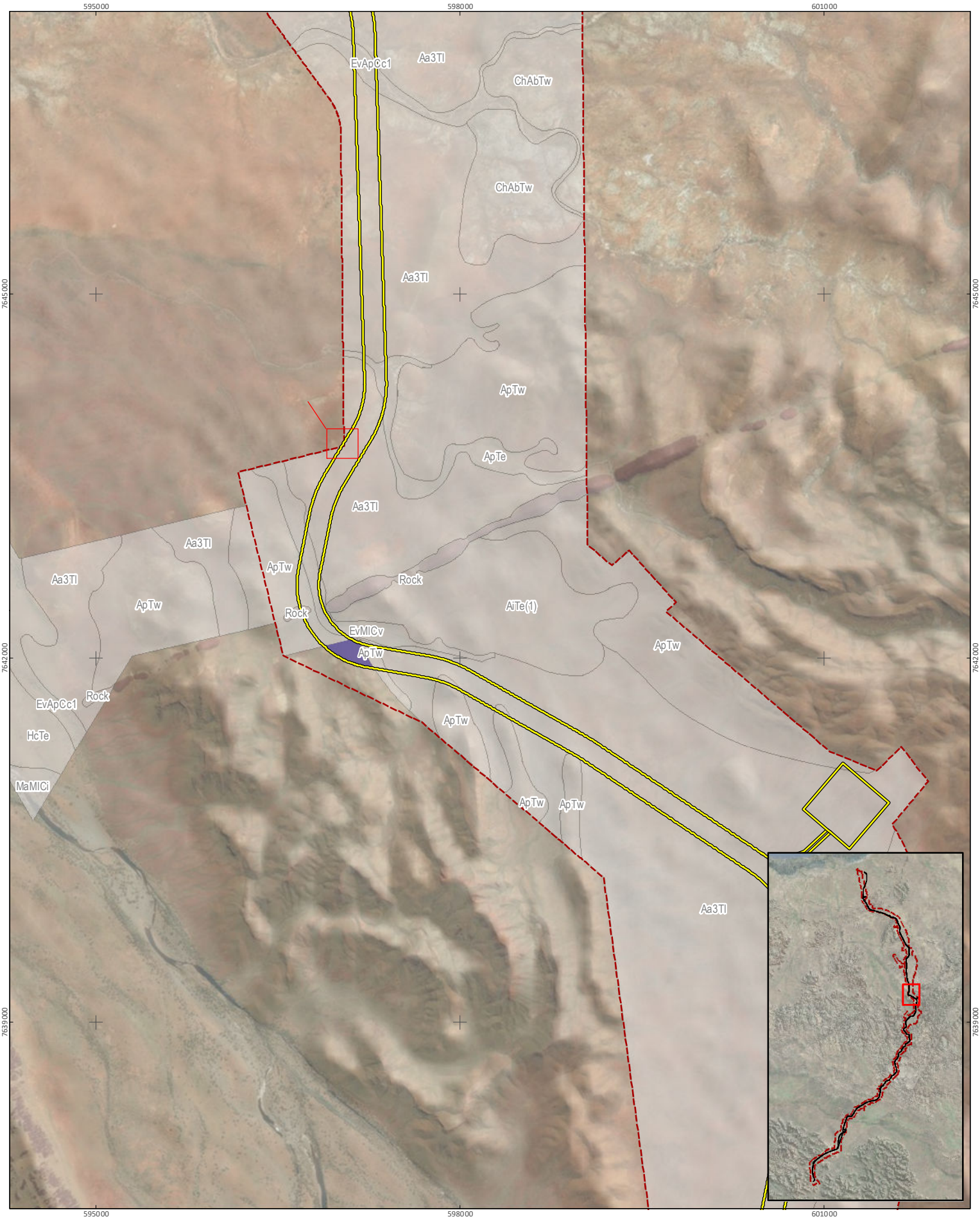

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Map author	JC

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Kilometres

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Study area (final potential disturbance area)

Approved development

Vegetation type from previous survey (Ecoscape 2014)

Vegetation

Aa3Ti

Figure 3-5.3

Vegetation types in the study area

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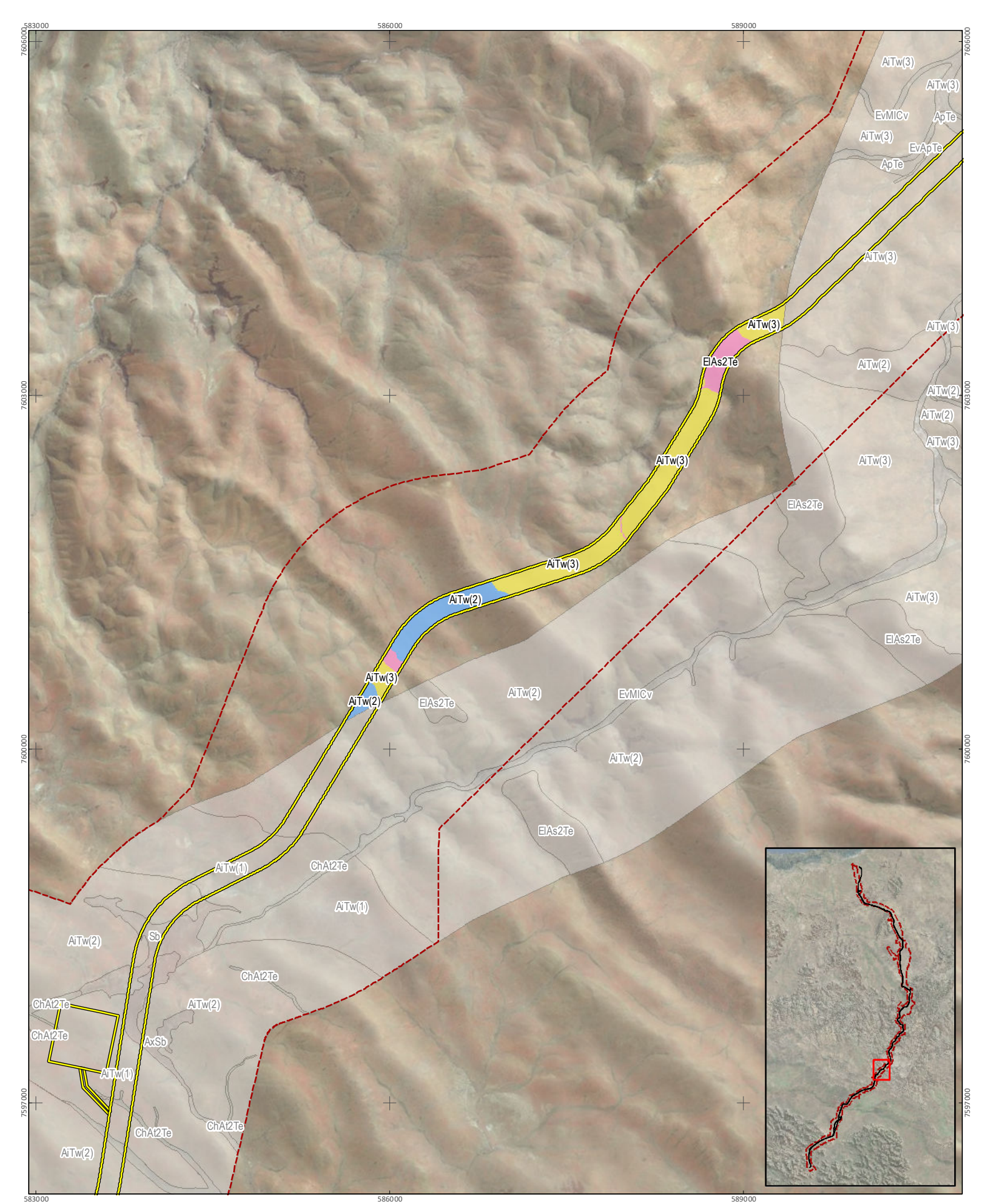

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0 0.25 0.5 1 1.5
Kilometres

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Western Australia
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Study area (final potential disturbance area)

Approved development

Vegetation type from previous survey (Ecoscape 2014)

Vegetation

Figure 3-5.4

Vegetation types in the study area

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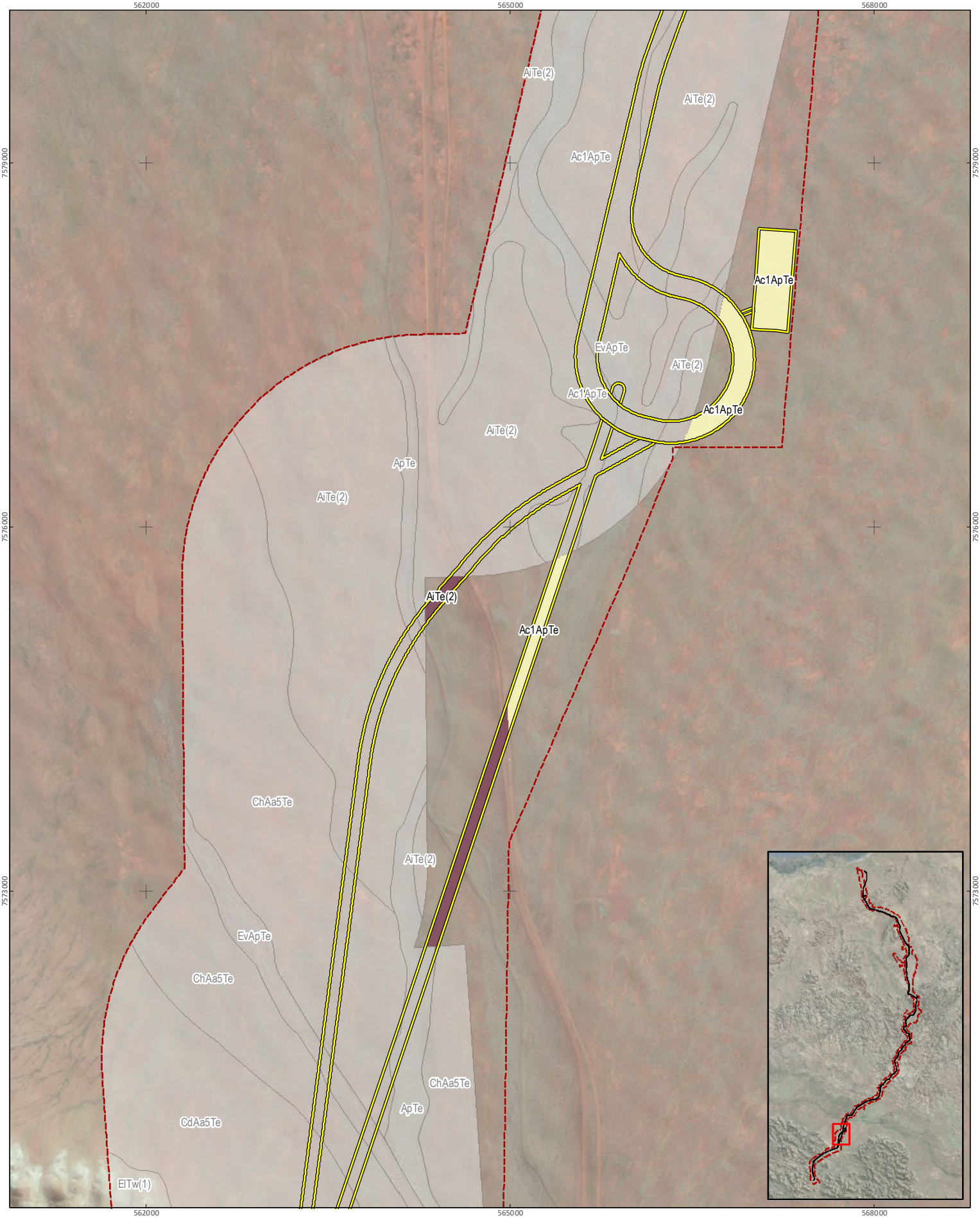

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Project No	1155
Date	19/10/2017
Drawn by	KW
Map author	JC

0 0.25 0.5 1 1.5
Kilometres

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

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Study area (final potential disturbance area)

Approved development

Vegetation type from previous survey (Ecoscape 2014)

Vegetation

Figure 3-5.5

Vegetation types in the study area

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Table 3-10 Extent of each vegetation type in previously unmapped portion study area

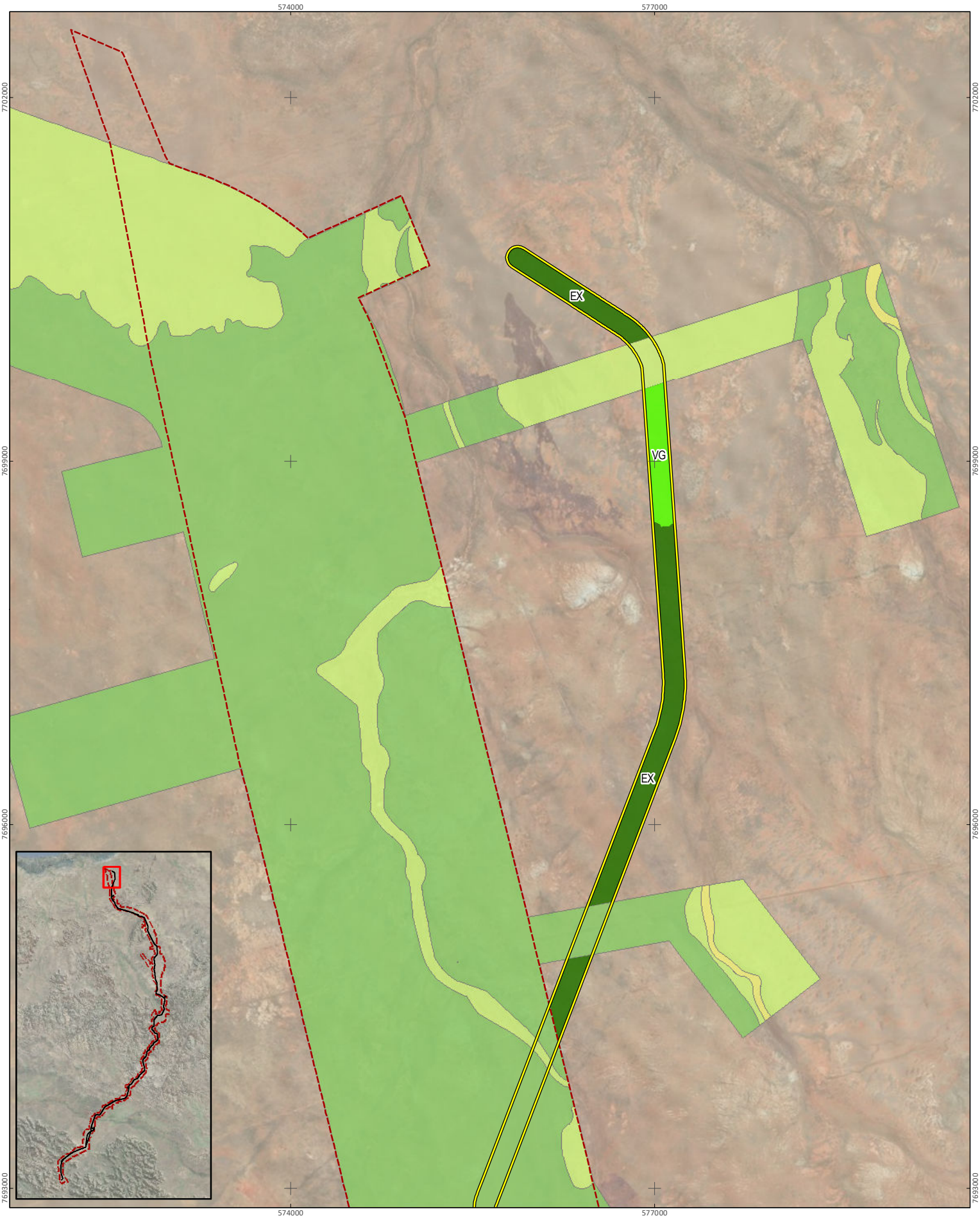
Vegetation type	Area (ha)	Percentage
Aa3Te	27.55	6.20%
Aa3Ti	55.34	12.40%
AaAsTw	27.90	6.20%
Ac1ApTe	62.87	14.00%
AiTe(2)	23.92	5.30%
AiTw(1)	37.27	8.30%
AiTw(2)	23.19	5.20%
AiTw(3)	57.63	12.90%
ApTw	4.91	1.10%
ChAa1Ta	11.61	2.60%
ChAbTw	18.53	4.10%
ElAs2Te	12.18	2.70%
ElTw(2)	36.83	8.20%
EvAt1Te	4.36	1.00%
Ex1	43.71	9.80%
Total	**447.81**	**100.00%**

3.2.1.6 Vegetation condition

The condition of vegetation across the previously unmapped portion of the study area ranged from Excellent to Very Good according to the applied condition scale (Figure 3-6). The majority of vegetation was mapped as Excellent (Table 3-11).

Table 3-11 Vegetation condition – extent of each condition rating in previously unmapped portion of study area

Condition (EPA 2016)	Area (ha)	Percentage
Excellent	424.49	94.79%
Very Good	23.32	5.21%
Total	**447.81**	**100%**



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Project No	1155
Date	11-Aug-17
Drawn by	AL
Map author	JC

0 0.25 0.5 1 1.5
Kilometres

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

Study area (final potential disturbance area)

Approved development envelope

Vegetation condition

Excellent (EX)

Very good (VG)

Vegetation condition from previous survey (Ecoscape 2014)

Excellent

Very good

Good

Figure 3-7.1

Vegetation condition in the study area

PHOENIX ENVIRONMENTAL SCIENCES

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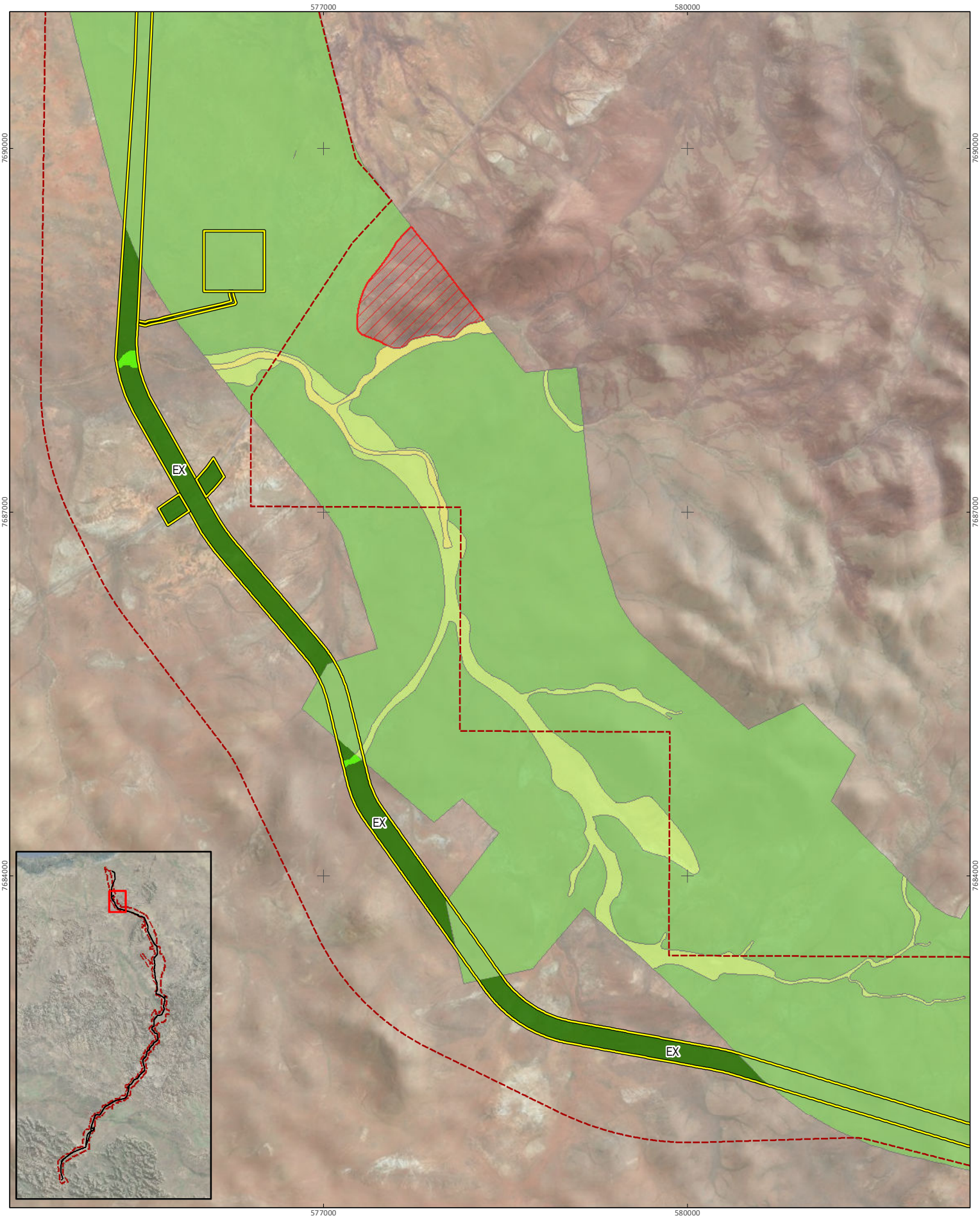

Balla Balla Infrastructure Group Ltd
Pilbara Iron Ore Project and
Balla Balla Infrastructure Project

Project No	1155
Date	11-Aug-17
Drawn by	AL
Map author	JC

0 0.25 0.5 1 1.5
Kilometres

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

P:\GIS\Projects\PIOPBalla\1155-PIO-BBI-ECO\Mapping\MapDocuments\Figures\1155_BBI_VegCond.mxd

Study area (final potential disturbance area)

Approved development envelope

Vegetation condition

Excellent (EX)

Very good (VG)

Vegetation condition from previous survey (Ecoscape 2014)

Burnt

Excellent

Very good

Good

Figure 3-c.2

Vegetation condition in the study area

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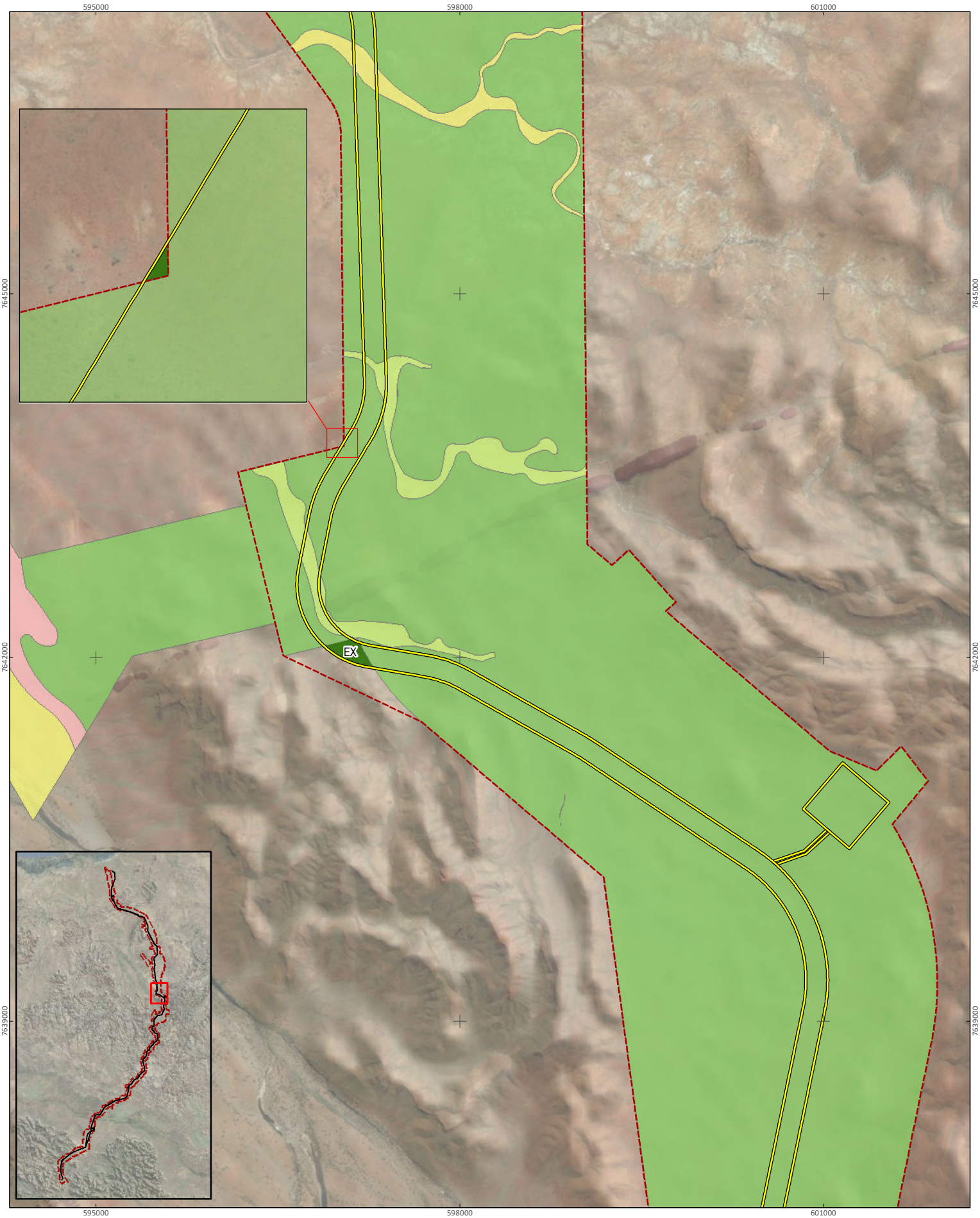

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0 0.25 0.5 1 1.5
Kilometres

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

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Study area (final potential disturbance area)

Approved development envelope

Vegetation condition

Excellent (EX)

Vegetation condition from previous survey (Ecoscape 2014)

Excellent

Very good

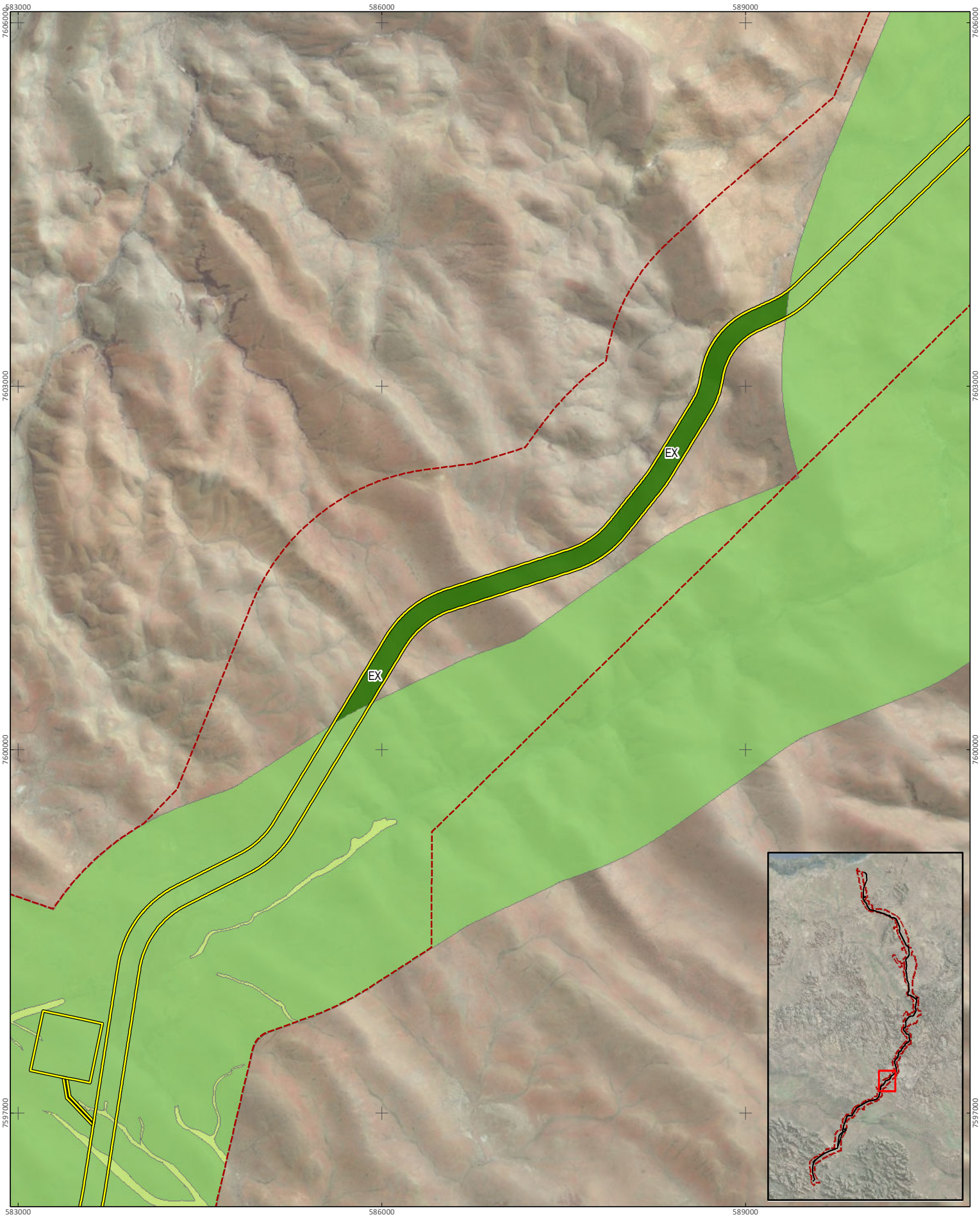
Good

Poor

Figure 3-c.3

Vegetation condition in the study area

PHOENIX ENVIRONMENTAL SCIENCES



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Project No	1155
Date	11-Aug-17
Drawn by	KW
Map author	JC

0 0.25 0.5 1 1.5
Kilometres

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

Study area (final potential disturbance area)

Approved development envelope

Vegetation condition

Excellent (EX)

Vegetation condition from previous survey (Ecoscape 2014)

Excellent

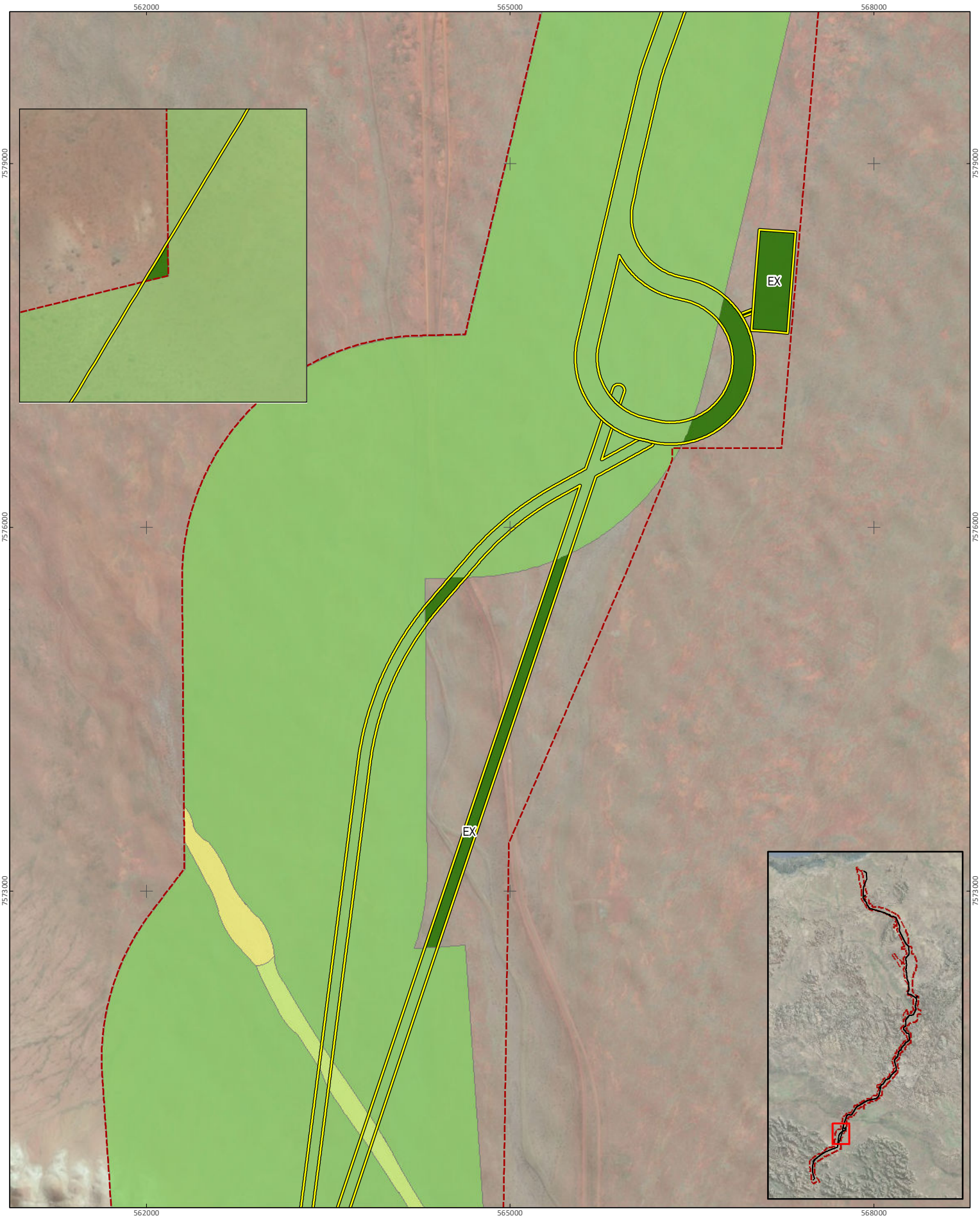
Very good

Figure 3-c.4

Vegetation condition in the study area

PHOENIX ENVIRONMENTAL SCIENCES

P:\GIS\Projects\PIOPBalla\1155-PIO-BBI-ECO\Mapping\MapDocuments\Figures\1155_BBI_VegCond.mxd



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0 0.25 0.5 1 1.5
Kilometres

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

P:\GIS\Projects\PIOPBalla\1155-PIO-BBI-ECO\Mapping\MapDocuments\Figures\1155_BBI_VegCond.mxd

Study area (final potential disturbance area)

Approved development envelope

Vegetation condition

Excellent (EX)

Vegetation condition from previous survey (Ecoscape 2014)

Excellent

Very good

Good

Figure 3-c.5

Vegetation condition in the study area

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3.2.1.7 Threatened and Priority Ecological Communities

3.2.1.7.1 Four plant assemblages of the Wona Land System

The previously mapped vegetation unit Sb (Ecoscape (2014) that was included in the current DBCA database searches as the Four plant assemblages of the Wona Land System PEC was confirmed to be the PEC (Figure 3-4). The boundary of the Sb vegetation community was confirmed to be accurate. The vegetation comprised an open herbland of *Streptoglossa bubakii*, *Sida fibulifera*, *Phyllanthus madderaspertensis*, *Rhynchosia minima*, *Cleome viscosa*, *Senna notabilis* and **Flaveria trinervia* over mixed grassland on a flat plain of cracking clays with large granite rocks (Plate 1).

No further occurrences of this PEC were found in the previously unmapped portion of the study area.

Plate 2 Vegetation Sb (Ecoscape 2014) confirmed as the PEC 'Four plant assemblages of the Wona Land System'

3.2.1.7.2 Horseflat Land System of the Roebourne Plains

The presence of the Horseflat Land System of the Roebourne Plains PEC was identified at the northern end of the study area (Figure 3-4). This ecological community was originally identified in the Approved Development Envelope by Ecoscape (2014) in vegetation type Ex1 (Figure 3-5). The current survey extended the mapped extent into previously unsurveyed areas that were also defined

as vegetation type Ex1 (Figure 3-5; Table 3-9). This area occurs within the DBCA recorded area for the PEC.

Based on the results of both current and previous surveys, the Horseflat Land System of the Roebourne Plains PEC occupies 51.1 ha of the study area, including the 7.39 ha mapped previously by Ecoscape (2014) and 43.7 ha mapped within the previously unsurveyed portion of the study area from the current survey.

3.2.1.8 Local and regional significance of vegetation

With the exception of the PEC, Horseflat Land System of the Roebourne Plains, none of the remaining vegetation types recorded in the unmapped portion of the study area are considered regionally significant as they do not represent habitat for Federal or State listed Threatened Flora or are representative of restricted vegetation with less than 30% Pre-European extent remaining.

Six vegetation types in the unmapped portion of the study area (Aa3Te, Aa3Tl, AiTw(2), ElAs2Te, ElTw(2), and Ex1) may be considered locally significant as they contain Priority flora species or the Horseflat Land System of the Roebourne Plains PEC.

Vegetation type Sb previously mapped by the Ecoscape (2014) in the study area can also be considered regionally significant as it has been confirmed as the 'Four plant assemblages of the Wona Land System PEC '.

3.2.2 Fauna and fauna habitats

3.2.2.1 Fauna habitat

Three fauna habitats were mapped in the previously unsurveyed portion of the study area (Table 3-12; Figure 3-7):

- Hummock and tussock grassland – Approximately 68.9% of the unsurveyed portion of the study area is comprised of hummock and tussock grassy plains. This habitat is dominated by mixed hummock and tussock grasses and scattered shrubs and trees, generally associated with stony substrates around mesas and rock hill slopes through to clay loam substrates.
- Open and closed shrubland – a mix of open and closed shrubland habitats containing small to large shrub species representing approximately 25.8% of the unsurveyed portion of the study area.
- Minor creek and drainage line – creek and drainage lines cover approximately 45.2% of the unsurveyed portion of the study area. This habitat is often bordered by sparse vegetation with spinifex or mixed shrubs with scattered patches of more densely vegetated areas.

All of these habitat types were previously recorded in the initial fauna surveys for the Project (Phoenix 2014). Hummock and tussock grassland was also the dominant habitat across the previously mapped portion of the study area. Based on previous and current habitat mapping, seven fauna habitats are present in the current study area (Table 3-12).

Table 3-12 Habitats in the current study area

Fauna habitat	Area in previously unsurveyed portion of study area (ha)	Total extent in study area (ha)
Hummock and tussock grassland	244.58	1,406.31
Minor creek and drainage line	18.53	192.63
Open and closed shrubland	91.70	1,276.43
Rocky hill slope	Not recorded	409.03
Woodland	Not recorded	10.41
Gully	Not recorded	10.31
Sandplain	Not recorded	192.81
Total	**354.81**	**3,497.93**

3.2.2.2 Conservation significant fauna

Two of the five target fauna species were recorded during the survey: Northern Quoll and Bilby. A summary of results for each of the five species is provided below.

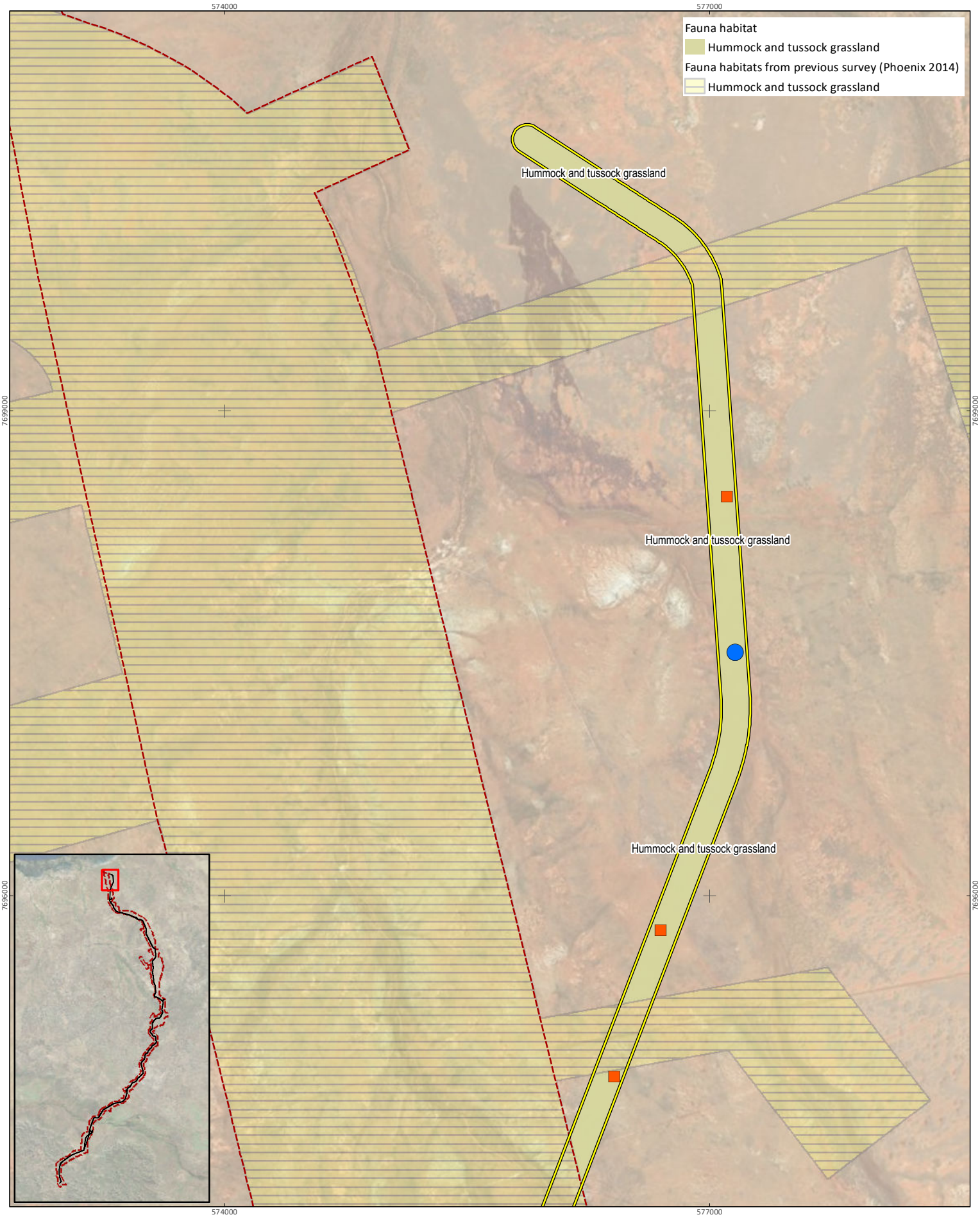
3.2.2.2.1 **Northern Quoll**

Northern Quoll was recorded on 915 images, from eight camera traps, at three camera trap sites (sites 7, 8 and 10) and once from secondary evidence (scat) during the field survey (Table 3-13; Figure 3-7).

Of the camera trap records, at least four separate individuals were identified (Table 3-13). Several other captures could not be uniquely identified due to positioning of the individual or image quality (marked as 'indet.' in Table 3-13). Some individuals were recorded at more than one site.

Two of the sites, a creekline/rocky slope and a gully, were close to the location of previous records and within areas previously mapped as critical Northern Quoll habitat (Phoenix 2014) (Figure 3-7). The third was further south along the creekline from the creekline/rocky slope site, where the species was not recorded previously (Figure 3-7).

No additional suitable denning/shelter habitat for Northern Quoll was identified in the previously unsurveyed portion of the study area during the survey.



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Project No	1155
Date	27-Oct-17
Drawn by	KW
Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Conservation significant fauna
Macrotis lagotis, Bilby (VU), old burrow
Macrotis lagotis, Bilby (VU), plot in suitable habitat

Figure 3-T.1

Fauna habitats and conservation significant fauna records from survey

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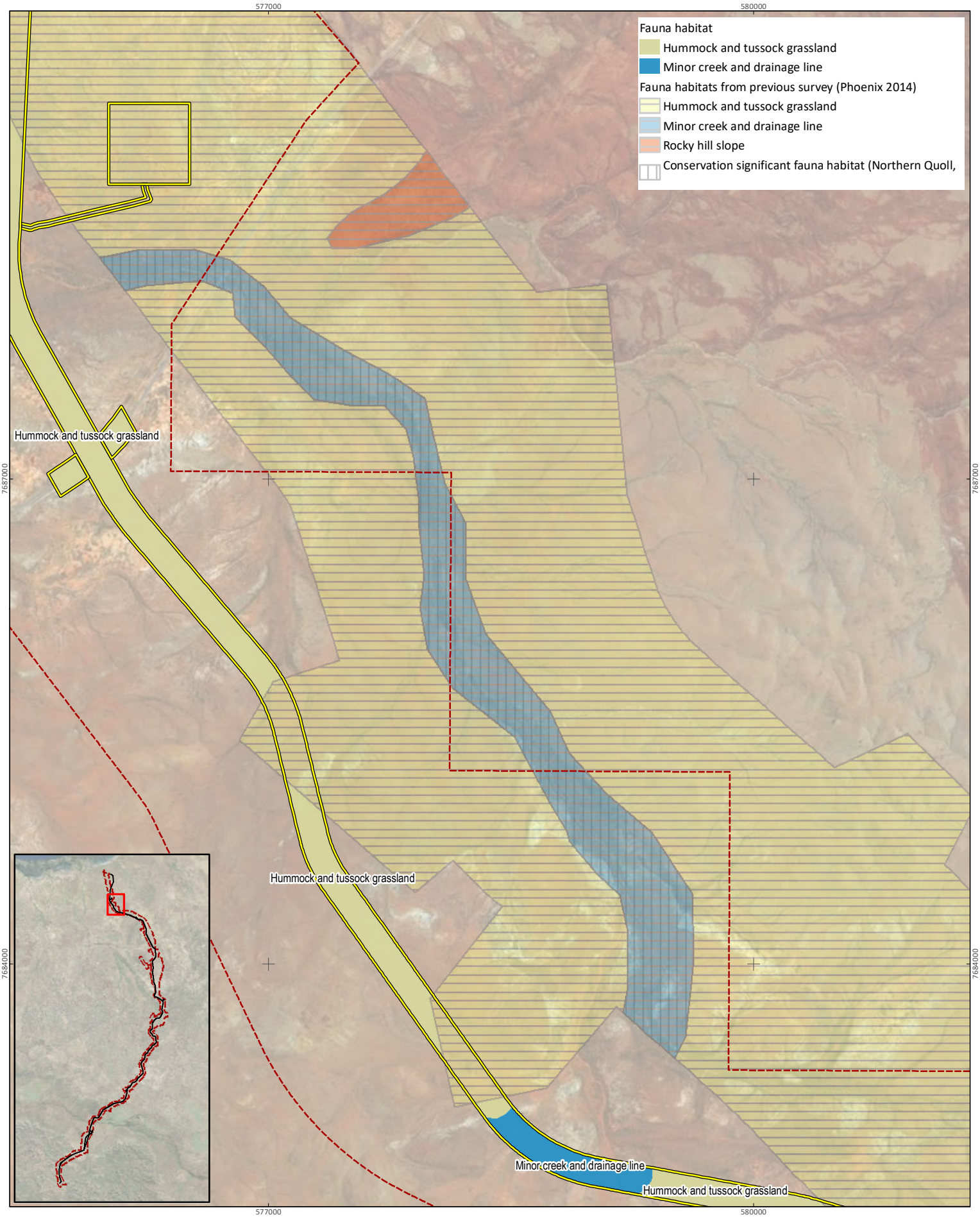

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0 0.2 0.4 0.8 1.2
Kilometres

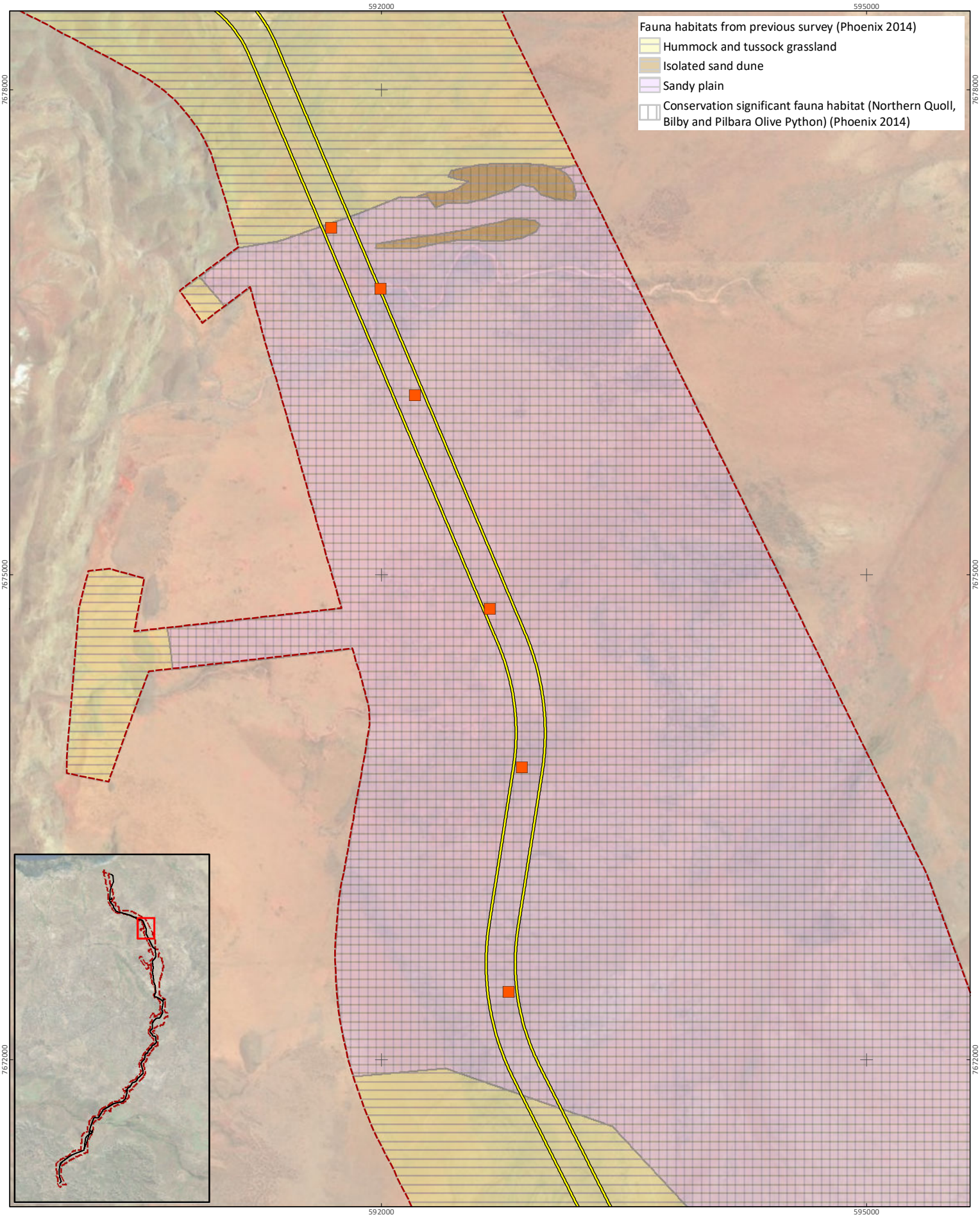
1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope

Figure 3-T.2

Fauna habitats and conservation significant fauna records from survey

PHOENIX ENVIRONMENTAL SCIENCES



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Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

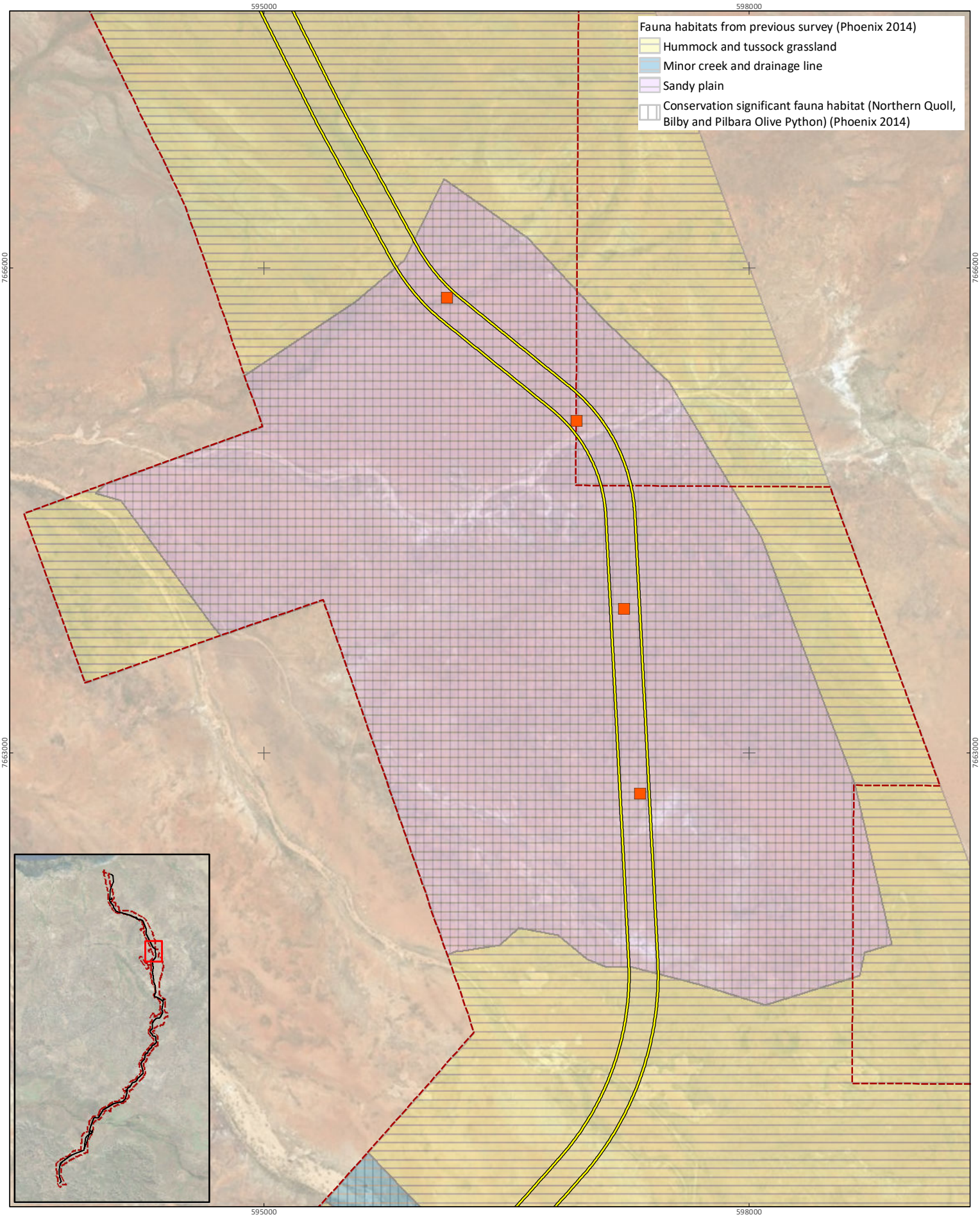
1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Conservation significant fauna
Macrotis lagotis, Bilby (VU), plot in suitable habitat

Figure 3-T.3

Fauna habitats and conservation significant fauna records from survey

PHOENIX ENVIRONMENTAL SCIENCES



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Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Conservation significant fauna
Macrotis lagotis, Bilby (VU), plot in suitable habitat

Figure 3-T.4

Fauna habitats and conservation significant fauna records from survey

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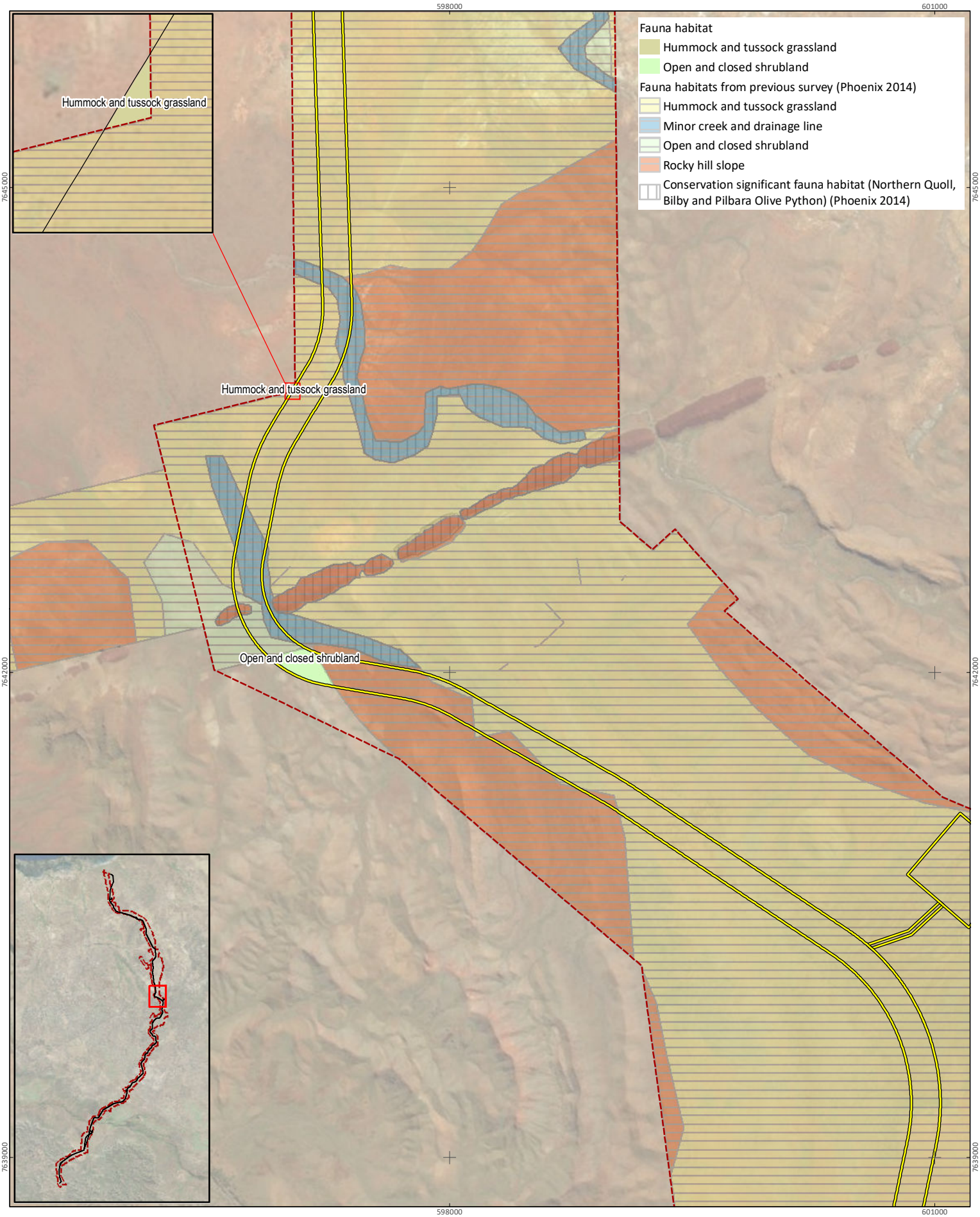

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Date	27-Oct-17
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Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

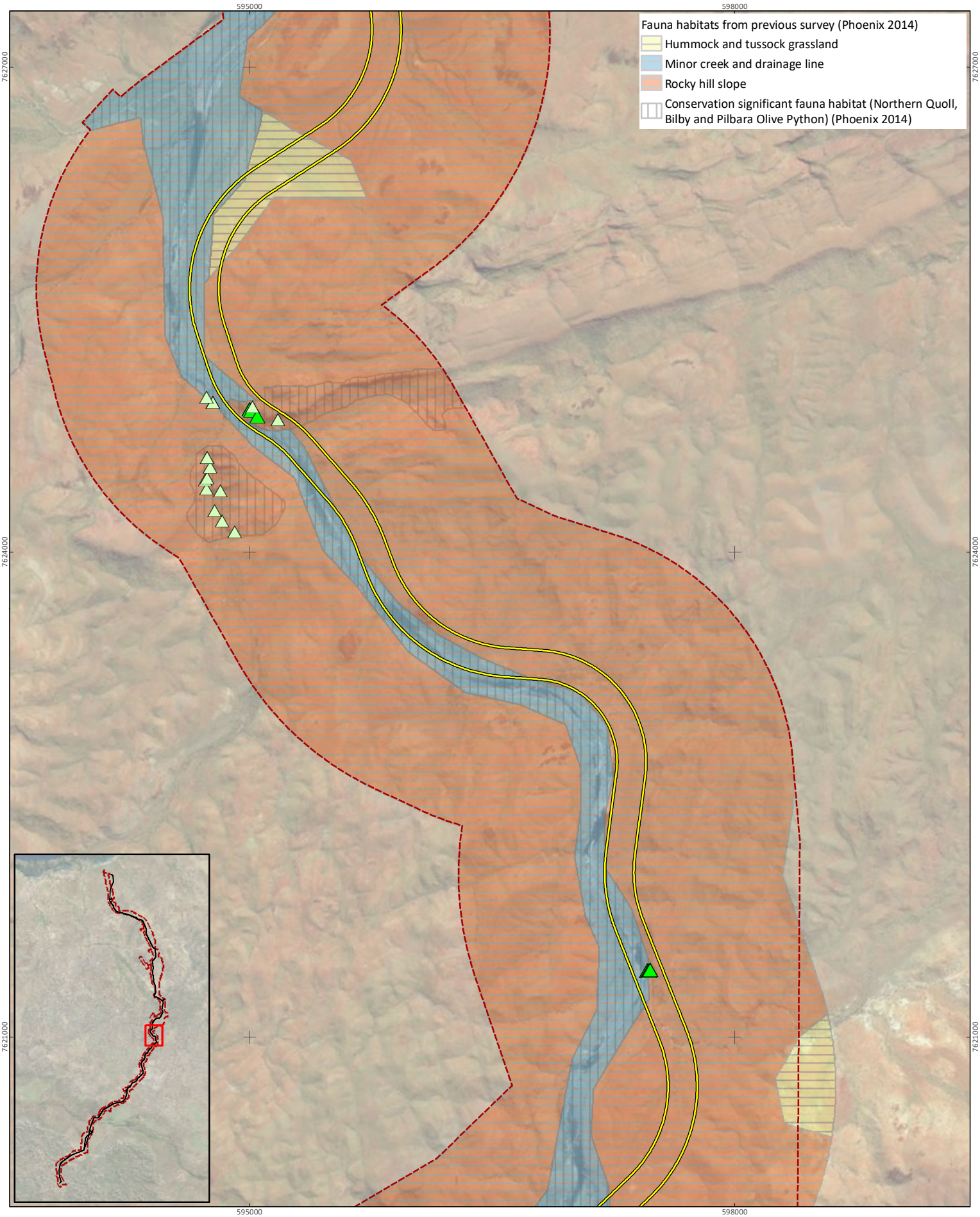
1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope

Figure 3-T.5

Fauna habitats and conservation significant fauna records from survey

PHOENIX ENVIRONMENTAL SCIENCES



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Project No	1155
Date	27-Oct-17
Drawn by	KW
Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

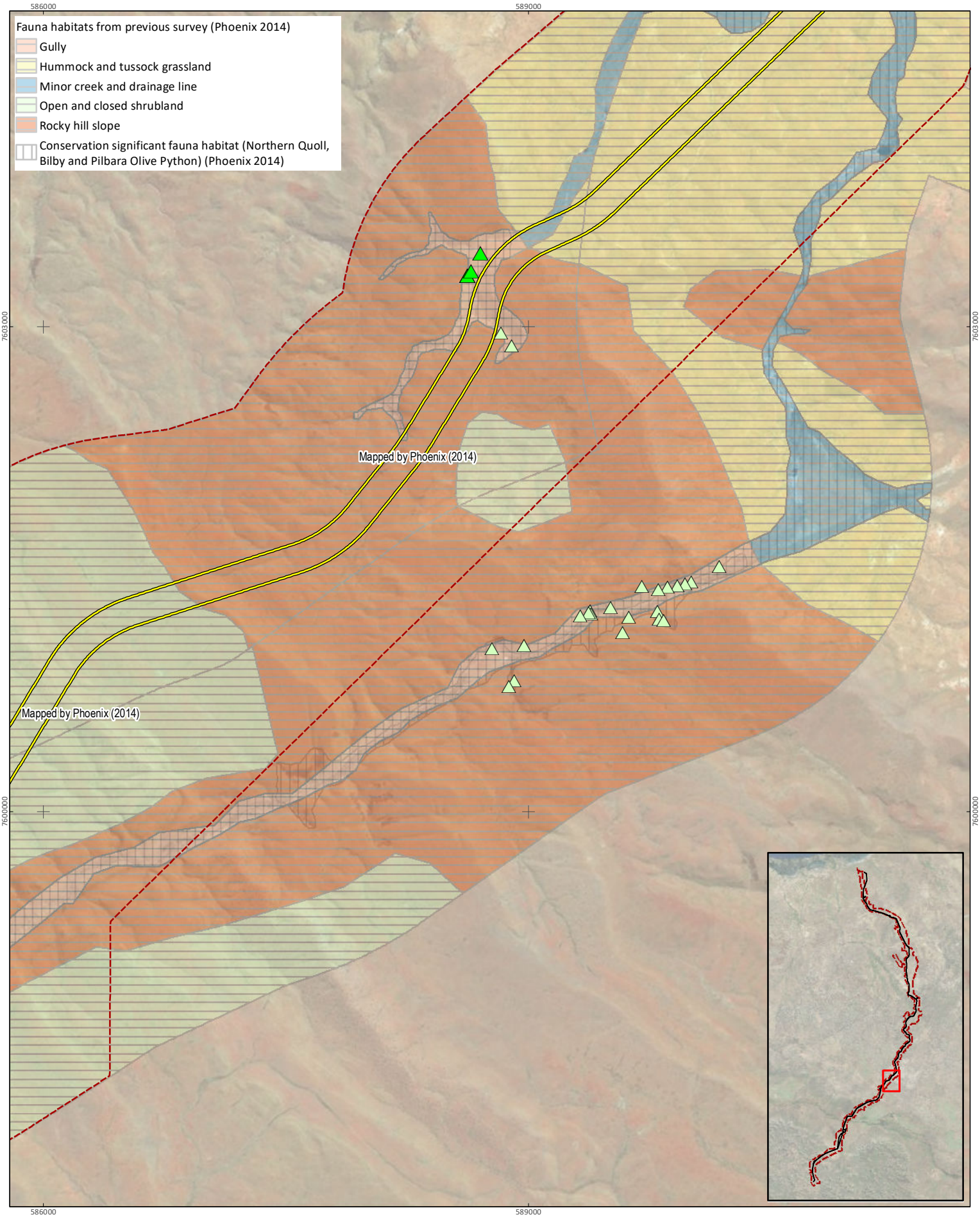
1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Conservation significant fauna from previous survey (Phoenix 2014)
Dasyurus hallucatus, Northern quoll (EN), trap, camera trap, scat, bones
Conservation significant fauna
Dasyurus hallucatus, Northern quoll (EN), direct sighting or scat

Figure 3-T.6

Fauna habitats and conservation significant fauna records from survey

PHOENIX ENVIRONMENTAL SCIENCES



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Date	27-Oct-17
Drawn by	KW
Map author	JC

0 0.2 0.4 0.8 1.2
Kilometres

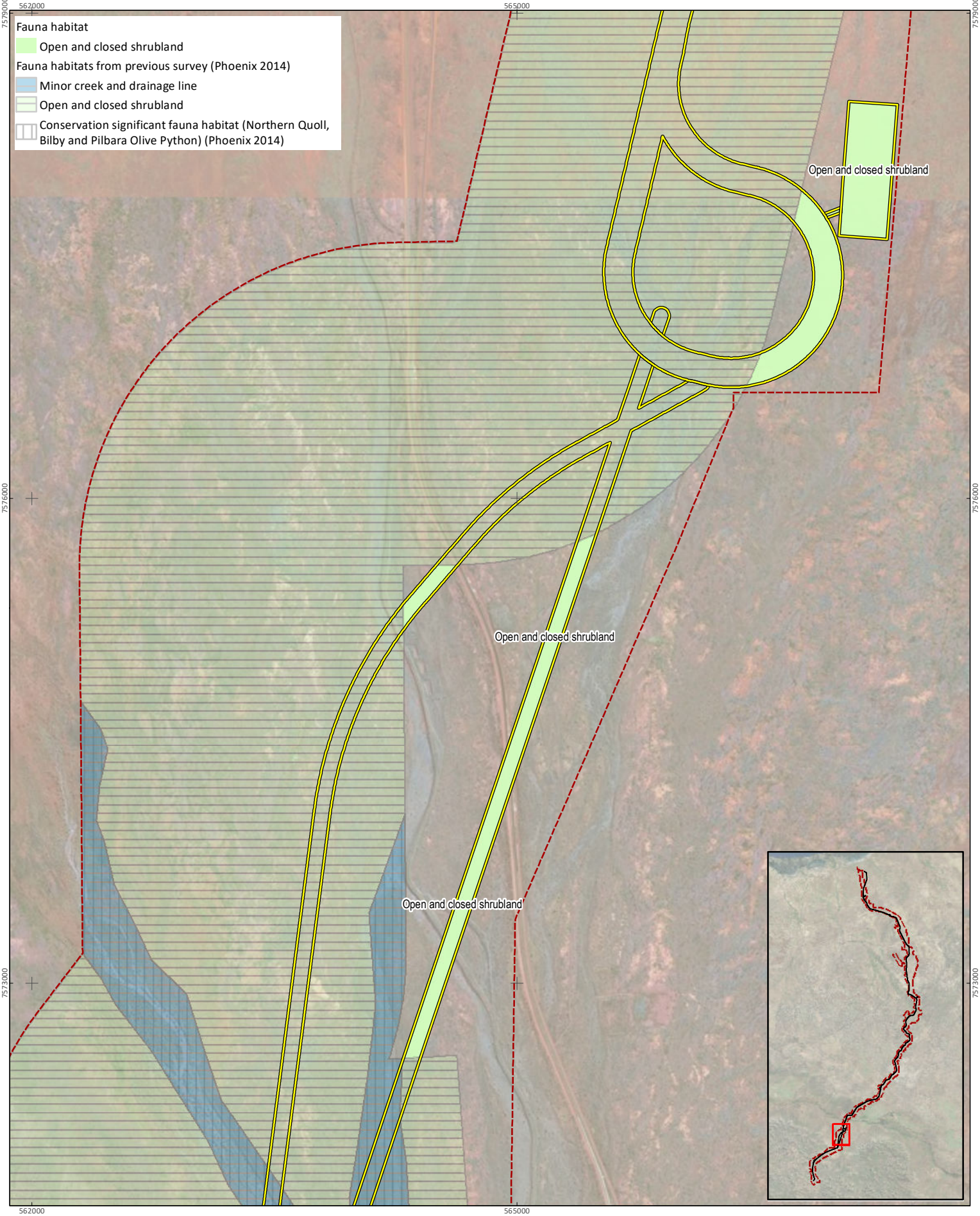
1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope
Conservation significant fauna from previous survey (Phoenix 2014)
Dasyurus hallucatus, Northern quoll (EN), trap, camera trap, scat, bones
Conservation significant fauna
Dasyurus hallucatus, Northern quoll (EN), direct sighting or scat

Figure 3-T.7

Fauna habitats and conservation significant fauna records from survey

PHOENIX ENVIRONMENTAL SCIENCES



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0 0.2 0.4 0.8 1.2
Kilometres

1:30,000 (at A4) GDA 1994 MGA Zone 50

Study area (final potential disturbance area)
Approved development envelope

Figure 3-T.8

Fauna habitats and conservation significant fauna records from survey

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Table 3-13 Locations of Northern Quoll records from the survey and individuals recorded

Site	Species	Common name	Latitude	Longitude	Record type	Individual ID
CT007a	*Dasyurus hallucatus*	Northern Quoll	-21.6712	117.8566	Camera trap	NQ001; NQ002
CT007b	*Dasyurus hallucatus*	Northern Quoll	-21.6710	117.8568	Camera trap	NQ002
CT008a	*Dasyurus hallucatus*	Northern Quoll	-21.4761	117.9170	Camera trap	NQ003
CT008b	*Dasyurus hallucatus*	Northern Quoll	-21.4761	117.9171	Camera trap	Indet.
CT008c	*Dasyurus hallucatus*	Northern Quoll	-21.4764	117.9175	Camera trap	NQ003
CT010a	*Dasyurus hallucatus*	Northern Quoll	-21.5073	117.9409	Camera trap	NQ005; indet.
CT010b	*Dasyurus hallucatus*	Northern Quoll	-21.5073	117.9410	Camera trap	NQ005; indet.
CT010c	*Dasyurus hallucatus*	Northern Quoll	-21.5073	117.9411	Camera trap	NQ005; indet.
NQ001	*Dasyurus hallucatus*	Northern Quoll	-21.6700	117.8574	Scat	NA

3.2.2.2.2 Pilbara Olive Python

No evidence of Pilbara Olive Python was recorded during the survey and no additional suitable habitat was identified in the previously unmapped portions of the study area.

3.2.2.2.3 Bilby

Additional suitable habitat for Bilby was identified in the previously unsurveyed portion of the study area at the northern end of the alignment (Figure 3-7). A single defunct Bilby burrow was recorded from a plot site in this area (Table 3-14; Figure 3-7).

No evidence of Bilby presence was identified in previously mapped areas of suitable habitat for the species (Phoenix 2014); however, a number of plots were assessed as suitable habitat (Figure 3-7).

Table 3-14 Locations of Bilby records from the survey

Site	Species	Common name	Latitude	Longitude	Record type
BT011	*Macrotis lagotis*	Bilby	-20.8208	117.7415	Burrow (defunct)

3.2.2.3 Pilbara Leaf-nosed Bat

No suitable habitat for the Pilbara Leaf-nosed Bat was identified in the previously unmapped portion study area. The species was not recorded during the survey.

3.2.2.4 Ghost Bat

No Ghost Bats were recorded during the survey. No suitable habitat for the species was identified in the previously unmapped portion study area.

3.3 SURVEY LIMITATIONS

There were no limitations with respect the fauna component of the surveys. Some limitations were encountered in the flora component of the survey (Table 3-15).

Table 3-15 Survey limitations

Limitations	Limitation?	Comments
Availability of contextual information at a regional and local scale	No	The reports from the previous surveys provided detailed information on the locality.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	No	The field botanists and zoologists for the surveys all have a high level of survey experience in the in the Pilbara bioregion.
Proportion of flora recorded and/or collected, any identification issues	Yes	Just over 10% of taxa could not be identified definitively to species level due to insufficient reproductive characters and some annual species may not have been present at the time of the single season survey.
Effort and extent; was the appropriate area fully surveyed	Partial	Suitable survey methods were employed based on EPA (2016). Three sites were not surveyed in all vegetation types as this survey was an extension to a much larger, adjacent study area, with nearly all vegetation types recorded previously.
Access within the study area	No	The use of a helicopter facilitated access to all sites.
Timing, rainfall, season	No	The survey was conducted at an appropriate time (in accordance with recommended survey timing for the Eremaean botanical province following a wet season with above average annual rainfall.
Disturbance that may have affected the results of the survey	No	No notable recent disturbances were observed that may have impacted the survey.

4 DISCUSSION

4.1 FLORA AND VEGETATION

Average species richness recorded in the previously unmapped portion of the study area was much higher compared to that recorded in the previous flora and vegetation survey conducted for the Project (Table 4-1). The current survey reported approximately six species per 1 km^2 whereas Ecoscape (2014) reported one species per 1 km^2.

Both studies were conducted in vegetation types dominated by hummock grasslands, sometimes with sparse or scattered shrubland and/or open woodlands. Ecoscape (2014) considered that the low species richness recorded was likely due to the timing of their survey (July–August) identifying that "a survey conducted in the season following rain would result in additional ephemeral species being recorded". The current study was conducted at a more optimal time (post-wet season, June) and following above average rainfall in the months prior to the survey which has likely contributed to the higher species richness.

The current survey recorded all prominent families identified in the previous survey (Table 4-2).

Table 4-1 Comparison of floristic data from the current survey with the previous survey

Survey	Area (km^2)	No. vegetation types	No. of identified species	No. of families	No. of genera	No. of weeds
Ecoscape (2014)	690.7	58	474	63	189	16
This survey	35.3	15	221	36	97	6

Table 4-2 Species numbers of the most dominant plant families recorded in the study area in comparison with the previous survey

Family	This study	Ecoscape (2014)
Fabaceae	50	106
Poaceae	37	68
Malvaceae	23	57
Amaranthaceae	18	23
Asteraceae	7	20
Total number of species	135	274
% dominant families comprise of all species recorded for the survey	**61.1**	**57.8**

4.1.1 Conservation significant flora

Six of the 83 Priority flora identified as potentially present in the study area in the desktop review were recorded during the field survey, including three not recorded in the previous survey (Ecoscape 2014). A seventh Priority species, *Acacia fecunda*, not identified by the desktop assessment was also recorded.

The record of *Acacia fecunda* (P3) in the study area represents a large (ca 250 km) north-western range extension and therefore a regionally significant new population for the species. The large range extension accounts for its absence from the desktop results. The identity of the species was ascertained at the state herbarium after the field survey and therefore the size of the population was not recorded. Subsequently, a targeted search to map the extent and size of the population would be required to quantify impacts from any proposed disturbance at this location.

Both populations of *Abutilon* sp. Pritzelianum (P1) recorded in the current survey represent new records for the species as the populations are located more than 500 m (Stack 2010) from all other records (DBCA 2017; Ecoscape 2014). Combined with the records from the previous survey (Ecoscape 2014), seven records comprised of a total of 225 individuals have been recorded in surveys conducted for the Project, with 44 plants located within the current study area (Table 4-3). The combined records represent approximately 13% of all known records for the species. A lack of population numbers for the majority of DBCA (2017) records precludes the capacity to determine what proportion of the total population is present in the study area.

Table 4-3 Summary of conservation significant flora from both surveys (Ecoscape 2014; current survey) and records in current study area

Species	Cons. status	Ecoscape (2014) survey record	Current survey record	Total records	Total number of plants recorded	Records in current study area	Number of plants in current study area
Abutilon sp. Pritzelianum	P1	Yes	Yes	7	225	6	44
Acacia fecunda	P3	No	Yes	1	nc*1	1	nc*
Goodenia nuda	P4	Yes	Yes	25	150	1	nc*
Helichrysum oligochaetum	P1	Yes	No	1	56		
Heliotropium muticum	P3	Yes	Yes	49	802	34	262
Hibiscus sp. Mt Brockman	P1	No	Yes	1	1		
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	Yes	No	6	140		
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Yes	No	4 (single population)	140	1 (part of)	10
Pentalepis trichodesmoides subsp. *hispida*	P2	Yes	No	1	1		
Rhynchosia bungarensis	P4	Yes	Yes	10	452	2	2
Themeda sp. Hamersley Station	P3	No	Yes	1	3	1 (on boundary)	3 (on boundary)
Sida sp. Barlee Range (S. van Leeuwen 1642)	P3	Yes	No	2	15		

*Not counted.

The population of *Goodenia nuda* (P4) recorded in the current survey represents a new population. The species has been recorded at 25 locations comprising at least 150 individuals across the current and previous (Ecoscape 2014) survey. Only one of these records is in the current study area (Table 4-3).

The records for *Heliotropium muticum* (P3) from the current survey represent four distinct populations, three of which represent new populations while one is an extension of a population recorded in the previous survey (Ecoscape 2014). A total of at least 803 individuals have been recorded by the two surveys. These records represent less than 5% of all known records for the species; a lack of population numbers for the majority of DBCA (2017) records precludes the capacity to determine what proportion of the total population of the species is present in the study area. Roughly 70% of the records, but only a third of the plants from the combined survey records (this study; Ecoscape 2014) are located in the current study area (Table 4-3).

The records for *Hibiscus* sp. Mt Brockman (P1), *Themeda* sp. Hamersley Station (P3) and *Rhynchosia bungarensis* (P4) recorded during the current survey represent the only records of the species in the combined survey area. A total of one, three and two individuals (respectively) of these species were recorded. The record for *Hibiscus* sp. Mt Brockman represents less than 10% of all known records for the species, and as one of the known records comprises a population with over 100 individuals (DBCA 2017) less than 1% of recorded individuals of the species. In the surveys conducted for the Project to date, *Hibiscus* sp. Mt Brockman has so far only been recorded outside the current study area, although within the Approved Development Envelope (Table 4-3).

The records for *Themeda* sp. Hamersley Station represent less than 3% of all known records for the species, and as one of the known records comprises a population with over 1 million plants (DBCA 2017), less than 0.1% of all recorded individuals. Based on surveys conducted to date, three individuals of *Themeda* sp. Hamersley Station have been recorded within (on the boundary of) the current study area (Table 4-3).

The records for the survey for *Rhynchosia bungarensis* represent less than 3% of all known records for the species. A lack of population numbers for the majority of DBCA (2017) records precludes the capacity to determine what proportion of the total population of the species is present in the study area. To date, only one solitary *R. bungarensis* plant has been recorded in the current study area (Table 4-3). Also, notably the new records are from the northern extremity of the study area, in contrast to the previous survey where it was recorded at the southern end of the Approved Development Envelope (Figure 3-1; Figure 3-4).

Three other Priority flora recorded in the previous survey (Ecoscape 2014) were not recorded during the current survey; *Helichrysum oligochaetum* (P1), *Oldenlandia* sp. Hamersley Station and *Pentalepis trichodesmoides* subsp. *hispida*. The previous records for *Helichrysum oligochaetum* are within the Approved Development Envelope but outside of the current study area (Table 4-3).

The previously recorded population of *Oldenlandia* sp. Hamersley Station is not located in the current study area (Table 4-3). *Oldenlandia* sp. Hamersley Station is a prostrate annual herb with flowering times recorded as March, May–July and September (DBCA 2017). Despite searching in the vicinity of the previous records, no plants of the species were located. It is possible that no extant plants of this annual species were present at the time of the survey but is likely that the taxon persists as seed in the soil seed bank.

The previous records for *Pentalepis trichodesmoides* subsp. *hispida* comprise a solitary plant outside the current study area (Table 4-3). *Pentalepis trichodesmoides* subsp. *hispida* is a perennial shrub with flowering times recorded as April and August–October (DBCA 2017). Despite searching in the vicinity of the record, the species could not be located. It is possible that the solitary plant recorded

in 2014 has subsequently perished but the taxon may persist at the location as seed in the soil seed bank.

The 23 taxa that could not be definitively identified to species level were considered unlikely to represent conservation significant flora. Four Priority *Triodia* species have been recorded in the Pilbara bioregion (DBCA 2017); however, suitable habitat was not present in the study area for any of these species. *Oldenlandia* sp. Hamersley Station (P3) is the only conservation significant Rubiaceae species recorded in the Pilbara (DBCA 2017). This species was collected in the previous survey (Ecoscape 2014); the Rubiaceae sp. from the current survey did not resemble this species. None of the remaining unidentified taxa resembled any conservation significant flora.

4.1.2 Vegetation

Except for areas identified as the Horseflat Land System of the Roebourne Plains PEC, the vegetation types defined for the previously unmapped portion of the study area are representative of the broad vegetation types mapped by Shepherd *et al.* (2002) with hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia* or hummock grassland with scattered shrubs or mallee *Triodia* spp. *Acacia* spp., *Grevillea* spp. *Eucalyptus* spp. Consequently, most of the vegetation in this part of the study area represents a widespread community well represented at a regional level with 99% of pre-European extent remaining. Majority of the vegetation (95%) was of excellent condition.

With the exception of one vegetation type (AaAsTw), the previously unsurveyed portion of the study area contained vegetation types that were also recorded previously (Ecoscape 2014) in the study area and the wider Approved Development Envelope. Six of the vegetation types in the unmapped portion of the study area (Aa3Te, Aa3TI, AiTw(2), ElAs2Te, ElTw(2), and Ex1) were considered locally significant as they contain Priority flora species or the Horseflat Land System of the Roebourne Plains PEC.

The mapped extent of the Four plant assemblages of the Wona Land System PEC from the surveys (Ecoscape (2014) Sb vegetation type, confirmed in the current survey) is 39.0 ha (Table 4-4). Of this, 7.2 ha (18.5%) is within the current study area.

The combined extent of the Horseflat Land System of the Roebourne Plains PEC mapped in the current and previous survey is 1,135 ha, of which 51.1 ha (4.5%) is present in the current study area (Table 4-4).

Table 4-4 Summary of PECs within study area

Community name	Total extent mapped in surveys (current; Ecoscape 2014) (ha)	Extent in current study area (ha)
Horseflat Land System of the Roebourne Plains (Ex1)	1,135.1	51.1
Four plant assemblages of the Wona Land System (Sb)	39.0	7.2

4.2 FAUNA AND FAUNA HABITAT

4.2.1 Fauna habitat

The previously unsurveyed portion of the study area contained fauna habitat types that were also recorded previously (Phoenix 2014) in the study area and the wider Approved Development Envelope. The current survey therefore has not identified any new habitat types to those already mapped for the Project. The current study area does not contain any restricted fauna habitat types; all are well represented in the wider Approved Development Envelope (Table 4-5).

Table 4-5 Summary of fauna habitats within study area

Fauna habitat type	Total extent mapped in surveys (current; Phoenix 2014) (ha)	Extent in current study area (ha)
Hummock and tussock grassland	23,241.2	1,406.3
Minor creek and drainage line	3,985.1	192.6
Open and closed shrubland	23,787.3	1,276.4
Rocky hill slope	10,260.2	409.0
Woodland	95.5	10.4
Gully	547.7	10.3
Sandplain	3,611.9	192.8
Isolated sand dune	22.2	-
Total	**65,551.1**	**3,497.8**

4.2.2 Conservation significant fauna

The results of the targeted fauna survey were similar to the findings of the previous fauna surveys conducted for the Project (Phoenix 2014). As with the 2014 surveys, the Northern Quoll was recorded at multiple locations, and limited to no evidence of Pilbara Olive Python, Bilby, Pilbara Leaf-nosed Bat or Ghost Bat was identified.

Based on the results of the current study and the previous survey (Phoenix 2014), 16 of a total of 48 Northern Quoll records are from within the current study area (Table 4-6). The only record of Pilbara Olive Python (Phoenix 2014) was from outside the current study area. The only evidence of Bilby presence across the two surveys, the old burrow record, is in the current study area.

Table 4-6 Summary of conservation significant fauna records

Species	Number of all records from current study and Phoenix (2014)	Number of records from current study area
Northern Quoll	48	16
Pilbara Olive Python	1	0
Bilby	1	1

Northern Quoll records for the surveys conducted for the Project to date indicate the species utilises suitable habitat at several locations in the Approved Development Envelope, including three locations within the current study area (Figure 3-7). Based on the records at both site CT008 and CT010 (Figure 2-3; Figure 3-7), it is also likely to utilise the minor creek and drainage line habitat between these sites for movement (Figure 3-7). The current study area avoids two areas where a high number of records were obtained in the previous survey (Phoenix 2014).

The number of individuals captured in the current survey was considerably lower to that of the previous survey (Phoenix 2014). This is likely to be due to several factors, including survey methods, timing, intensity and site locations. However, this survey did not aim to replicate the previous survey, but rather was intended to add to the existing dataset, specifically for the current study area, to inform the Conservation Significant Fauna Management Plan for the Project.

The Department of the Environment (2016) defines important populations as “high density populations – which occur in refuge-rich habitat critical to the survival of the species”. If camera trap detection is used, high density populations are characterised by numerous camera triggers of multiple individuals across multiple cameras at a site. A low density population may be characterised by infrequent camera triggers of one or two individuals confined to one or cameras and sites or where no trapping has identified a northern quoll but latrine evidence remains (Department of the Environment 2016).

Of the three sites that the species was recorded from in the current survey, two individuals each were captured at two sites (CT007, CT008) and at least one individual (possibly more) was recorded at the third site (CT010). The number of camera triggers was high at the sites (915 in total from eight camera traps) and individuals were captured across multiple cameras at a site, throughout the night and on multiple nights. Therefore, the results do not neatly fit into the definition of either a high or low density population.

As a precautionary measure, the Northern Quoll population within the study area should be treated as a high density population. This is supported by the previous survey records (Phoenix 2014) for two of the sites which resampled two areas previously mapped as critical habitat for the species.

The current survey identified additional suitable habitat for Bilby at the northern end of the study area that will need consideration in the Conservation Significant Fauna Management Plan.

Although not recorded in the current survey, the findings of the previous survey (Phoenix 2014) for Pilbara Olive Python are still applicable for the current study area. The minor creek and drainage line habitat mapped as suitable for the species (Figure 3-3) and noted to be ‘lined by rocky land features and dotted with permanent pools which are ideal for basking, foraging and sheltering’ intersects the current study area. The Conservation Significant Fauna Management Plan will need to have regard for this species.

Echolocation recordings were undertaken in association with semi-permanent pools, considered to have high potential for detection of Pilbara Leaf-nosed Bat and Ghost Bat. They were not detected; however, this is not considered confirmation of absence as there are Threatened Fauna Database records for both species within the area of the desktop study conducted for the Project. While the Project will impact foraging habitat for both species, it is considered unlikey that roost caves for either species will be directly impacted by the Project.

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Appendix 1 Flora survey site descriptions

Site:	Q014	**Type:**	Quadrat (50 m x 50 m)
Date(s):	11 June 2017	**Position:**	-21.9246909768, 117.632417008
Total vegetation cover (%):	55	**Topography:**	plain
Tree/shrub cover >2 m (%):	12	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	5	**Soil:**	clay loam
Grass cover (%):	40	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall open shrubland of *Acacia citrinoviridis* with scattered *Grevillea wickhamii* over a hummock grassland of *Triodia* sp. (resinous) on stony soils (flat plain).		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia sp. (resinous)	40.0	00.50		
Acacia citrinoviridis	10.0	04.50		
Acacia pyrifolia	04.0	01.80		
Senna artemisioides subsp. *oligophylla*	01.0	01.00		
Grevillea wickhamii	01.0	02.20		
Corchorus crozophorifolius	00.5	00.50		
Acacia ancistrocarpa	00.5	02.00		
Cenchrus ciliaris	00.3	00.50	*	
Bulbostylis barbata	00.3	00.10		
Polycarpaea corymbosa	00.1	00.50		
Tephrosia sp. Fortescue (A.A. Mitchell 606)	00.1	00.50		
Notoleptopus decaisnei	00.1	00.20		
Ptilotus nobilis	00.1	00.30		
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	00.1	01.20		
Goodenia lamprosperma	00.1	00.30		
Polycarpaea longiflora	00.1	00.20		
Dysphania rhadinostachya	00.1	00.10		
Bonamia ? *pilbarensis*	00.1	00.10		
Rhynchosia minima	00.1	00.20		
Ptilotus calostachyus	00.1	00.50		
Aristida holathera	00.1	00.30		

Solanum orbiculatum	00.1	00.10
Aristida contorta	00.1	00.30
Hybanthus aurantiacus	00.1	00.30
Gomphrena canescens	00.1	00.10
Eriachne pulchella subsp. *dominii*	00.1	00.20
Fimbristylis simulans	00.1	00.10
Cleome viscosa	00.1	00.20
Indigofera monophylla	00.1	00.50
Eriachne aristidea	00.1	00.20
Boerhavia coccinea	00.1	00.20
Evolvulus alsinoides var. *decumbens*	00.1	00.20

Site:	Q015	**Type:**	Quadrat (50 m x 50 m)
Date(s):	11 June 2017	**Position:**	-21.9073329766, 117.64735599
Total vegetation cover (%):	35	**Topography:**	plain
Tree/shrub cover >2 m (%):	12	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	2	**Soil:**	clay loam
Grass cover (%):	25	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall shrubland of *Acacia pruinocarpa, Acacia dictyophleba* and *Acacia ancistrocarpa* over a low open shrubland of *Acacia monticola x trachycarpa* over *Triodia epactia* and *Triodia wiseana* on stony soils (flats/plain).		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia epactia	20.0	00.70		
Acacia pruinocarpa	08.0	03.00		
Triodia wiseana	05.0	00.50		
Acacia ancistrocarpa	02.5	02.00		
Acacia dictyophleba	01.5	02.00		
Rhynchosia minima	01.0	00.40		
Bonamia rosea	01.0	00.30		
Hakea lorea subsp. *lorea*	00.3	01.80		
Acacia monticola x *trachycarpa*	00.3	01.00		
Senna artemisioides subsp. *oligophylla*	00.3	01.20		
Pterocaulon sphacelatum	00.1	00.30		
Amaranthus induratus	00.1	00.10		
Sporobolus australasicus	00.1	00.05		
Dysphania rhadinostachya subsp. *rhadinostachya*	00.1	00.30		
Sida fibulifera	00.1	00.30		
Acacia synchronicia	00.1	01.50		
Enneapogon polyphyllus	00.1	00.40		
Ptilotus clementii	00.1	00.20		
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	00.1	00.30		
Euphorbia australis var. *subtomentosa*	00.1	00.05		

Senna glutinosa subsp. *glutinosa*	00.1	01.20
Eriachne pulchella subsp. *dominii*	00.1	00.20
Gomphrena canescens	00.1	00.10
Eulalia aurea	00.1	00.50
Trichodesma zeylanicum	00.1	00.50
Ptilotus nobilis	00.1	00.30
Cleome viscosa	00.1	00.30
Indigofera monophylla	00.1	00.40
Notoleptopus decaisnei	00.1	00.20
Tribulus macrocarpus	00.1	00.10
Cucumis variabilis	00.1	00.30
Paspalidium basicladum	00.1	00.30
Sida echinocarpa	00.1	00.30
Evolvulus alsinoides var. *decumbens*	00.1	00.20
Hibiscus sturtii var. *campylochlamys*	00.1	00.30
Themeda triandra	00.1	00.70

Site:	Q016	**Type:**	Quadrat (50 m x 50 m)
Date(s):	12 June 2017	**Position:**	-20.9043299694, 117.725194031
Total vegetation cover (%):	25	**Topography:**	river
Tree/shrub cover >2 m (%):	20	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	1	**Soil:**	sandy loam, clay loam, clay
Grass cover (%):	20	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	grazing – high		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Open woodland of *Eucalyptus victrix* over a tall shrubland of *Acacia monticola x trachycarpa* over a tussock grassland of **Cenchrus ciliaris* with scattered *Triodia epactia* and *T. lanigera* on edges of river banks.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Cenchrus ciliaris	18.0	00.40	*	
Eucalyptus victrix	15.0	12.00		
Acacia monticola x *trachycarpa*	12.0	02.50		
Triodia epactia	01.5	00.60		
Triodia lanigera	01.0	00.50		
Acacia ampliceps	01.0	03.50		
Acacia stellaticeps	00.5	01.20		
Indigofera colutea	00.3	00.40		
Vachellia farnesiana	00.3	01.50	*	
Carissa lanceolata	00.3	01.80		
Indigofera trita	00.1	01.00		
Cleome viscosa	00.1	00.30		
Trianthema pilosum	00.1	00.30		
Abutilon amplum	00.1	00.50		
Ptilotus incanus	00.1	00.30		
Euphorbia coghlanii	00.1	00.20		
Cassytha capillaris	00.1	00.50		
Ptilotus axillaris	00.1	00.20		
Eragrostis tenellula	00.1	00.50		
Evolvulus alsinoides var. *decumbens*	00.1	00.10		

Euphorbia australis var. *subtomentosa*	00.1	00.05	
Eragrostis xerophila	00.1	00.40	
Cyperus vaginatus	00.1	01.00	
Portulaca oleracea	00.1	00.10	
Rhynchosia minima	00.1	00.30	
Sida echinocarpa	00.1	00.40	
Aerva javanica	00.1	00.50	*
Sporobolus australasicus	00.1	00.20	
Acacia pyrifolia	00.1	00.20	
Senna notabilis	00.1	00.30	
Trigastrotheca molluginea	00.1	00.10	
Bulbostylis barbata	00.1	00.10	
Stemodia grossa	00.1	00.30	

Site:	Q017	**Type:**	Quadrat (50 m x 50 m)
Date(s):	12 June 2017	**Position:**	-20.8272049756, 117.740181964
Total vegetation cover (%):	40	**Topography:**	plain
Tree/shrub cover >2 m (%):	10	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	7	**Soil:**	sandy loam, clay
Grass cover (%):	30	**Rock type:**	quartz
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open shrubland of *Acacia bivenosa, Acacia inaequilatera* and *Acacia pyrifolia* with scattered *Senna glutinosa* subsp. *pruinosa* over *Triodia wiseana* on quartz stony plains.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana	30.0	00.50		
Acacia bivenosa	07.0	01.50		
Acacia inaequilatera	06.0	02.50		
Acacia pyrifolia	04.0	01.50		
Hakea chordophylla	00.3	01.50		
Swainsona formosa	00.3	00.40		
Ptilotus polystachyus	00.1	00.50		
Polygala glaucifolia	00.1	00.05		
Senna artemisioides subsp. *oligophylla*	00.1	00.50		
Tribulus hirsutus	00.1	00.20		
Triumfetta clementii	00.1	00.50		
Bonamia rosea	00.1	00.30		
Euphorbia australis	00.1	00.05		
Indigofera trita	00.1	00.40		
Evolvulus alsinoides var. *decumbens*	00.1	00.30		
Eragrostis cumingii	00.1	00.30		
Carissa lanceolata	00.1	01.20		
Sporobolus australasicus	00.1	00.20		
Senna glutinosa subsp. *pruinosa*	00.1	01.50		
Eriachne pulchella subsp. *dominii*	00.1	00.10		

Sida ? arsiniata	00.1	00.40
Hybanthus aurantiacus	00.1	00.20
Gomphrena canescens	00.1	00.10
Yakirra australiensis	00.1	00.10
Cucumis variabilis	00.1	00.30
Euphorbia biconvexa	00.1	00.10
Solanum lasiophyllum	00.1	00.50

Site:	Q018	**Type:**	Quadrat (50 m x 50 m)
Date(s):	12 June 2017	**Position:**	-20.7943759947, 117.732613022
Total vegetation cover (%):	55	**Topography:**	plain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	50	**Rock type:**	quartz
Herb cover (%):	5	**Fire age:**	not evident
Disturbance details:	grazing – high		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tussock grassland of *Eragrostis xerophila*, and *Sorghum timorense*over a sparse herbland of *Rhynchosia minima* on flat plain.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eragrostis xerophila	45.0	00.40		
Sorghum timorense	07.0	00.80		
Rhynchosia minima	05.0	00.30		
Indigofera trita	00.2	00.30		
Gomphrena canescens	00.1	00.20		
Notoleptopus decaisnei	00.1	00.20		
Euphorbia australis	00.1	00.05		
Evolvulus alsinoides var. *decumbens*	00.1	00.20		
Sida fibulifera	00.1	00.30		
Portulaca pilosa	00.1	00.10	*	
Streptoglossa sp.	00.1	00.30		
Ptilotus aervoides	00.1	00.05		
Goodenia muelleriana	00.1	00.20		
Operculina aequisepala	00.1	00.30		
Indigofera linifolia	00.1	00.20		
Streptoglossa ? *liatroides*	00.1	00.40		
Corchorus tridens	00.1	00.10		
Streptoglossa ? *tenuiflora*	00.1	00.10		
Portulaca oleracea	00.1	00.20		

Site:	Q019	**Type:**	Quadrat (50 m x 50 m)
Date(s):	12 June 2017	**Position:**	-20.779830962, 117.697351025
Total vegetation cover (%):	55	**Topography:**	plain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam, clay
Grass cover (%):	52	**Rock type:**	quartz
Herb cover (%):	3	**Fire age:**	not evident
Disturbance details:	grazing – high		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tussock grassland of *Eragrostis xerophila* with scattered *Triodia epactia* over a sparse herbland of *Rhynchosia minima* on crackling clayey loam with scattered quartz.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eragrostis xerophila	50.0	00.30		
Rhynchosia minima	04.0	00.30		
Triodia epactia	00.3	00.40		
Sporobolus australasicus	00.1	00.10		
Euphorbia coghlanii	00.1	00.10		
Portulaca oleracea	00.1	00.10		
Sida fibulifera	00.1	00.20		
Streptoglossa ? *liatroides*	00.1	00.50		
Gomphrena canescens	00.1	00.20		
Enneapogon caerulescens	00.1	00.10		
Flaveria trinervia	00.1	00.10	*	
Rhynchosia bungarensis	00.1	00.10		P4 (WC Act)
Euphorbia australis	00.1	00.05		
Cleome viscosa	00.1	00.20		
Streptoglossa ? *tenuiflora*	00.1	00.10		
Ptilotus aervoides	00.1	00.05		
Euphorbia biconvexa	00.1	00.10		
Evolvulus alsinoides var. *decumbens*	00.1	00.20		
Ptilotus gomphrenoides	00.1	00.10		
Indigofera trita	00.1	00.30		

Site:	Q020	**Type:**	Quadrat (50 m x 50 m)
Date(s):	13 June 2017	**Position:**	-20.9160420019, 117.72895298
Total vegetation cover (%):	45	**Topography:**	plain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	3	**Soil:**	clay loam, clay
Grass cover (%):	42	**Rock type:**	quartz
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	vehicle tracks		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Sparse tall open shrubland of *Acacia ancistrocarpa* and *Acacia pyrifolia* over a low sparse shrubland of *Acacia stellaticeps* over a hummock grassland of*Triodia wiseana* with *Triodia basedowii* on quartz stony flat plains.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana	35.0	00.50		
Triodia basedowii	07.0	01.00		
Acacia stellaticeps	01.5	01.20		
Acacia ancistrocarpa	01.0	02.00		
Acacia pyrifolia	00.5	02.00		
Sclerolaena costata	00.5	00.40		
Acacia bivenosa	00.3	01.80		
Iseilema dolichotrichum	00.3	01.50		
Euphorbia australis var. *subtomentosa*	00.1	00.10		
Eriachne pulchella subsp. *dominii*	00.1	00.20		
Sporobolus australasicus	00.1	00.10		
Gomphrena canescens subsp. *canescens*	00.1	00.20		
Goodenia muelleriana	00.1	00.40		
Goodenia microptera	00.1	00.40		
Alysicarpus muelleri	00.1	00.05		
Tephrosia clementii	00.1	00.20		
Sclerolaena ? *lanicuspis*	00.1	00.20		
Hybanthus aurantiacus	00.1	00.30		
Abutilon ? sp. Dioicum	00.1	00.50		
Trianthema triquetrum	00.1	00.20		

Polygala glaucifolia	00.1	00.10	
Evolvulus alsinoides var. *decumbens*	00.1	00.20	
Tribulus hirsutus	00.1	00.20	
Salsola australis	00.1	00.20	
Cucumis variabilis	00.1	00.30	
Aerva javanica	00.1	00.50	*
Ptilotus polystachyus	00.1	00.30	
Bulbostylis barbata	00.1	00.10	
Euphorbia coghlanii	00.1	00.20	
Euphorbia biconvexa	00.1	00.20	
Polycarpaea corymbosa	00.1	00.05	
Paspalidium basicladum	00.1	00.20	
Indigofera monophylla	00.1	00.40	
Triumfetta clementii	00.1	00.30	
Indigofera colutea	00.1	00.30	
Portulaca oleracea	00.1	00.20	
Dysphania rhadinostachya	00.1	00.10	
Senna notabilis	00.1	00.20	
Ptilotus nobilis	00.1	00.30	
Enneapogon caerulescens	00.1	00.10	
Rhynchosia minima	00.1	00.20	
Bonamia pannosa	00.1	00.10	

Site:	Q021	**Type:**	Quadrat (50 m x 50 m)
Date(s):	13 June 2017	**Position:**	-20.9432520069, 117.748762015
Total vegetation cover (%):	35	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	3	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam, clay
Grass cover (%):	33	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Sparse open woodland of *Corymbia hamersleyana* over a tall sparse shrubland of *Acacia ancistrocarpa* with scattered *Acacia pyrifolia* over a hummock grassland of*Triodia epactia* on stony soils (foothills).		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia epactia	33.0	00.50		
Acacia ancistrocarpa	01.0	02.20		
Corymbia hamersleyana	00.5	02.00		
Cajanus cinereus	00.5	01.80		
Acacia pyrifolia	00.5	02.20		
Bulbostylis barbata	00.2	00.10		
Rhynchosia minima	00.2	00.30		
Polycarpaea corymbosa	00.1	00.05		
Eriachne pulchella subsp. *dominii*	00.1	00.10		
Indigofera colutea	00.1	00.30		
Euphorbia boophthona	00.1	00.20		
Evolvulus alsinoides var. *decumbens*	00.1	00.20		
Senna notabilis	00.1	00.10		
Gomphrena canescens	00.1	00.10		
Polygala glaucifolia	00.1	00.05		
Trigastrotheca molluginea	00.1	00.10		
Tephrosia clementii	00.1	00.10		
Bonamia pannosa	00.1	00.10		

Site:	Q023	**Type:**	Quadrat (50 m x 50 m)
Date(s):	13 June 2017	**Position:**	-20.9551279903, 117.76612496
Total vegetation cover (%):	60	**Topography:**	plain
Tree/shrub cover >2 m (%):	10	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	1	**Soil:**	clay loam, clay
Grass cover (%):	50	**Rock type:**	quartz
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall open shrubland of *Acacia inaequilatera* and *Acacia bivenosa* with scatteted *Acacia pyrifolia* over a hummock grassland of *Triodia wiseana* and *Triodia wiseana* on quartz stony plains.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana	50.0	00.50		
Acacia inaequilatera	08.0	03.00		
Acacia bivenosa	01.5	02.20		
Cassytha capillaris	01.0	00.10		
Acacia pyrifolia	00.5	01.50		
Acacia acradenia	00.5	02.50		
Polygala ? *isingii*	00.1	00.10		
Eriachne pulchella subsp. *dominii*	00.1	00.20		
Euphorbia australis var. *subtomentosa*	00.1	00.05		
Bulbostylis barbata	00.1	00.10		
Indigofera colutea	00.1	00.30		
Polymeria calycina	00.1	00.10		
Yakirra australiensis	00.1	00.20		
Notoleptopus decaisnei	00.1	00.20		
Goodenia ? *forrestii*	00.1	00.20		
Senna notabilis	00.1	00.15		
Swainsona ? *stenodonta*	00.1	00.20		
Evolvulus alsinoides var. *decumbens*	00.1	00.10		
Sida ? *arsiniata*	00.1	00.40		
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	00.1	00.40		

Goodenia microptera	00.1	00.30
Polycarpaea corymbosa	00.1	00.05
Portulaca oleracea	00.1	00.10
Sporobolus australasicus	00.1	00.10
Trigastrotheca molluginea	00.1	00.10
Euphorbia coghlanii	00.1	00.20
Paspalidium basicladum	00.1	00.10
Triumfetta clementii	00.1	00.30
Cucumis variabilis	00.1	00.30
Dysphania rhadinostachya	00.1	00.10
Cleome viscosa	00.1	00.30
Tephrosia clementii	00.1	00.10
Euphorbia biconvexa	00.1	00.20
Acacia tenuissima	00.1	01.50
Gomphrena canescens	00.1	00.10

Site:	Q025	**Type:**	Quadrat (50 m x 50 m)
Date(s):	13 June 2017	**Position:**	-20.9608649826, 117.776137982
Total vegetation cover (%):	45	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	1	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam, clay
Grass cover (%):	43	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Sparse open shrubland of *Acacia inaequilatera*, *Acacia pyrifolia* and *Grevillea pyramidalis* over a hummock grassland of *Triodia ? brizoides* on stony hillslopes.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia ? *brizoides*	43.0	00.50		
Acacia pyrifolia	01.0	01.50		
Acacia inaequilatera	00.5	01.70		
Cullen leucochaites	00.3	01.20		
Grevillea pyramidalis	00.3	02.00		
Cleome viscosa	00.1	00.20		
Tephrosia clementii	00.1	00.10		
Eriachne pulchella subsp. *dominii*	00.1	00.10		
Tribulus hirsutus	00.1	00.10		
Senna glutinosa subsp. x *luerssenii*	00.1	01.00		
Boerhavia coccinea	00.1	00.20		
Bonamia pilbarensis	00.1	00.10		
Polycarpaea corymbosa	00.1	00.10		
Bonamia pannosa	00.1	00.10		
Cajanus cinereus	00.1	00.60		
Goodenia ? *forrestii*	00.1	00.10		
Bulbostylis barbata	00.1	00.10		
Acacia acradenia	00.1	01.50		

Site:	Q026	**Type:**	Quadrat (50 m x 50 m)
Date(s):	14 June 2017	**Position:**	-21.6954020044, 117.830394041
Total vegetation cover (%):	20	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	1	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	5	**Soil:**	clay loam, clay
Grass cover (%):	18	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	1 - 5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open woodland of *Corymbia hamersleyana* over a sparse tall shrubland of *Acacia inaequilatera* and *Grevillea pyramidalis* and *G. wickhamii* over a low sparse shrubland of *Acacia ? bivenosa* over hummock grassland of*Triodia ? epactia* and *Triodia ? wiseana* on stony hilltops.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia ? *epactia*	15.0	00.60		
Triodia ? *wiseana*	03.0	00.40		
Cajanus cinereus	03.0	01.20		
Acacia ? *bivenosa*	02.0	01.50		
Indigofera monophylla	01.0	00.50		
Acacia inaequilatera	01.0	02.50		
Corymbia hamersleyana	00.5	08.00		
Grevillea pyramidalis	00.3	02.20		
Grevillea wickhamii	00.3	01.80		
Triodia ? *basedowii*	00.1	00.40		
Hibiscus sturtii var. *campylochlamys*	00.1	00.20		
Solanum horridum	00.1	00.30		
Solanum lasiophyllum	00.1	00.30		
Trichodesma zeylanicum	00.1	01.00		
Senna glutinosa subsp. x *luerssenii*	00.1	01.20		
Goodenia stobbsiana	00.1	00.20		
Cassytha capillaris	00.1	00.10		
Bonamia pannosa	00.1	00.10		
Dampiera candicans	00.1	00.40		

Ptilotus calostachyus	00.1	00.50
Eriachne pulchella subsp. *dominii*	00.1	00.10
Polycarpaea corymbosa	00.1	00.05
Polygala glaucifolia	00.1	00.05
Oldenlandia crouchiana	00.1	00.10
Acacia colei	00.1	02.00
Sida sp. Pilbara (A.A. Mitchell PRP 1543)		

Site:	Q027	**Type:**	Quadrat (50 m x 50 m)
Date(s):	14 June 2017	**Position:**	-21.6944400133, 117.83123902
Total vegetation cover (%):	20	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	10	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	3	**Soil:**	sandy loam, clay
Grass cover (%):	12	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low open woodland of *Eucalyptus leucophloia* over a sparse shrubland of *Grevillea wickhamii* over a low open shrubland of *Dampiera candicans* over *Triodia* sp. (sterile) on stony soils in association with drainage lines.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia sp. (sterile)	12.0	00.50		
Eucalyptus leucophloia	08.0	10.00		
Grevillea wickhamii	02.0	02.20		
Dampiera candicans	02.0	00.40		
Indigofera monophylla	00.5	00.40		
? *Bonamia pilbarensis*	00.1	00.05		
Isotropis atropurpurea	00.1	00.40		
Ptilotus calostachyus	00.1	00.60		
Eriachne pulchella subsp. *dominii*	00.1	00.10		
Bonamia pannosa	00.1	00.10		
Senna glutinosa subsp. *glutinosa*	00.1	01.00		
Trigastrotheca molluginea	00.1	00.10		
Polycarpaea corymbosa	00.1	00.05		
Solanum orbiculatum	00.1	00.20		
Tephrosia clementii	00.1	00.20		
? *Cyperus* sp.	00.1	00.20		
Goodenia stobbsiana	00.1	00.20		
Eragrostis xerophila	00.1	00.30		
Bulbostylis barbata	00.1	00.10		
Hibiscus sturtii var. *campylochlamys*	00.1	00.20		

Site:	Q028	**Type:**	Quadrat (unbounded)
Date(s):	14 June 2017	**Position:**	-20.8143841562, 117.740699576
Total vegetation cover (%):	50	**Topography:**	plain
Tree/shrub cover >2 m (%):	1	**Soil colour:**	red brown
Shrub cover <2 m (%):	5	**Soil:**	sandy clay
Grass cover (%):	45	**Rock type:**	none
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall sparse shrubland of *Acacia tenuissima* and *Acacia pyrifolia* over low open shrubland of *Acacia bivenosa* and *Acacia synchronicia* over hummock grassland of *Triodia wiseana.*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana	45.0	00.50		
Acacia bivenosa	03.5	01.20		
Acacia tenuissima	01.5	01.20		
Acacia synchronicia	00.5	01.20		
Acacia pyrifolia	00.5	02.00		
Indigofera monophylla	00.3	00.60		
Bulbostylis barbata	00.1	00.20		
Bonamia rosea	00.1	00.20		
Tephrosia clementii	00.1	00.10		
Eriachne pulchella subsp. *dominii*	00.1	00.10		
Sporobolus australasicus	00.1	00.10		
Trigastrotheca molluginea	00.1	00.10		
Heliotropium muticum	00.1	00.20		P3 (WC Act)
Portulaca oleracea	00.1	00.30		
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	00.1	00.20		
Hybanthus aurantiacus	00.1	00.40		
Acacia ancistrocarpa	00.1	02.00		
Senna notabilis	00.1	00.10		
Pluchea tetranthera	00.1	00.40		
Yakirra australiensis	00.1	00.05		

Bonamia pannosa	00.1	00.10

Site:	Q029	**Type:**	Quadrat (50 m x 50 m)
Date(s):	14 June 2017	**Position:**	-20.8043087838, 117.739967984
Total vegetation cover (%):	60	**Topography:**	floodplain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	red-brown
Shrub cover <2 m (%):	0	**Soil:**	clay
Grass cover (%):	55	**Rock type:**	none
Herb cover (%):	5	**Fire age:**	not evident
Disturbance details:	grazing – high		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Grassland of *Eragrostis xerophila* and scattered *Chrysopogon fallax* and *Triodia epactia* over sparse herbland of *Rhynchosia minima* and *Sida fibulifera* on clay floodplain.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eragrostis xerophila	50.0	00.20		
Rhynchosia minima	03.0	00.20		
Triodia epactia	02.0	00.40		
Chrysopogon fallax	01.0	00.50		
Sida fibulifera	01.0	00.30		
Sorghum timorense	00.3	00.40		
Streptoglossa ? *liatroides*	00.1	00.15		
Cleome viscosa	00.1	00.30		
Rhynchosia bungarensis	00.1	00.10		P4 (WC Act)
Goodenia muelleriana	00.1	00.20		
Portulaca oleracea	00.1	00.20		
Portulaca pilosa	00.1	00.20	*	
Operculina aequisepala	00.1	00.20		
Flaveria trinervia	00.1	00.10	*	
Streptoglossa ? *tenuiflora*	00.1	00.10		
Euphorbia biconvexa	00.1	00.10		
Ptilotus aervoides	00.1	00.05		
Sporobolus australasicus	00.1	00.10		
Ptilotus gomphrenoides	00.1	00.20		
Gomphrena canescens	00.1	00.10		

Iseilema membranaceum	00.1	00.10

Site:	Q030	**Type:**	Quadrat (50 m x 50 m)
Date(s):	15 June 2017	**Position:**	-21.6850230282, 117.849763026
Total vegetation cover (%):	35	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	7	**Soil colour:**	red-brown
Shrub cover <2 m (%):	2	**Soil:**	clay loam
Grass cover (%):	30	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low open woodland of *Corymbia hamersleyana* over a sparse tall shrubland of *Acacia inaequilatera* over a sparse low shrubland of *Acacia pyrifolia* and *Indigofera monophylla* over hummock grassland of *Triodia ? wiseana* on rocky hillslopes.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia ? *wiseana*	30.0	00.50		
Acacia inaequilatera	06.0	02.50		
Indigofera monophylla	01.0	00.50		
Corymbia hamersleyana	01.0	06.00		
Acacia pyrifolia	00.5	01.20		
Acacia monticola	00.2	01.50		
Polycarpaea corymbosa	00.1	00.10		
Eriachne pulchella subsp. *dominii*	00.1	00.20		
Hybanthus aurantiacus	00.1	00.40		
Bonamia pannosa	00.1	00.10		
Senna glutinosa subsp. *glutinosa*	00.1	01.00		
Bulbostylis barbata	00.1	00.10		
Trigastrotheca molluginea	00.1	00.10		
Solanum lasiophyllum	00.1	00.30		
Cleome viscosa	00.1	00.30		
Grevillea pyramidalis	00.1	00.80		
Ptilotus polystachyus	00.1	00.05		
Boerhavia coccinea	00.1	00.30		
Grevillea wickhamii	00.1	01.50		

Site:	Q032	**Type:**	Quadrat (50 m x 50 m)
Date(s):	15 June 2017	**Position:**	-21.6728535498, 117.85688588
Total vegetation cover (%):	40	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	2	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	2	**Soil:**	clay loam
Grass cover (%):	36	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016) Eremaean		
Vegetation description:	Low open woodland of *Corymbia hamersleyana* over a tall sparse shrubland of *Grevillea pyramidalis* and *Acacia inaequilatera* over a low sparse shrubland of *Indigofera monophylla* over *Triodia ? wiseana* and*Triodia epactia* on stony hillslopes		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia ? *wiseana*	25.0	00.50		
Triodia epactia	10.0	00.60		
Indigofera monophylla	03.0	00.50		
Acacia inaequilatera	02.0	02.00		
Corymbia hamersleyana	01.5	06.00		
Grevillea pyramidalis	00.5	01.50		
Solanum lasiophyllum	00.1	00.30		
Acacia tumida var. *pilbarensis*	00.1	01.50		
Acacia pyrifolia	00.1	01.20		
Polycarpaea corymbosa	00.1	00.05		
Trichodesma zeylanicum	00.1	01.20		
Bulbostylis barbata	00.1	00.10		
Senna glutinosa subsp. *pruinosa*	00.1	01.00		
Bonamia pannosa	00.1	00.05		
Senna glutinosa subsp. *glutinosa*	00.1	00.80		
Tribulus platypterus	00.1	01.00		

Site:	Q035	**Type:**	Quadrat (50 m x 50 m)
Date(s):	16 June 2017	**Position:**	-21.3206499632, 117.936306009
Total vegetation cover (%):	40	**Topography:**	plain
Tree/shrub cover >2 m (%):	1	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	38	**Rock type:**	ferrous - ironstone
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low sparse woodland of *Corymbia hamersleyana* over a tall sparse shrubland of *Acacia pyrifolia, Acacia inaequilatera* and *Acacia acradenia* over a hummock grassland of *Triodia wiseana* on stony soils on plains.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana	38.0	00.60		
Corymbia hamersleyana	01.0	02.50		
Acacia inaequilatera	00.3	02.00		
Eriachne pulchella subsp. *dominii*	00.3	00.10		
Acacia pyrifolia	00.2	00.60		
Pluchea tetranthera	00.1	00.40		
Trigastrotheca molluginea	00.1	00.10		
Bulbostylis barbata	00.1	00.10		
Tephrosia clementii	00.1	00.10		
Ptilotus calostachyus	00.1	00.50		
Goodenia stobbsiana	00.1	00.40		
Polycarpaea corymbosa	00.1	00.05		
Senna glutinosa subsp. *pruinosa*	00.1	01.20		
Acacia acradenia	00.1	02.00		

Site:	R002	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8068943771, 117.740540195
Total vegetation cover (%):	50	**Topography:**	plain
Tree/shrub cover >2 m (%):	0.1	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	0.1	**Soil:**	clay loam
Grass cover (%):	50	**Rock type:**	quartz
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Sparse shrubland of *Acacia bivenosa and Acacia inaequilatera* over grassland of *Eragrostis xerophylla*, and*Triodia epactia*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Acacia inaequilatera				
Acacia bivenosa				
Triodia epactia				
Eragrostis xerophila				

Site:	R024	**Type:**	Relevé (unbound)
Date(s):	13 June 2017	**Position:**	-20.960989, 117.77712
Total vegetation cover (%):	65	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	25	**Soil colour:**	red-brown
Shrub cover <2 m (%):	5	**Soil:**	gravel / alluvial, sand
Grass cover (%):	40	**Rock type:**	granite rocks
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall shrubland of *Acacia acradenia* and *Acacia tenuissima* with scattered *Acacia pyrifolia* var. *pyrifolia* and *Grevillea pyramidalis* and scattered *Corymbia hamersleyana* trees over a hummock grassland of *Triodia ? brizoides*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia ? *brizoides*	40.0	00.60		
Acacia acradenia	20.0	02.50		
Acacia tenuissima	05.0	02.00		
Acacia pyrifolia var. *pyrifolia*	00.5	01.20		
Grevillea pyramidalis	00.5	02.00		
Indigofera trita	00.1	00.30		
Eriachne mucronata	00.1	00.30		
Phyllanthus maderaspatensis	00.1	00.30		
Trigastrotheca molluginea	00.1	00.10		
Bonamia ? *linearis*	00.1	00.10		
Rubiaceae sp.	00.1	00.20		
Indigofera monophylla	00.1	00.60		
Polycarpaea corymbosa	00.1	00.05		
Oldenlandia crouchiana	00.1	00.10		
Ptilotus polystachyus	00.1	00.05		
Boerhavia coccinea	00.1	00.10		
Corymbia hamersleyana	00.1	02.00		
Senna notabilis	00.1	00.20		
Triumfetta clementii	00.1	00.30		
Bonamia pannosa	00.1	00.10		

Eriachne pulchella subsp. *dominii*	00.1	00.10
Evolvulus alsinoides var. *decumbens*	00.1	00.20
Euphorbia australis var. *subtomentosa*	00.1	00.10
Streptoglossa ? *liatroides*	00.1	00.10
Tephrosia clementii	00.1	00.10
Cleome viscosa	00.1	00.30
Iseilema dolichotrichum	00.1	00.05
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	00.1	00.30
Bulbostylis barbata	00.1	00.10

Site:	R003	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8051563486, 117.740254153
Total vegetation cover (%):	50	**Topography:**	plain
Tree/shrub cover >2 m (%):	0.1	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	1	**Soil:**	clay loam
Grass cover (%):	50	**Rock type:**	quartz
Herb cover (%):	5	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Isolated trees of *Acacia inaequilatera* over a sparse herbland of *Rhynchosia minima* and *Indigofera trita* in tussock grassland of *Eragrostis xerophila*, and *Sorghum timorense*on flat plain		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Sorghum timorense				
Indigofera trita				
Rhynchosia minima				
Acacia inaequilatera				
Eragrostis xerophila				

Site:	R031	**Type:**	Relevé (unbounded)
Date(s):	15 June 2017	**Position:**	-21.684802, 117.850453
Total vegetation cover (%):	40	**Topography:**	creek
Tree/shrub cover >2 m (%):	15	**Soil colour:**	brown
Shrub cover <2 m (%):	7	**Soil:**	sand
Grass cover (%):	25	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Open woodland of *Corymbia hamersleyana* over tall shrubland of *Acacia tumida* var. *pilbarensis* and *Acacia elachantha* over low sparse shrubland of *Acacia monticola* over grassland of **Setaria verticillata*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Setaria verticillata	20.0	00.80	*	
Acacia tumida var. *pilbarensis*	15.0	02.50		
Cyperus vaginatus	02.0	01.00		
Corymbia hamersleyana	02.0	06.00		
Cymbopogon ambiguus	01.5	00.80		
Acacia bivenosa	01.0	01.70		
Acacia monticola	01.0	00.70		
Melaleuca linophylla	01.0	02.50		
Indigofera monophylla	01.0	00.50		
Acacia inaequilatera	00.5	02.20		
Acacia elachantha	00.5	03.50		
Acacia ? *coriacea* subsp. *pendens*	00.3	04.00		
Pterocaulon sphacelatum	00.1	00.60		
Senna artemisioides subsp. *helmsii* x *oligophylla*	00.1	00.50		
Corchorus lasiocarpus subsp. *parvus*	00.1	00.30		
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	00.1	00.20		
Senna glutinosa subsp. *glutinosa*	00.1	01.20		
Euphorbia biconvexa	00.1	00.20		
Goodenia stobbsiana	00.1	00.20		
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	00.1	01.20		

Cleome viscosa	00.1	00.20
Boerhavia coccinea	00.1	00.20
Eriachne aristidea	00.1	00.30
Acacia monticola x *trachycarpa*	00.1	01.80
Dichanthium sericeum subsp. *humilius*	00.1	00.70
Grevillea wickhamii	00.1	01.80
Trachymene oleracea subsp. *oleracea*	00.1	00.30

Site:	R033	**Type:**	Relevé (unbounded)
Date(s):	15 June 2017	**Position:**	-21.67354, 117.856773
Total vegetation cover (%):	15	**Topography:**	creek
Tree/shrub cover >2 m (%):	3	**Soil colour:**	red-brown
Shrub cover <2 m (%):	5	**Soil:**	rocks
Grass cover (%):	10	**Rock type:**	granite rocks
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open woodland of *Corymbia hamersleyana* and *Terminalia circumalata* over sparse shrubland of *Melaleuca linophylla* and *Acacia tumida* var. *pilbarensis* over hummock grassland of*Triodia* sp. (resinous).		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia sp. (resinous)	02.0	00.50		
Corymbia hamersleyana	02.0	08.00		
Cyperus vaginatus	02.0	01.00		
Terminalia circumalata	01.0	03.50		
Melaleuca linophylla	00.5	02.00		
Acacia tumida var. *pilbarensis*	00.3	02.00		
Rhynchosia minima	00.3	00.20		
Goodenia lamprosperma	00.1	00.30		
Crotalaria medicaginea var. *neglecta*	00.1	00.40		
Tinospora smilacina	00.1	00.30		
Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)	00.1	00.03		
Eragrostis tenellula	00.1	00.20		
Streptoglossa decurrens	00.1	00.50		
Ammannia multiflora	00.1	00.30		
Acacia ? *coriacea* subsp. *pendens*	00.1	02.50		
Sesbania cannabina	00.1	01.00		
Fimbristylis cephalophora	00.1	00.20		
Isotropis atropurpurea	00.1	00.25		
Trachymene oleracea subsp. *oleracea*	00.1	00.20		

Terminalia sp.	00.1	02.00		
Lobelia arnhemiaca	00.1	00.10		
Hibiscus leptocladus	00.1	00.40		
Trichodesma zeylanicum	00.1	00.40		
Senna notabilis	00.1	00.40		
Solanum orbiculatum	00.1	00.20		
Acacia monticola	00.1	00.70		
Indigofera monophylla	00.1	00.50		
Eriachne aristidea	00.1	00.30		
Cleome viscosa	00.1	00.50		
Pluchea tetranthera	00.1	00.30		
Flaveria trinervia			*	
Acacia ? *fecunda*				P3 (WC Act)

Site:	R004	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.810057887, 117.740504538
Total vegetation cover (%):	40	**Topography:**	plain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	orange-brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	40	**Rock type:**	quartz
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tussock grassland of *Eragrostis xerophila*, over a sparse herbland of *Rhynchosia minima* on flat plain		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Rhynchosia minima				
Eragrostis xerophila				

Site:	R005	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8135982146, 117.741042255
Total vegetation cover (%):	40	**Topography:**	plain
Tree/shrub cover >2 m (%):	1	**Soil colour:**	red-brown
Shrub cover <2 m (%):	5	**Soil:**	sandy clay
Grass cover (%):	35	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open woodland of *Corymbia hamersleyana* and *Eucalyptus leucophloia* over sparse shrubland of *Acacia pyrifolia*, *Acacia inaequilatera*, *Acacia ancistrocarpa* and *Acacia bivenosa* over hummock grassland of *Triodia epactia* on sandy clay soils		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia epactia				
Acacia bivenosa				
Acacia ancistrocarpa				
Acacia inaequilatera				
Acacia pyrifolia				
Eucalyptus leucophloia				
Corymbia hamersleyana				

Site:	R006	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8200415325, 117.741321721
Total vegetation cover (%):		**Topography:**	drainage line
Tree/shrub cover >2 m (%):		**Soil colour:**	
Shrub cover <2 m (%):		**Soil:**	
Grass cover (%):		**Rock type:**	
Herb cover (%):		**Fire age:**	not evident
Disturbance details:	grazing		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Open *Eucalyptus victrix* and *Corymbia hamersleyana* woodland over a tall open *Acacia monticola x trachycarpa* shrubland over low **Cenchrus ciliaris* tussock grassland with isolated *Tiodia* spp. grasses on sandy soils		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia lanigera				
Triodia epactia				
Cenchrus ciliaris			*	
Eucalyptus victrix				
Acacia monticola x *trachycarpa*				
Corymbia hamersleyana				

Site:	R007	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8390195942, 117.736025081
Total vegetation cover (%):		**Topography:**	plain
Tree/shrub cover >2 m (%):		**Soil colour:**	red-brown
Shrub cover <2 m (%):		**Soil:**	sandy clay
Grass cover (%):		**Rock type:**	none
Herb cover (%):		**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open woodland of *Corymbia hamersleyana* and *Eucalyptus leucophloia* over sparse shrubland of *Acacia pyrifolia, Acacia inaequilatera*, *Acacia ancistrocarpa* and *Acacia bivenosa* over hummock grassland of*Triodia wiseana* on flood plain		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia wiseana				
Acacia bivenosa				
Acacia inaequilatera				
Acacia pyrifolia				
Eucalyptus leucophloia				
Corymbia hamersleyana				

Site:	R008	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-20.8466059132, 117.73334384
Total vegetation cover (%):		**Topography:**	plain
Tree/shrub cover >2 m (%):		**Soil colour:**	brown red
Shrub cover <2 m (%):		**Soil:**	silty sand
Grass cover (%):		**Rock type:**	none
Herb cover (%):		**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Tall open *Acacia ancistrocarpa*, *A. pyrifolia* and *Grevillea pyramidalis* shrubland over low open *Acacia bivenosa* and *A. stellaticeps* shrubland over mid *Triodia* spp. hummock grassland on plain in brown red silty sand soils		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Triodia epactia				
Acacia stellaticeps				
Acacia bivenosa				
Grevillea pyramidalis				
Acacia pyrifolia				
Acacia ancistrocarpa				

Site:	R009	**Type:**	Relevé (unbounded)
Date(s):	16 June 2017	**Position:**	-21.7155940839, 117.813386596
Total vegetation cover (%):	25	**Topography:**	plain
Tree/shrub cover >2 m (%):	0	**Soil colour:**	red brown
Shrub cover <2 m (%):	10	**Soil:**	cracking clays
Grass cover (%):	2	**Rock type:**	granite
Herb cover (%):	20	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Open herbland of *Streptoglossa bubakii*, *Sida fibulifera*, *Phyllanthus maderaspatensis*, *Rhynchosia minima*, *Cleome viscosa*, *Senna notabilis* and **Flaveria trinervia* over mixed grassland on a flat plain of cracking clays with large granite rocks.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Flaveria trinervia			*	
Senna notabilis				
Cleome viscosa				
Rhynchosia minima				
Phyllanthus maderaspatensis				
Sida fibulifera				
Streptoglossa bubakii				

Appendix 2 NVIC Information Hierarchy (ESCAVI 2003) and comparable WA current practice (from EPA 2016d)

Western Australia Current Practice			National Standard		
Hierarchy of terms	**Brief description in WA**	**Indicative scale**	**NVIS Level**	**Description**	**NVIS structural/floristic components required**
Vegetation formation	Structure and growth form – Forest, Woodland.	1:5 000 000	I	Class	Dominant growth form for the ecologically or structurally dominant stratum.
Vegetation sub-formation	Structural and dominant vegetation layer - Eucalypt Forest, Banksia Woodland.	1:2 500 000	II	Structural Formation	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
Vegetation association	Structural form and dominant species - Medium woodland; York gum (Eucalyptus loxophleba) & Wandoo	1:1 000 000 to 1:250 000	III	Broad Floristic Formation	Dominant growth form, cover, height and dominant land cover genus for the uppermost or dominant stratum.
Vegetation complex	Structural and floristic description linked to geomorphology – Quindalup Complex.	1:250 000 to 1:100 000	IV	Sub-Formation	Dominant growth form, cover, height and dominant genus and Family for the three traditional strata. (i.e. Upper, Mid and Ground).
Vegetation type	Floristic definition by strata with structural detail. Often represented with a code and floristic description.	1:100 000 to 1:10 000	V	Association	Dominant growth form, height, cover and up to 3 species for the three traditional strata. (i.e. Upper, Mid and Ground).
Plant community	Basic unit of vegetation classification, site specific and highly localised with detailed floristics for each stratum.	1:10 000	VI	Sub-Association	Dominant growth form, height, cover and up to 5 species for all layers/strata.
Floristic Community Type	Floristic composition definition; e.g. Northern banksia woodlands over herb rich shrublands on the Swan Coastal Plain.	No absolute scale			

Appendix 3 Terrestrial fauna survey site descriptions

Habitat: grassland

Site: **BT001 (Transect) (-21.004088, 117.882238)**

Habitat description: Mosaic of spinifex grassland and shrubland on deep sandy soils.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: red brown

Rock type: none

Fire age: >5 years

Disturbance: evidence of feral animals

Site: **BT002 (Transect) (-21.013431, 117.887282)**

Habitat description: Excellent condition, mature spinifex grassland, with pockets of shrubland, on deep sandy soils.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: red brown

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks

Site: **BT006 (Transect) (-21.106231, 117.925619)**

Habitat description: Grassland of low spinifex and aristida spp. and shrubland associate with creekline. Heavily grazed. Deep granite derived soils.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: yellow, brown

Rock type: none

Fire age: >5 years

Disturbance: evidence of feral animals, grazing – high, livestock tracks

Site: **BT007 (Transect) (-21.113049, 117.933357)**

Habitat description: Grassland of low spinifex and aristida spp. Heavily grazed. Deep granite derived soils.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: brown, yellow

Rock type: granite - bolders

Fire age: 1-5 years

Disturbance: evidence of feral animals, grazing – high, livestock tracks

Site:	**BT008 (Transect) (-21.123541, 117.936269)**
Habitat description:	Grassland of low spinifex and aristida spp. and shrubland associate with creekline. Heavily grazed. Deep granite derived soils.
Topography:	plain
Slope:	negligible
Soil:	sand
Soil colour:	brown
Rock type:	Granite boulders and pebbles
Fire age:	>5 years
Disturbance:	Evidence of feral animals; grazing-high

Site:	**BT009 (Transect) (-21.133887, 117.937285)**
Habitat description:	Grassland of low spinifex and aristida spp. and shrubland associate with creekline. Heavily grazed. Deep granite derived soils.
Topography:	plain
Slope:	negligible
Soil:	sand
Soil colour:	brown
Rock type:	granite
Fire age:	1–5 years
Disturbance:	evidence of feral animals; grazing-high

Site: **BT010 (Transect) (-20.812113, 117.740993)**

Habitat description: Spinifex grassland on gibber plain.

Topography: plain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: red brown

Rock type: basalt

Fire age: >5 years

Disturbance: grazing – medium, livestock tracks, vehicle tracks

Site: **BT011 (Transect) (-20.820803, 117.741523)**

Habitat description: Spinifex grassland on moderate creekline - highly eroded.

Topography: creek

Slope: negligible

Soil: sand

Soil colour: red–brown, yellow

Rock type:

Fire age: >5 years

Disturbance: erosion channels, evidence of feral animals, livestock tracks, weed infestation

Site: **BT012 (Transect) (-20.836353, 117.737169)**

Habitat description: Spinifex grassland, on soil relatively deep sandy soils.

Topography: plain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: red–brown

Rock type: none

Fire age: >5 years

Disturbance: grazing – medium, livestock tracks, vehicle tracks

Site: **BT013 (Transect) (-20.844562, 117.73446)**

Habitat description: Spinifex grassland, on soil relatively deep sandy soils.

Topography: plain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: red–brown

Rock type: none

Fire age: >5 years

Disturbance: grazing – medium, livestock tracks, vehicle tracks

Habitat: open woodland

Site: **BAT004 (Targeted Fauna Species Site) (-21.670322, 117.85729)**

Habitat description: Water pools in gorge.

Topography: gorge

Slope: steep

Soil: clay loam

Soil colour: red brown

Rock type: ferrous - ironstone

Fire age: >5 years

Disturbance: none

Site: **BT014 (Transect) (-21.007496, 117.885195)**

Habitat description: Open woodland on major creekline. Deep sandy soils in channel and on banks.

Topography: river

Slope: negligible

Soil: sand,

Soil colour: red–orange,

Rock type: none

Fire age: >5 years

Disturbance: evidence of feral animals

Site: **CT004a (Targeted Fauna Species Site) (-22.056843, 117.48202)**

Habitat description: Open woodland on rocky slope of minor ridge.

Topography: hill slope

Slope: steep

Soil: sandy clay, sandy loam

Soil colour: red-brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site: **CT004b (Targeted Fauna Species Site) (-22.056475, 117.481799)**

Habitat description: Open woodland on rocky slope of minor ridge.

Topography: hill slope

Slope: steep

Soil: sandy clay, sandy loam

Soil colour: red-brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site: **CT006a (Targeted Fauna Species Site) (-22.047824, 117.50149)**

Habitat description: Tall shrubland over mature spinifex hummock grassland in floodplain.

Topography: floodplain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: 1-5 years

Disturbance: none

Site: **CT006b (Targeted Fauna Species Site) (-22.048124, 117.501635)**

Habitat description: Tall shrubland over mature spinifex hummock grassland in floodplain.

Topography: floodplain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site:	**CT007a (Targeted Fauna Species Site) (-21.671225, 117.856579)**
Habitat description:	Steep gorge opening onto plain. A number of water pools present. No evidence of cattle presence.
Topography:	gorge
Slope:	steep
Soil:	sandy clay, sandy loam
Soil colour:	red-brown
Rock type:	basalt
Fire age:	>5 years
Disturbance:	none

Site:	**CT007b (Targeted Fauna Species Site) (-21.67101, 117.856787)**
Habitat description:	Steep gorge opening onto plain. A number of water pools present. No evidence of cattle presence.
Topography:	gorge
Slope:	steep
Soil:	sandy clay, sandy loam
Soil colour:	red-brown
Rock type:	basalt
Fire age:	>5 years
Disturbance:	none

Site: **CT008a (Targeted Fauna Species Site) (-21.476059, 117.916999)**

Habitat description: Open woodland on steep rock ridge. Abundant rockfall and well shaded, adjacent to water pool.

Topography: river

Slope: negligible

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: evidence of feral animals, livestock tracks, weed infestation

Site: **CT008b (Targeted Fauna Species Site) (-21.476116, 117.917081)**

Habitat description: Open woodland on steep rock ridge. Abundant rockfall and well shaded, adjacent to water pool.

Topography: river

Slope: negligible

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: evidence of feral animals, livestock tracks, weed infestation

Site: **CT008c (Targeted Fauna Species Site) (-21.476426, 117.917466)**

Habitat description: Open woodland on steep rock ridge. Abundant rockfall and well shaded, adjacent to water pool.

Topography: river

Slope: negligible

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: evidence of feral animals, livestock tracks, weed infestation

Site: **CT010a (Targeted Fauna Species Site) (-21.507295, 117.94092)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: steep

Soil: sandy clay, sandy loam

Soil colour: red-brown

Rock type: basalt

Fire age: >5 years

Disturbance: none

Site: **CT010b (Targeted Fauna Species Site) (-21.507312, 117.941029)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: steep

Soil: sandy clay, sandy loam

Soil colour: red-brown

Rock type: basalt

Fire age: >5 years

Disturbance: none

Site: **CT010c (Targeted Fauna Species Site) (-21.507252, 117.941106)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: steep

Soil: sandy clay, sandy loam

Soil colour: red-brown

Rock type: basalt

Fire age: >5 years

Disturbance: none

Habitat: shrubland

Site: **BAT005 (Targeted Fauna Species Site) (-21.488275, 117.926894)**

Habitat description: Pool on major river.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: orange

Rock type: basalt

Fire age: >5 years

Disturbance: none

Site: **BT003 (Transect) (-21.025337, 117.891806)**

Habitat description: Mosaic of shrubland and spinifex grassland on deep sandy soils. Mature hummocks throughout.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: red brown

Rock type: none

Fire age: >5 years

Disturbance: none

Site: **BT004 (Transect) (-21.034193, 117.893761)**

Habitat description: Dense mosaic of spinifex grassland and shrubland on deep sandy soils. Mature hummocks throughout.

Topography: plain

Slope: negligible

Soil: sand

Soil colour: red brown

Rock type: none

Fire age: >5 years

Disturbance: none

Site: **BT005 (Transect) (-21.046713, 117.893063)**

Habitat description: Mosaic of shrubland and spinifex grassland. Mature hummocks throughout. Sandy soils in eastern half, clay loam with outcropping ironstone and pebbles in western half.

Topography: plain

Slope: negligible

Soil: sand, sandy clay

Soil colour: red–brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site: **CT005a (Targeted Fauna Species Site) (-22.031928, 117.514466)**

Habitat description: Dense shruland between hills in broad floodplain.

Topography: floodplain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site: **CT005b (Targeted Fauna Species Site) (-22.031876, 117.514637)**

Habitat description: Dense shruland between hills in broad floodplain.

Topography: floodplain

Slope: negligible

Soil: sandy clay, sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: none

Site: **CT009a (Targeted Fauna Species Site) (-21.488038, 117.927132)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: moderate

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: grazing – low, livestock tracks, vehicle tracks

Site: **CT009b (Targeted Fauna Species Site) (-21.487937, 117.926961)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: moderate

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: grazing – low, livestock tracks, vehicle tracks

Site: **CT009c (Targeted Fauna Species Site) (-21.487752, 117.92676)**

Habitat description: Mosaic of shrubland over spinifex grassland at base of large rocky hill.

Topography: hill slope

Slope: moderate

Soil: sandy loam

Soil colour: brown

Rock type: ferrous - Ironstone

Fire age: >5 years

Disturbance: grazing – low, livestock tracks, vehicle tracks

Appendix 4 Flora species inventory

Family	Species
Aizoaceae	*Trianthema pilosum*
Aizoaceae	*Trianthema triquetrum*
Amaranthaceae	**Aerva javanica*
Amaranthaceae	*Amaranthus induratus*
Amaranthaceae	*Gomphrena canescens*
Amaranthaceae	*Gomphrena canescens* subsp. *canescens*
Amaranthaceae	*Ptilotus aervoides*
Amaranthaceae	*Ptilotus arthrolasius*
Amaranthaceae	*Ptilotus astrolasius*
Amaranthaceae	*Ptilotus axillaris*
Amaranthaceae	*Ptilotus calostachyus*
Amaranthaceae	*Ptilotus clementii*
Amaranthaceae	*Ptilotus fusiformis*
Amaranthaceae	*Ptilotus gomphrenoides*
Amaranthaceae	*Ptilotus incanus*
Amaranthaceae	*Ptilotus nobilis*
Amaranthaceae	*Ptilotus obovatus*
Amaranthaceae	*Ptilotus polystachyus*
Amaranthaceae	*Carissa lanceolata*
Amaranthaceae	*Cynanchum floribundum*
Araliaceae	*Trachymene oleracea* subsp. *oleracea*
Asteraceae	**Flaveria trinervia*
Asteraceae	*Pluchea tetranthera*
Asteraceae	*Pterocaulon sphacelatum*
Asteraceae	*Streptoglossa ?liatroides*
Asteraceae	*Streptoglossa ?tenuiflora*
Asteraceae	*Streptoglossa decurrens*
Asteraceae	*Streptoglossa* sp.
Boraginaceae	*Heliotropium cunninghamii*
Boraginaceae	*Heliotropium muticum* (P3)
Boraginaceae	*Heliotropium ovalifolium*
Boraginaceae	*Trichodesma zeylanicum*
Campanulaceae	*Lobelia arnhemiaca*
Campanulaceae	**Wahlenbergia capensis*
Caryophyllaceae	*Polycarpaea corymbosa*
Caryophyllaceae	*Polycarpaea longiflora*

Family	Species
Chenopodiaceae	*Dysphania rhadinostachya*
Chenopodiaceae	*Dysphania rhadinostachya* subsp. *rhadinostachya*
Chenopodiaceae	*Salsola australis*
Chenopodiaceae	*Sclerolaena ?lanicuspis*
Chenopodiaceae	*Sclerolaena cornishiana*
Chenopodiaceae	*Sclerolaena costata*
Cleomaceae	*Cleome viscosa*
Combretaceae	*Terminalia circumalata*
Combretaceae	*Terminalia* sp.
Convolvulaceae	?*Bonamia pilbarensis*
Convolvulaceae	*Bonamia ?linearis*
Convolvulaceae	*Bonamia ?pilbarensis*
Convolvulaceae	*Bonamia erecta*
Convolvulaceae	*Bonamia pannosa*
Convolvulaceae	*Bonamia pilbarensis*
Convolvulaceae	*Bonamia rosea*
Convolvulaceae	*Evolvulus alsinoides* var. *decumbens*
Convolvulaceae	*Operculina aequisepala*
Convolvulaceae	*Polymeria calycina*
Cucurbitaceae	*Cucumis variabilis*
Cyperaceae	?*Cyperus* sp.
Cyperaceae	*Bulbostylis barbata*
Cyperaceae	*Cyperus vaginatus*
Cyperaceae	*Fimbristylis cephalophora*
Cyperaceae	*Fimbristylis simulans*
Euphorbiaceae	*Euphorbia australis*
Euphorbiaceae	*Euphorbia australis* var. *subtomentosa*
Euphorbiaceae	*Euphorbia biconvexa*
Euphorbiaceae	*Euphorbia boophthona*
Euphorbiaceae	*Euphorbia coghlanii*
Fabaceae	*Acacia ?bivenosa*
Fabaceae	*Acacia ?coriacea* subsp. *pondens*
Fabaceae	*Acacia ?fecunda*
Fabaceae	*Acacia acradenia*
Fabaceae	*Acacia ampliceps*
Fabaceae	*Acacia ancistrocarpa*
Fabaceae	*Acacia arida*

Family	Species
Fabaceae	*Acacia atkinsiana*
Fabaceae	*Acacia bivenosa*
Fabaceae	*Acacia citrinoviridis*
Fabaceae	*Acacia colei*
Fabaceae	*Acacia dictyophleba*
Fabaceae	*Acacia elachantha*
Fabaceae	*Acacia inaequilatera*
Fabaceae	*Acacia monticola*
Fabaceae	*Acacia monticola* x *trachycarpa*
Fabaceae	*Acacia pruinocarpa*
Fabaceae	*Acacia pyrifolia*
Fabaceae	*Acacia pyrifolia* var. *pyrifolia*
Fabaceae	*Acacia spondylophylla*
Fabaceae	*Acacia stellaticeps*
Fabaceae	*Acacia synchronicia*
Fabaceae	*Acacia tenuissima*
Fabaceae	*Acacia tumida* var. *pilbarensis*
Fabaceae	*Alysicarpus muelleri*
Fabaceae	*Cajanus cinereus*
Fabaceae	*Crotalaria medicaginea* var. *neglecta*
Fabaceae	*Cullen leucochaites*
Fabaceae	*Indigofera colutea*
Fabaceae	*Indigofera linifolia*
Fabaceae	*Indigofera monophylla*
Fabaceae	*Indigofera trita*
Fabaceae	*Isotropis atropurpurea*
Fabaceae	*Rhynchosia bungarensis* (P4)
Fabaceae	*Rhynchosia minima*
Fabaceae	*Senna artemisioides* subsp. *helmsii* x *oligophylla*
Fabaceae	*Senna artemisioides* subsp. *oligophylla*
Fabaceae	*Senna glutinosa* subsp. *glutinosa*
Fabaceae	*Senna glutinosa* subsp. *pruinosa*
Fabaceae	*Senna glutinosa* subsp. x *luerssenii*
Fabaceae	*Senna notabilis*
Fabaceae	*Sesbania cannabina*
Fabaceae	*Swainsona* ?*stenodonta*
Fabaceae	*Swainsona formosa*

Family	Species
Fabaceae	*Tephrosia clementii*
Fabaceae	*Tephrosia* sp. Bungaroo Creek *(M.E. Trudgen 11601)*
Fabaceae	*Tephrosia* sp. Fortescue *(A.A. Mitchell 606)*
Fabaceae	**Vachellia farnesiana*
Fabaceae	*Vigna* sp. Hamersley Clay *(A.A. Mitchell PRP 113)*
Fabaceae	*Zornia albiflora*
Goodeniaceae	*Dampiera candicans*
Goodeniaceae	*Goodenia* ?*forrestii*
Goodeniaceae	*Goodenia cusackiana*
Goodeniaceae	*Goodenia lamprosperma*
Goodeniaceae	*Goodenia microptera*
Goodeniaceae	*Goodenia muelleriana*
Goodeniaceae	*Goodenia nuda* (P4)
Goodeniaceae	*Goodenia* sp.
Goodeniaceae	*Goodenia stobbsiana*
Haloragaceae	*Gonocarpus ephemerus*
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*
Lauraceae	*Cassytha capillaris*
Lythraceae	*Ammannia multiflora*
Malvaceae	*Abutilon amplum*
Malvaceae	*Abutilon lepidum*
Malvaceae	*Abutilon* sp. Dioicum (A.A. Mitchell PRP 1618)
Malvaceae	*Abutilon* ?sp. Dioicum
Malvaceae	*Abutilon* sp. Pritzelianum (S. van Leeuwen 5095) (P1)
Malvaceae	*Corchorus crozophorifolius*
Malvaceae	*Corchorus lasiocarpus* subsp. *parvus*
Malvaceae	*Corchorus tridens*
Malvaceae	*Gossypium australe*
Malvaceae	*Hibiscus coatesii*
Malvaceae	*Hibiscus leptocladus*
Malvaceae	*Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (P1)
Malvaceae	*Hibiscus sturtii* var. *campylochlamys*
Malvaceae	*Seringia* ?*elliptica*
Malvaceae	*Sida* ?*arsiniata*
Malvaceae	*Sida echinocarpa*
Malvaceae	*Sida fibulifera*
Malvaceae	*Sida rohlenae* subsp. *rohlenae*

Family	Species
Malvaceae	*Sida* sp. Pilbara *(A.A. Mitchell PRP 1543)*
Malvaceae	*Triumfetta appendiculata*
Malvaceae	*Triumfetta clementii*
Malvaceae	*Triumfetta maconochieana*
Malvaceae	*Triumfetta ramosa*
Menispermaceae	*Tinospora smilacina*
Molluginaceae	*Trigastrotheca molluginea*
Myrtaceae	*Corymbia hamersleyana*
Myrtaceae	*Eucalyptus leucophloia*
Myrtaceae	*Eucalyptus victrix*
Myrtaceae	*Melaleuca glomerata*
Myrtaceae	*Melaleuca linophylla*
Nyctaginaceae	*Boerhavia coccinea*
Phrymaceae	*Mimulus gracilis*
Phrymaceae	*Peplidium* sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)
Phyllanthaceae	*Notoleptopus decaisnei*
Phyllanthaceae	*Phyllanthus maderaspatensis*
Plantaginaceae	*Stemodia grossa*
Poaceae	*Aristida contorta*
Poaceae	*Aristida holathera*
Poaceae	**Cenchrus ciliaris*
Poaceae	*Chrysopogon fallax*
Poaceae	*Cymbopogon ambiguus*
Poaceae	*Dichanthium sericeum* subsp. *humilius*
Poaceae	*Enneapogon caerulescens*
Poaceae	*Enneapogon polyphyllus*
Poaceae	*Eragrostis cumingii*
Poaceae	*Eragrostis tenella*
Poaceae	*Eragrostis tenellula*
Poaceae	*Eragrostis xerophila*
Poaceae	*Eriachne aristidea*
Poaceae	*Eriachne mucronata*
Poaceae	*Eriachne pulchella* subsp. *dominii*
Poaceae	*Eulalia aurea*
Poaceae	*Iseilema dolichotrichum*
Poaceae	*Iseilema membranaceum*
Poaceae	*Paspalidium basicladum*

Family	Species
Poaceae	*Schizachyrium fragile*
Poaceae	**Setaria verticillata*
Poaceae	*Sorghum timorense*
Poaceae	*Sporobolus australasicus*
Poaceae	*Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3)
Poaceae	*Themeda triandra*
Poaceae	*Triodia ?basedowii*
Poaceae	*Triodia ?brizoides*
Poaceae	*Triodia ?epactia*
Poaceae	*Triodia ?wiseana*
Poaceae	*Triodia aff wiseana*
Poaceae	*Triodia angusta*
Poaceae	*Triodia basedowii*
Poaceae	*Triodia epactia*
Poaceae	*Triodia lanigera*
Poaceae	*Triodia* sp. (resinous)
Poaceae	*Triodia* sp. (sterile)
Poaceae	*Triodia wiseana*
Poaceae	*Yakirra australiensis*
Polygalaceae	*Polygala ?isingii*
Polygalaceae	*Polygala glaucifolia*
Portulacaceae	*Calandrinia quadrivalvis*
Portulacaceae	*Portulaca oleracea*
Portulacaceae	**Portulaca pilosa*
Proteaceae	*Grevillea pyramidalis*
Proteaceae	*Grevillea wickhamii*
Proteaceae	*Hakea chordophylla*
Proteaceae	*Hakea lorea* subsp. *lorea*
Rubiaceae	*Oldenlandia crouchiana*
Rubiaceae	Unidentified Rubiaceae species
Solanaceae	*Nicotiana benthamiana*
Solanaceae	**Solanum aviculare*
Solanaceae	*Solanum horridum*
Solanaceae	*Solanum lasiophyllum*
Solanaceae	*Solanum orbiculatum*
Violaceae	*Hybanthus aurantiacus*
Zygophyllaceae	*Tribulus hirsutus*

Family	Species
Zygophyllaceae	*Tribulus macrocarpus*
Zygophyllaceae	*Tribulus platypterus*
Zygophyllaceae	*Tribulus suberosus*