TORO ENERGY LIMITED

Level 3, 33 Richardson Street
West Perth WA 6005
Australia
PO Box 584
West Perth 6872
+61 8 9214 2100 t
+61 8 9226 2958 f
toroenergy.com.au

19 February 2014

Dr Paul Vogel
Chairman
Environmental Protection Authority
The Atrium Level 8,
168 St Georges Terrace
Perth WA 6000

Attention: Robert Hughes

Dear Dr Vogel

REFERRAL PURSUANT TO SECTION 38(1) OF THE ENVIRONMENTAL PROTECTION ACT 1986 – EXTENSION TO THE WILUNA URANIUM PROJECT

Please find attached a hard copy and electronic copy (two thumb drives) of a referral for an extension to the Wiluna Uranium Project.

Yours faithfully
TORO ENERGY LIMITED

Dr Vanessa Guthrie
Managing Director

Environmental Protection Authority

GOVERNMENT OF WESTERN AUSTRALIA

EPA REFERRAL FORM PROPONENT

Referral of a Proposal by the Proponent to the Environmental Protection Authority under Section 38(1) of the *Environmental Protection Act 1986*.

PURPOSE OF THIS FORM

Section 38(1) of the *Environmental Protection Act 1986* (EP Act) provides that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the EP Act. This form sets out the information requirements for the referral of a proposal by a proponent.

Proponents are encouraged to familiarise themselves with the EPA's *General Guide on Referral of Proposals* [see Environmental Impact Assessment/Referral of Proposals and Schemes] before completing this form.

A referral under section 38(1) of the EP Act by a proponent to the EPA must be made on this form. A request to the EPA for a declaration under section 39B (derived proposal) must be made on this form. This form will be treated as a referral provided all information required by Part A has been included and all information requested by Part B has been provided to the extent that it is pertinent to the proposal being referred. Referral documents are to be submitted in two formats – hard copy and electronic copy. The electronic copy of the referral will be provided for public comment for a period of 7 days, prior to the EPA making its decision on whether or not to assess the proposal.

CHECKLIST

Before you submit this form, please check that you have:

	Yes	No
Completed all the questions in Part A (essential).	x	
Completed all applicable questions in Part B.	x	
Included Attachment 1 – location maps.	x	
Included Attachment 2 – additional document(s) the proponent wishes to provide (if applicable).	x	
Included Attachment 3 – confidential information (if applicable).		X
Enclosed an electronic copy of all referral information, including spatial data and contextual mapping but excluding confidential information.	x	

Following a review of the information presented in this form, please consider the following question (a response is optional).

Do you consider the proposal requires formal environmental impact assessment? x☐ Yes ☐ No ☐ Not sure
If yes, what level of assessment? ☐ Assessment on Proponent Information x☐ Public Environmental Review

PROPONENT DECLARATION (to be completed by the proponent)

I, Dr Vanessa Guthrie *(full name)* declare that I am authorised on behalf of Toro Energy Limited (being the person responsible for the proposal) to submit this form and further declare that the information contained in this form is true and not misleading.

Signature 	Name - Dr Vanessa Guthrie
Position - Managing Director	Company - Toro Energy Limited
Date 19/02/14	

PART A - PROPONENT AND PROPOSAL INFORMATION

(All fields of Part A must be completed for this document to be treated as a referral)

1 PROPONENT AND PROPOSAL INFORMATION

1.1 Proponent

Name	Toro Energy Limited
Joint Venture parties (if applicable)	N/A
Australian Company Number (if applicable)	ABN 48 117 127 590
Postal Address (where the proponent is a corporation or an association of persons, whether incorporated or not, the postal address is that of the principal place of business or of the principal office in the State)	P O Box 584, West Perth WA 6872
Key proponent contact for the proposal: • name • address • phone • email	Dr Vanessa Guthrie P O Box 584, West Perth WA 6872 9214 2100 Vanessa.guthrie@toroenergy.com.au
Consultant for the proposal (if applicable): • name • address • phone • email	N/A

1.2 Proposal

Title	Extension to the Wiluna Uranium Project
Description	The proposal is the mining of uranium at two locations south of Wiluna, Western Australia. The locations are known as **Millipede** (approximately 30 kilometres (km) south of Wiluna) and **Lake Maitland** (105 km south east of Wiluna). The proponent, Toro Energy Limited (Toro) already has approval following EPA Assessment 1819 to mine uranium at two other locations near Wiluna, at Centipede and Lake Way, and to process uranium from those locations at a plant adjacent to the Centipede/Millipede deposits. It is proposed to use this plant to also process uranium mined at Millipede and Lake Maitland, thereby doubling the plant's operational life to beyond 20 years and reducing regional

	footprint and environmental impacts by reducing a duplication of operations and infrastructure. The other principal components of the proposal would include, but may not be limited to: development of infrastructure (roads, power and water source and supply facilities, access and haul roads, waste management facilities, including for tailings); transport of product by road to either Adelaide or Darwin for shipment; closure and rehabilitation of mined and other disturbed areas. The extension of the Wiluna Uranium Project would not increase the already assessed (EPA Assessment 1819) annual maximum production rate for the Project. The main effect of the proposed action would be to extend mining and processing by the Project from 10 years to beyond 20 years. Mining at Lake Maitland was the subject of a previous proposal (EPA Assessment 1821). As the new owner of Lake Maitland, Toro has withdrawn EPA Assessment 1821 and substitutes this proposal as the alternative development proposal. (In October 2009, Toro submitted to the EPA for assessment, the Wiluna Uranium Project. At that time, it was not the holder of the Millipede and Lake Maitland tenements. It acquired Millipede in January 2012 and Lake Maitland in November 2013).
Extent (area) of proposed ground disturbance.	1615 hectares (ha)
Timeframe in which the activity or development is proposed to occur (including start and finish dates where applicable).	Project timing is dependent on a range of factors including the duration of the environmental impact assessment and approval process and market circumstances. The following is a current indicative time frame: • Commence mine development at Millipede by late 2016 (mining to continue up to 2021) • Commence mine development at Lake Maitland by 2021 and continue mining for approximately

	six years Mining already assessed (EPA Assessment 1819) at Centipede would also commence in 2016 and at the already assessed (EPA Assessment 1819) Lake Way deposit by 2027. Mine closure and rehabilitation for the entire Project would be completed by 2039.
Details of any staging of the proposal.	The proposed action would be integrated into the already assessed (EPA Assessment 1819) Wiluna Uranium Project as a staged extension of that Project. Mine development would begin at Millipede and Centipede in late 2016 and continue up to 2021. Mine development would commence at Lake Maitland by 2021, with mining continuing for about six years. Mine development at Lake Way would commence by 2027 with mining continuing for up to six years. Ore mined from all four deposits would be processed at the already assessed (EPA Assessment 1819) plant adjacent to the Centipede/Millipede deposits. The capacity of the plant would not change but its operational life could extend to beyond 20 years. When Toro referred the original Wiluna Uranium Project for assessment in 2009, it comprised the Centipede and Lake Way deposits. At that time, Toro did not hold the Millipede and Lake Maitland tenements. There are environmental benefits in integrating Millipede and Lake Maitland into the Wiluna Uranium Project, including consolidation of processing activities and tailings storage and a smaller project footprint at Lake Maitland.
Is the proposal a strategic proposal?	No
Is the proponent requesting a declaration that the proposal is a derived proposal? If so, provide the following information on the strategic assessment within which the referred proposal was identified: • title of the strategic assessment; and	No

• Ministerial Statement number.	
Please indicate whether, and in what way, the proposal is related to other proposals in the region.	See above
Does the proponent own the land on which the proposal is to be established? If not, what other arrangements have been established to access the land?	Yes
What is the current land use on the property, and the extent (area in hectares) of the property?	Pastoral

1.3 Location

Name of the Shire in which the proposal is located.	Wiluna
For urban areas: • street address; • lot number; • suburb; and • nearest road intersection.	N/A
For remote localities: • nearest town; and • distance and direction from that town to the proposal site.	Wiluna - Millipede is 30 km south of Wiluna - Lake Maitland is 105 km south-east of Wiluna
Electronic copy of spatial data - GIS or CAD, geo-referenced and conforming to the following parameters: • GIS: polygons representing all activities and named; • CAD: simple closed polygons representing all activities and named; • datum: GDA94; • projection: Geographic (latitude/longitude) or Map Grid of Australia (MGA); • format: Arcview shapefile, Arcinfo coverages, Microstation or AutoCAD.	Enclosed?: Yes

1.4 Confidential Information

Does the proponent wish to request the EPA to allow any part of the referral information to be treated as confidential?	No
If yes, is confidential information attached as a separate document in hard copy?	NA

1.5 Government Approvals

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.		No	
Is approval required from any Commonwealth or State Government agency or Local Authority for any part of the proposal? If yes, please complete the table below.		Yes	
Agency/Authority	Approval required	Application lodged Yes / No	Agency/Local Authority contact(s) for proposal
Commonwealth Department of the Environment	Approval under *Environment Protection and Biodiversity*	Yes	C'th Department of the Environment

	Conservation Act 1999 **(this proposal)**		
Commonwealth Department of Industry	Approval to export product under Regulation 9 of the Customs (Prohibited Exports) Regulations under the *Customs Act 1901*	No	C'th Department of Industry
Australian Safeguards and Non-Proliferation Office (ASNO) (C'th)	Permit to process and transport nuclear material under the *Nuclear Non-Proliferation (Safeguards) Act 1987*	No	ASNO
Environmental Protection Authority of Western Australia (EPA)	Approval following assessment under Part IV of the *Environmental Protection Act 1986*	Yes **(this proposal)**	EPA
Western Australian Department of Mines and Petroleum (DMP)	Mining proposal (including mine closure and rehabilitation plan); project management plan; tailings operating strategy (*Mining Act 1978);* radiation management plan (*Mines Safety and Inspection Act 1994);* dangerous goods licence (*Dangerous Goods Safety Act 2004)*	No	DMP
Western Australian Department of Environmental Regulation (DER)	Licence under Part V of the *Environmental Protection Act 1986;* permits to take may be required under the *Wildlife Conservation Act 1950*	No	DER
Western Australian Department of Water (DOW)	Licence to abstract water; permit to disturb bed and banks under *Rights in Water and*	No	DOW

	Irrigation Act 1914		
Western Australian Radiological Council	Approval of radiation waste management plan; licensing of persons and premises under the *Radiation Safety Act 1975;* approval for storing, packing and transport of radioactive materials under the Radiation Safety (Transport of Radioactive Substances) Regulations 2002	No	Radiological Council
Western Australian Department of Aboriginal Affairs (DAA)	Consent to disturb Aboriginal heritage sites under Section 18 of the *Aboriginal Heritage Act 1972*	No	DAA
Native Title Holders and/or claimants	Agreements for land access pursuant to the *Native Title Act 1993* (C'th) and the *Native Title (State Provisions) Act 1999*	No	Millipede – Central Desert Native Title Services Lake Maitland – the Kultju People
Shire of Wiluna, Western Australia	Building applications and other consents under the *Planning and Development Act 2005*	No	Shire of Wiluna

PART B - ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT

2. ENVIRONMENTAL IMPACTS

Describe the impacts of the proposal on the following elements of the environment, by answering the questions contained in Sections 2.1-2.11:

2.1 flora and vegetation;

2.2 fauna;

2.3 rivers, creeks, wetlands and estuaries;

2.4 significant areas and/ or land features;

2.5 coastal zone areas;

2.6 marine areas and biota;

2.7 water supply and drainage catchments;

2.8 pollution;

2.9 greenhouse gas emissions;

2.10 contamination; and

2.11 social surroundings.

These features should be shown on the site plan, where appropriate.

For all information, please indicate:

(a) the source of the information; and

(b) the currency of the information.

2.1 Flora and Vegetation

2.1.1 Do you propose to clear any native flora and vegetation as a part of this proposal?

[A proposal to clear native vegetation may require a clearing permit under Part V of the EP Act (Environmental Protection (Clearing of Native Vegetation) Regulations 2004)]. Please contact the Department of Environment and Conservation (DEC) for more information.

(please tick) x Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section

2.1.2 How much vegetation are you proposing to clear (in hectares)?

Due to the distance between Millipede and Lake Maitland the polygon being submitted as part of this proposal is some 9498 ha.

Inside the polygon, the clearing has been estimated as follows:

Millipede

- 175 ha for mining
- 125 ha for support activities including below ground tailings storage and water management infrastructure
- 240 ha for stockpiles (low grade ore, top soil, subsoil etc)

Lake Maitland

- *6*10 ha for mining
- 190 ha for support infrastructure including administration and workshop, in-mine access and haul roads and water management infrastructure
- 275 ha for the haul road to link Lake Maitland with the processing plant adjacent to the Centipede/Millipede deposits

The total clearing for the proposal is expected to be up to 1615 ha.

2.1.3 Have you submitted an application to clear native vegetation to the DEC (unless you are exempt from such a requirement)?

☐ Yes x No **If yes**, on what date and to which office was the application submitted of the DEC?

2.1.4 Are you aware of any recent flora surveys carried out over the area to be disturbed by this proposal?

x Yes ☐ No

If yes, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s). Attachment 2.

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

Millipede

Lake Way and Centipede Baseline Vegetation and Flora Survey, unpublished report prepared for Toro Energy Limited, October 2007. Outback Ecology Services, Western Australia.

Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Lake Way, Centipede and borefield. Draft, unpublished report prepared for Toro Energy Limited, July 2011. Niche Environmental Services.

Lake Maitland

Lake Maitland Uranium Project Baseline Survey: Vegetation and Flora Surveys, May and November 2007 and May 2009. Outback Ecology Services, Western Australia.

2.1.5 Has a search of DEC records for known occurrences of rare or priority flora or threatened ecological communities been conducted for the site?

x Yes ☐ No

If you are proposing to clear native vegetation for any part of your proposal, a search of DEC records of known occurrences of rare or priority flora and threatened ecological communities will be required. Please contact DEC for more information.

2.1.6 Are there any known occurrences of rare or priority flora or threatened ecological communities on the site?

☐ Yes x No

If yes, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

2.1.7 If located within the Perth Metropolitan Region, is the proposed development within or adjacent to a listed Bush Forever Site? (You will need to contact the Bush Forever Office, at the Department for Planning and Infrastructure)

Not applicable

☐ Yes ☐ No **If yes**, please indicate which Bush Forever Site is affected (site number and name of site where appropriate).

2.1.8 What is the condition of the vegetation at the site?

At both Millipede and Lake Maitland, vegetation condition ranges from 'excellent' to 'degraded' with recorded degradation attributed to cattle, sheep, camel, kangaroo and rabbit grazing and disturbances from fire, vehicles and exploration activities.

2.2 Fauna

2.2.1 Do you expect that any fauna or fauna habitat will be impacted by the proposal?

(please tick) x Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.2.2 Describe the nature and extent of the expected impact.

Millipede

Nine major terrestrial vertebrate fauna habitats have been delineated in the project area.

- Melaleuca Grove - low closed to open forest of *Melaleuca xerophila* on sandy soils. This habitat occurs as fringing vegetation, particularly on inflow areas, between the samphire flats of Lake Way and upslope vegetation units.
- Mulga over Spinifex - Mulga *(Acacia aneura* var *aneura)* low open woodland over a hummock grassland of *Triodia melvillei* (spinifex) with a scattered shrub layer on sandy soils. Over the survey area this community ranges in structure from hummock grassland with a few scattered emergents through to a low woodland with a 10% to 30% upper storey tree cover.
- Eucalypt Woodland - low open woodland of *Eucalyptus striaticalyx* subsp. striaticalyx over a low sparse to dense shrubland of Pittosporum phylliraeoides ("weeping pittosporum"), *Eremophila* spp., and *Senna artemisioides* subsp. Filifolia ("punty bush") on loamy soils with deep leaf litter, logs and branches present.
- Mulga Woodland - low woodland of Mulga (*Acacia aneura* var *aneura*) over a low scrub of *Senna artemisioides* subsp *filifolia* and *Eremophila* spp. with an open low grass of *Aristida contorta* ("bunched kerosene grass") and *Enteropogon ramosus* ("curly windmill grass") on loamy soils with leaf litter, logs and branches present.
- Mallee over Spinifex - coppicing low open woodland of *Eucalyptus eremicola* subsp. peeneri over a hummock grassland of Triodia sp, with a scattered shrub layer of *Grevillea sarissa* subsp. *Succinct, Acacia* spp. and *Eremophila* spp on sandy soils.
- Woodland on Calcrete Flats - scattered Casuarina pauper over a low open scrub of *Acacia tetragonophylla* ("dead-finish" or "kurara") and *A. victoriae* ("elegant wattle") over very open herbs *Sclerolaena bicornis* ("goathead burr") over very open low grass of *Enneapogon caerulescens*.
- Samphire Flats - low heath of *Halosarcia* spp. over a scattered low grassland of *Eragrostis* spp.

- Claypan - bare claypan that is intermittently inundated, surrounded by a thin zonation (<20 m) of fringing vegetation consisting of *Eucalyptus camaldulensis* ("red gum") over a dense mixed shrub layer over a dense cover of grasses. At ground level leaf litter, logs and branches were present.
- Drainage Line / Floodplain - narrow drainage channel with an associated floodplain comprising a dense mixed shrubland of *Acacia* spp., *Olearia stuartii* ("rock daisy-bush" or "Stuart's daisy-bush"), *Senna* spp, and *Grevillea sarissa* subsp. *succincta*.

All habitats present over the areas surveyed are widely represented throughout the wider region and no critical habitat, World Heritage Properties, Ramsar Wetland Sites or Nationally Important Wetland sites occur in the Millipede locality.

Fauna surveys in the project area have recorded 31 mammals (20 native), 75 reptiles, 105 birds and 5 amphibians.

Stygofauna net samples from 104 drill holes across yielded 2,809 invertebrate specimens, of which 2,495 represented up to 50 stygofauna taxa. The Copepoda was the most abundant species group collected, with 1,416 samples representing more than half of the total collected.

Baseline subterranean fauna studies have shown that stygofauna occur in calcrete strata (or calcareous, non-cohesive sediments), but generally not in clayey sediments. The volume of calcrete to be removed as a result of mining would be a very minor proportion of the calcrete habitat available in the Lake Way playa area.

Lake Maitland

Nine broad fauna habitats have been identified at Lake Maitland and surrounding areas. With the exception of Kopi Dune, these habitats are widespread and common throughout the Murchison 1 bioregion.

- Lake Edge Spinifex: comprising almost exclusively of Bull Spinifex hummock grassland with some very low grasses and occasional low shrubs on sandy alluviums overlying calcretes. This habitat tends to occur as a band between the two calcrete habitats and the Samphire habitats

- Calcrete Plain: heavily grazed Wanderrie grasses on calcrete platforms with shallow red loam soils

- Kopi Dune: uncommon habitat in the landscape made up of dunes predominantly encrusted with gypsiferous sediments supporting large *Eucalyptus* species and a sparse understorey or *Lawrensia helmsii*

- Mallee Spinifex Sandplain: the vegetation typically comprises a low woodland of Mallee *(Eucalyptus eremicola*) and Mulga *(Acacia aneura*) with a low scrub laywer of *Hakea preissii, Eremophila oldfieldii* and *Acacia ayersiana* over Spinifex on deep red sandplains

- Mulga Woodland/Shrubland Plain: supports close to scattered Multa shrublands on loamy and hardpan plains. Characteristics vary depending upon elevation in the landscape. Lower lying areas tend to have an under storey dominated by chenopods. Open plains vary between unvegetated hardpan plains to variable cover by Wanderrie grasses or Spinifex grasses

- Samphire Flats: typified by three halophytic vegetation types that have different salinity substrate tolerances

- Spinifex Sandplain: extensive deep sandplains supporting Spinifex hummock grasslands with occasional sparse to scattered *Eucalyptus* species, *Hakea* species and *Acacia* sub species

- Shrubland on Sandplains: consisting of sandy banks or sandplains with deep earthy red sand supporting *Lawrencia squamata* and *Lycium austral*

- Claypan: devoid of vegetation but potential habitat for migratory shorebirds

Fauna surveys at Lake Maitland have identified 27 mammal species (of which 18 are native and nine introduced), 68 bird species and 44 reptile species.

Lake Maitland does not have a diverse or abundant stygofauna community compared with other areas in the Yilgarn such as Lake Way or Yarrabubba calcrete in the Murchison.

Baseline survey work has resulted in the following key findings relating to stygofauna:

- Approximately 500 specimens were collected at 50 sampling sites
- Over all of the sites, within and outside the project area, the number of stygofauna caught was generally low, with the majority of sites yielding less than 10 stygofaunal specimens
- At least half of the taxa recorded from the groundwaters of Lake Maitland have a known distribution outside the project area

2.2.3 Are you aware of any recent fauna surveys carried out over the area to be disturbed by this proposal?

x Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey(s). Attachment 2.

If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.

Millipede

Fauna surveys were undertaken by Outback Ecology Services in 2008 and 2011.

Baseline Terrestrial Fauna Survey, Lake Way. Unpublished report prepared for Toro Energy Limited, May 2008. Outback Ecology Services, Western Australia.

Terrestrial Fauna Assessment. Unpublished report prepared for Toro Energy Limited, January 2011. Outback Ecology Services, Western Australia.

Lake Maitland

Fauna surveys were undertaken by Outback Ecology Services in 2009 and 2010.

Lake Maitland Baseline Terrestrial Fauna Survey. Report prepared for Mega Uranium Pty Ltd. Outback Ecology Services, Western Australia.

Lake Maitland Terrestrial Fauna Habitat Assessment. Report for Mega Uranium Pty Ltd. Outback Ecology Services, Western Australia.

Millipede

No threatened fauna species listed under the EPBC Act or the *Wildlife Conservation Act 1950* (WA), or priority fauna species listed under the Western Australian Department of Environmental Regulation Priority Species List have been observed during field surveys conducted in the project area.

Lake Maitland

The following fauna species were identified on the EPBC Act *Protected Matters Report* as threatened or having conservation significance with the potential to occur within the project area:

Threatened Species	*Status*	*Significance*
Birds		
Acanthiza iredalei iredalei Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within the area
Polytelis alexandrae Princess parrot, Alexandra's parrot	Vulnerable	Species or species habitat may occur within the area
Leipoa ocellata Mallefowl	Vulnerable	Species or species habitat may occur within the area
Mammals		
Notoryctes caurinus Karkarratul, Northern Marsupial Mole	Endangered	Species or species habitat likely to occur within area
Reptiles		
Egernia kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within the area

Fauna surveys at Lake Maitland have identified the following threatened or significant species:

- The Mulgara *(Dasycercus cristicauda)* – Vulnerable under EPBC Act and Schedule 1 of the *Wildlife Conservation Act 1950* (WA)
- Bush Stone-curlew *(Burhinus grallarius)* – Schedule 4 of the *Wildlife Conservation Act 1950* (WA)

Other species of conservation significance assessed as possibly occurring at Lake Maitland but not observed during surveys were:

- Malleefowl (*Leipoa ocellata)* – Vulnerable under EPBC Act and Schedule 1 of the *Wildlife Conservation Act 1950*

- Major Mitchell's Cockatoo *(Cacatua leadbeateri*) – Schedule 4 of the *Wildlife Conservation Act 1950*
- Peregrine Falcon (*Falco peregrines*) – Schedule 4 of the *Wildlife Conservation Act 1950*
- Grey Falcon *(Falco hypoleucos)* – Priority 4 of the *Wildlife Conservation Act 1950*

2.2.4 Has a search of DEC records for known occurrences of Specially Protected (threatened) fauna been conducted for the site?

x Yes No (please tick)

2.2.5 Are there any known occurrences of Specially Protected (threatened) fauna on the site?

☐ Yes x No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

2.3 Rivers, Creeks, Wetlands and Estuaries

2.3.1 Will the development occur within 200 metres of a river, creek, wetland or estuary?

(please tick) x Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.3.2 Will the development result in the clearing of vegetation within the 200 metre zone?

x Yes ☐ No **If yes**, please describe the extent of the expected impact. No significant impact on priority flora or vegetation is expected. The extent and significance of disturbance arising from the proposal will be described in the PER.

2.3.3 Will the development result in the filling or excavation of a river, creek, wetland or estuary?

x Yes ☐ No **If yes**, please describe the extent of the expected impact. At Millipede excavation would occur at the edge of Lake Way and in areas which constitute small lacustrine estuaries along the Lake Way shoreline.

2.3.4 Will the development result in the impoundment of a river, creek, wetland or estuary?

x Yes	☐ No	**If yes**, please describe the extent of the expected impact. Flood protection works would be required at both Millipede and Lake Maitland to exclude surface water flows from the proposed mine pits.

Will the development result in draining to a river, creek, wetland or estuary?

☐ Yes x No **If yes**, please describe the extent of the expected impact.

2.3.5 Are you aware if the proposal will impact on a river, creek, wetland or estuary (or its buffer) within one of the following categories? (please tick)

Conservation Category Wetland	☐ Yes	x No	☐ Unsure
Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998	☐ Yes	x No	☐ Unsure
Perth's Bush Forever site	☐ Yes	x No	☐ Unsure
Environmental Protection (Swan & Canning Rivers) Policy 1998	☐ Yes	x No	☐ Unsure
The management area as defined in s4(1) of the *Swan River Trust Act 1988*	☐ Yes	x No	☐ Unsure
Which is subject to an international agreement, because of the importance of the wetland for waterbirds and waterbird habitats (e.g. Ramsar, JAMBA, CAMBA)	☐ Yes	x No	☐ Unsure

2.4 Significant Areas and/ or Land Features

2.4.1 Is the proposed development located within or adjacent to an existing or proposed National Park or Nature Reserve?

☐ Yes x No **If yes**, please provide details.

2.4.2 Are you aware of any Environmentally Sensitive Areas (as declared by the Minister under section 51B of the EP Act) that will be impacted by the proposed development?

☐ Yes x No **If yes**, please provide details.

2.4.3 Are you aware of any significant natural land features (e.g. caves, ranges etc) that will be impacted by the proposed development?

☐ Yes x No **If yes**, please provide details.

2.5 Coastal Zone Areas (Coastal Dunes and Beaches)

2.5.1 Will the development occur within 300metres of a coastal area?

(please tick) ☐ Yes **If yes**, complete the rest of this section.

x No **If no**, go to the next section.

2.5.2 What is the expected setback of the development from the high tide level and from the primary dune?

2.5.3 Will the development impact on coastal areas with significant landforms including beach ridge plain, cuspate headland, coastal dunes or karst?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.5.4 Is the development likely to impact on mangroves?

☐ Yes ☐ No **If yes**, please describe the extent of the expected impact.

2.6 Marine Areas and Biota

2.6.1 Is the development likely to impact on an area of sensitive benthic communities, such as seagrasses, coral reefs or mangroves?

☐ Yes x No **If yes**, please describe the extent of the expected impact.

2.6.2 Is the development likely to impact on marine conservation reserves or areas recommended for reservation (as described in *A Representative Marine Reserve System for Western Australia*, CALM, 1994)?

☐ Yes x No **If yes**, please describe the extent of the expected impact.

2.6.3 Is the development likely to impact on marine areas used extensively for recreation or for commercial fishing activities?

☐ Yes x No **If yes**, please describe the extent of the expected impact, and provide any written advice from relevant agencies (e.g. Fisheries WA).

2.7 Water Supply and Drainage Catchments

2.7.1 Are you in a proclaimed or proposed groundwater or surface water protection area?

(You may need to contact the Department of Water (DoW) for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes x No **If yes**, please describe what category of area.

2.7.2 Are you in an existing or proposed Underground Water Supply and Pollution Control area?

(You may need to contact the DoW for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes x No **If yes**, please describe what category of area.

2.7.3 Are you in a Public Drinking Water Supply Area (PDWSA)?

(You may need to contact the DoW for more information or refer to the DoW website. A proposal to clear vegetation within a PDWSA requires approval from DoW.)

☐ Yes x No **If yes**, please describe what category of area.

2.7.4 Is there sufficient water available for the proposal?

(Please consult with the DoW as to whether approvals are required to source water as you propose. Where necessary, please provide a letter of intent from the DoW)

x Yes ☐ No (please tick)

2.7.5 Will the proposal require drainage of the land?

x Yes ☐ No **If yes**, how is the site to be drained and will the drainage be connected to an existing Local Authority or Water Corporation drainage system? Please provide details. Mining at both Millipede and Lake Maitland would require pit dewatering. Details of hydrogeological studies to address this aspect of the proposal will be provided in the PER.

2.7.6 Is there a water requirement for the construction and/ or operation of this proposal?

(please tick) x Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

2.7.7 What is the water requirement for the construction and operation of this proposal, in kilolitres per year?

The water requirement remains the same as for the approved mining at Centipede and Lake Way (EPA Assessment 1819) over a further period of about 10 years.

2.7.8 What is the proposed source of water for the proposal? (e.g. dam, bore, surface water etc.)

Water would be sourced from local groundwater. The water for the process plant would come from dewatered local groundwater and from the West Creek borefield as already assessed in EPA assessment 1819. A source of water has been identified north of Lake Maitland which would supplement the West Creek supply and provide any additional water required for the extension of the Wiluna Uranium Mine under this referral.

2.8 Pollution

2.8.1 Is there likely to be any discharge of pollutants from this development, such as noise, vibration, gaseous emissions, dust, liquid effluent, solid waste or other pollutants?

(please tick) x Yes **If yes**, complete the rest of this section.

☐ No **If no**, go to the next section.

Mining at both Millipede and Lake Maitland would generate solid wastes, effluents, noise, dust and radiation. Mining at both locations would be undertaken in compliance with sound management practices to minimise and mitigate impacts. The PER will provide detailed information about the management and mitigation of impacts.

2.8.2 Is the proposal a prescribed premise, under the Environmental Protection Regulations 1987?

(Refer to the EPA's *General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986* for more information)

x Yes ☐ No **If yes**, please describe what category of prescribed premise. **Category 6.** Mine dewatering: premises on which water is extracted and discharged into the environment to allow mining of ore.

2.8.3 Will the proposal result in gaseous emissions to air?

x Yes ☐ No **If yes**, please briefly describe. At both Millipede and Lake Way there is the potential for generation of dust during vegetation clearing. There is a lower likelihood of dust generation during mining and ore handling/stockpiling because the ore at both locations is generally below the water table and the material being mined would typically be moist to wet. There is potential for radon gas emissions from the pit void and ore stockpiles during active operations. A small quantity of greenhouse gases would be emitted by the mobile mining fleet.

2.8.4 Have you done any modelling or analysis to demonstrate that air quality standards will be met, including consideration of cumulative impacts from other emission sources?

X Yes ☐ No

If yes, please briefly describe. As part of baseline investigations at both locations, dust in the air has been sampled to measure total dust concentrations and also to characterise the typical composition and concentration of radionuclides in naturally occurring dust.

2.8.5 Will the proposal result in liquid effluent discharge?

x Yes ☐ No

If yes, please briefly describe the nature, concentrations and receiving environment. At both Millipede and Lake Maitland, the main effluent streams would be:

- potentially, water from pit dewatering (see 2.8.6)
- septic effluent which would be treated by means of a conventional proprietary system and meet the requirements of the Wiluna Shire and the Western Australian Department of Health.

2.8.6 If there is likely to be discharges to a watercourse or marine environment, has any analysis been done to demonstrate that the State Water Quality Management Strategy or other appropriate standards will be able to be met?

☐ Yes x No

If yes, please describe. There would be no discharge to surface water during routine operation as water from pit dewatering would be used as part of the process water supply. In the event that a significant rainfall event occurred during mining, there would be sufficient storage to retain incident rainfall until it could be used, evaporated or demonstrated to be of appropriate quality for controlled release to the environment. If accumulated surplus rainwater was within the range of natural water quality, approvals would be sought for discharge of surplus rainwater. Toro would only seek to discharge water in circumstances where the discharge water complied with criteria to ensure there was no adverse environmental impact.

2.8.7 Will the proposal produce or result in solid wastes?

x Yes ☐ No

If yes, please briefly describe the nature, concentrations and disposal location/ method. The main solids arising from mining at both Millipede and Lake Maitland would be:

- Non-mineralised overburden
- Tailings from which uranium has been extracted
- General non-hazardous rubbish and sewage from operational areas.

Non- mineralised overburden, some very low grade ore and tailings would be returned to pit voids as part of progressive rehabilitation. It is proposed to store at Millipede, tailings generated from the processing of ore mined at Lake Maitland. Details of the geochemical and environmental characteristics of this waste stream will be documented in the PER. Domestic solid wastes would be recycled to the extent practicable. Non-recyclable materials would be disposed of to a purpose-built landfill or at the Shire landfill. Sewage would be treated by means of a proprietary treatment plant and disposed of in accordance with Shire of Wiluna and Western Australian Department of Health requirements.

2.8.8 Will the proposal result in significant off-site noise emissions?

☐ Yes x No **If yes**, please briefly describe.

2.8.9 Will the development be subject to the Environmental Protection (Noise) Regulations 1997?

x Yes ☐ No **If yes**, has any analysis been carried out to demonstrate that the proposal will comply with the Regulations?

Please attach the analysis. Assessment of noise impacts has been undertaken for the already assessed mining at Centipede and Lake Way. The impacts would be the same for mining at Millipede and Lake Maitland because of the similarity of the mining method. The results of noise modelling showed that emissions from the proposed mining would comply with the Environmental Protection (Noise) Regulations 1997.

2.8.10 Does the proposal have the potential to generate off-site, air quality impacts, dust, odour or another pollutant that may affect the amenity of residents and other "sensitive premises" such as schools and hospitals (proposals in this category may include intensive agriculture, aquaculture, marinas, mines and quarries etc.)?

x Yes ☐ No **If yes**, please describe and provide the distance to residences and other "sensitive premises".

Millipede – Baseline studies and modelling of potential impacts on air quality have shown that mining would not result in exceedance of any air quality standards at any off-site sensitive receptors.

Lake Maitland – Air quality impact assessment modelling has indicated that all contaminants of interest would comply with relevant compliance criteria.

2.8.11 If the proposal has a residential component or involves "sensitive premises", is it located near a land use that may discharge a pollutant?

☐ Yes x No ☐ Not Applicable

If yes, please describe and provide the distance to the potential pollution source

2.9 Greenhouse Gas Emissions

2.9.1 Is this proposal likely to result in substantial greenhouse gas emissions (greater than 100 000 tonnes per annum of carbon dioxide equivalent emissions)?

☐ Yes x No **If yes**, please provide an estimate of the annual gross emissions in absolute and in carbon dioxide equivalent figures.

2.9.2 Further, if yes, please describe proposed measures to minimise emissions, and any sink enhancement actions proposed to offset emissions.

2.10 Contamination

2.10.1 Has the property on which the proposal is to be located been used in the past for activities which may have caused soil or groundwater contamination?

☐ Yes	X No for Lake Maitland	X Unsure for Millipede	**If yes**, please describe

Millipede – Historic and current mining operations in the Wiluna area have discharged water to Lake Way. The discharges are clearly visible on aerial imagery of Lake Way. Toro is unaware whether dissolved or suspended matter in mine water discharges may have affected lake sediment or groundwater in the project area.

2.10.2 Has any assessment been done for soil or groundwater contamination on the site?

x Yes for Millipede	X No for Lake Maitland	**If yes**, please describe.

Millipede – Baseline studies to characterise solid and lake sediment quality were carried out at Centipede in 2007. The ore at Centipede is continuous with that at Millipede. Measurements of total metal concentrations of surface samples indicated that variable levels of As, Cd, Cr, Cu, Pb, Ni, Zn and Hg were present. Most soils sampled were below the detectable limit for As, Cd, Pb and Hg. However, Cr, Cu, Ni and Zn were regularly measured at a detectable level.

Background studies of radionuclides in soils have also been carried out in the Wiluna Uranium Project acrea.

The Environmental Review and Management Programme published in 2011 for the Wiluna Uranium Project reported extensively on trace elements in soil and groundwater. (Wiluna Uranium Project, Environmental Review and Management Programme, EPA Assessment 1819, Toro Energy Limited, 2011 – Sections 4.6.3.2 and 4.8.5)

2.10.3 Has the site been registered as a contaminated site under the *Contaminated Sites Act 2003*? (on finalisation of the CS Regulations and proclamation of the CS Act)

☐ Yes	x No	**If yes**, please describe.

2.11 Social Surroundings

2.11.1 Is the proposal on a property which contains or is near a site of Aboriginal ethnographic or archaeological significance that may be disturbed?

x Yes ☐ No ☐ Unsure **If yes**, please describe.
There are registered heritage sites in proximity to the Millipede deposit. Site surveys have been undertaken and will be described in the PER. Agreement has been reached with Native Title Holders on where mining can be undertaken at Millipede so that cultural heritage values are protected. There are no registered sites of Aboriginal ethnographic or archaeological significance at Lake Maitland.

2.11.2 Is the proposal on a property which contains or is near a site of high public interest (e.g. a major recreation area or natural scenic feature)?

☐ Yes x No **If yes**, please describe.

2.11.3 Will the proposal result in or require substantial transport of goods, which may affect the amenity of the local area?

☐ Yes x No **If yes**, please describe.

3. PROPOSED MANAGEMENT

3.1 Principles of Environmental Protection

3.1.1 Have you considered how your project gives attention to the following Principles, as set out in section 4A of the EP Act? (For information on the Principles of Environmental Protection, please see EPA Position Statement No. 7, available on the EPA website)

1. The precautionary principle.	x Yes	☐ No
2. The principle of intergenerational equity.	x Yes	☐ No
3. The principle of the conservation of biological diversity and ecological integrity.	x Yes	☐ No
4. Principles relating to improved valuation, pricing and incentive mechanisms.	x Yes	☐ No
5. The principle of waste minimisation.	x Yes	☐ No

3.1.2 Is the proposal consistent with the EPA's Environmental Protection Bulletins/Position Statements and Environmental Assessment Guidelines/Guidance Statements (available on the EPA website)?

x Yes ☐ No

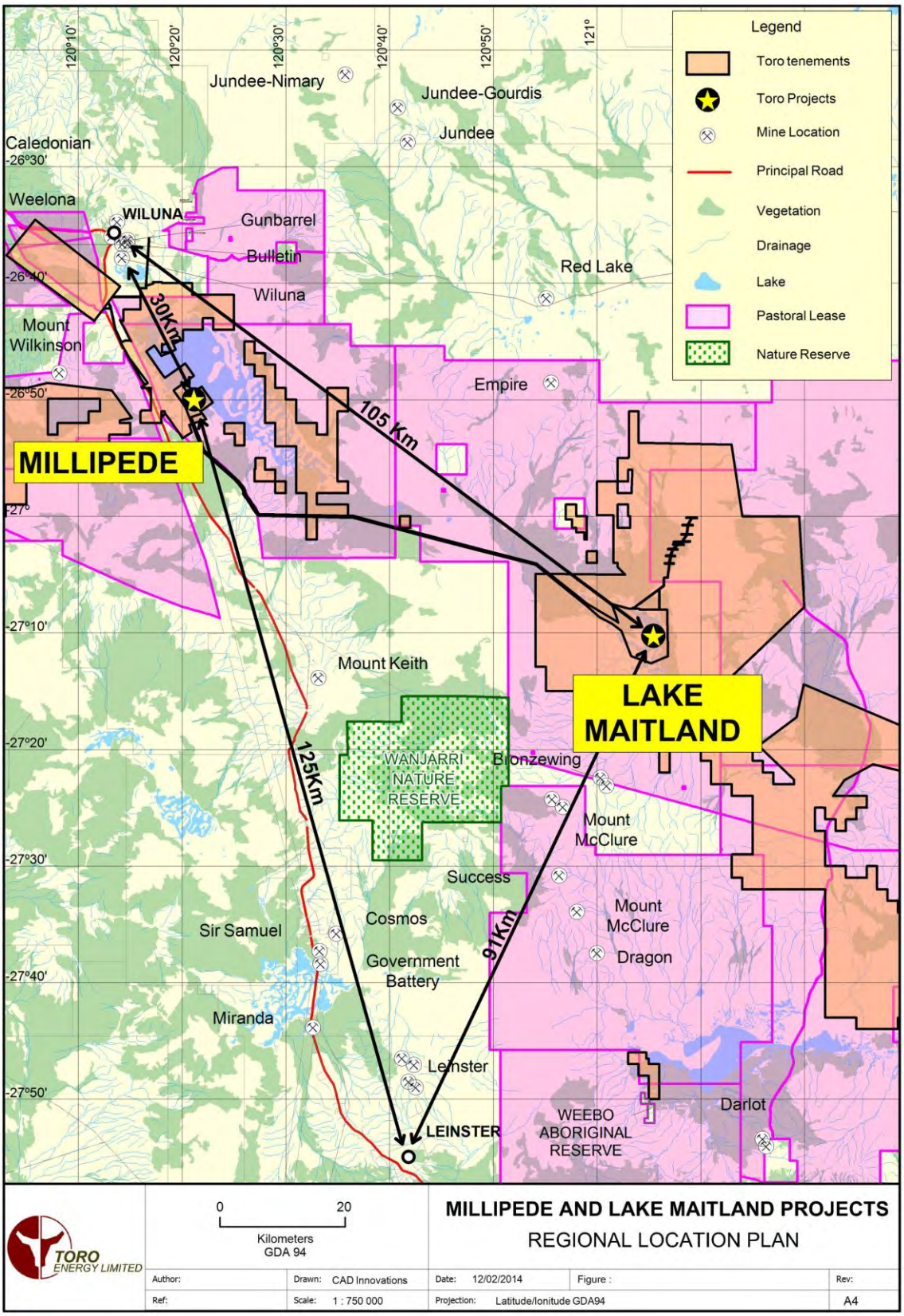
3.2 Consultation

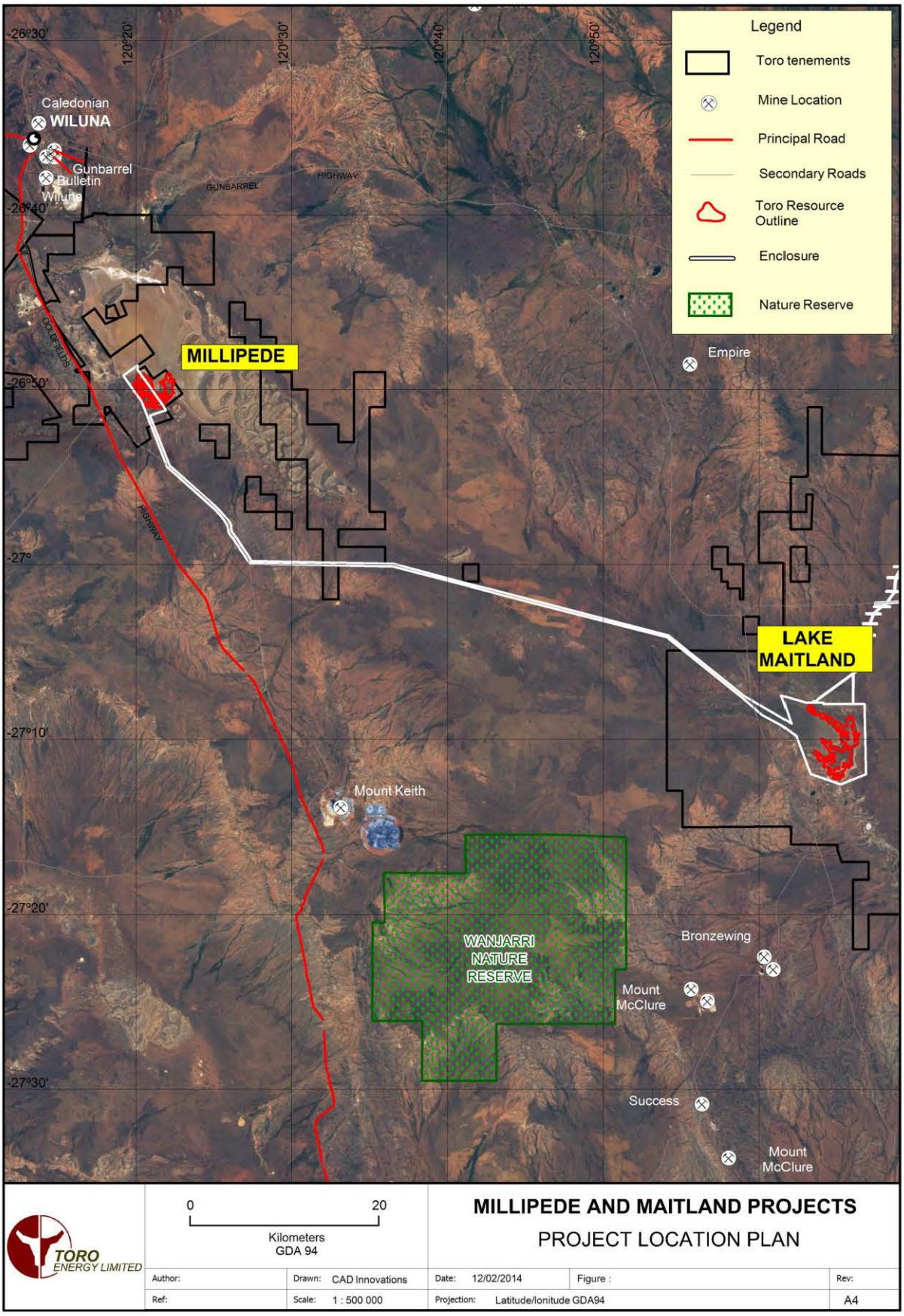
3.2.1 Has public consultation taken place (such as with other government agencies, community groups or neighbours), or is it intended that consultation shall take place?

x Yes ☐ No

If yes, please list those consulted and attach comments or summarise response on a separate sheet. Consultation has been undertaken with a range of Federal, State and Local Government agencies, Native Title Holders and Claimants, individuals and the general community over a period of more than five years. The view of stakeholders in the region is generally strongly favourable for further mining development, including uranium mining. Native Title Holders and Claimants have also indicated support for the Wiluna Uranium Project as a means of generating community benefits. (See Attachment 3) The public consultation undertaken will be fully documented in the PER.

Attachment 1- Maps and other location information

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Toro tenements
Mine Location
Principal Road
Secondary Roads
Toro Resource Outline
Enclosure
Nature Reserve
MILLIPEDE
LAKE MAITLAND
WANJARRI NATURE RESERVE
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WILUNA
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TORO ENERGY LIMITED
MILLIPEDE AND MAITLAND PROJECTS
PROJECT LOCATION PLAN
Author:
Drawn: CAD Innovations
Date: 12/02/2014
Figure :
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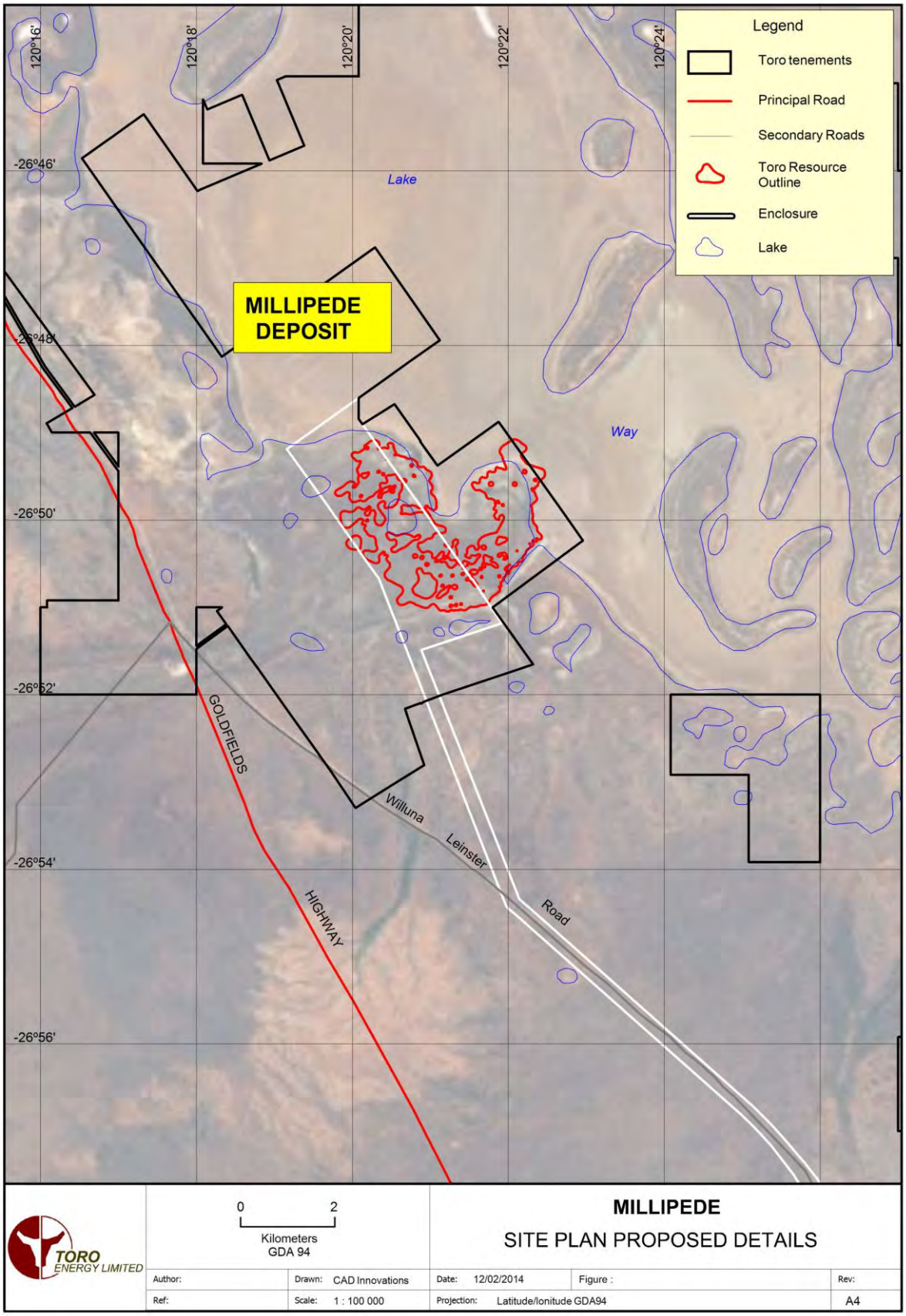
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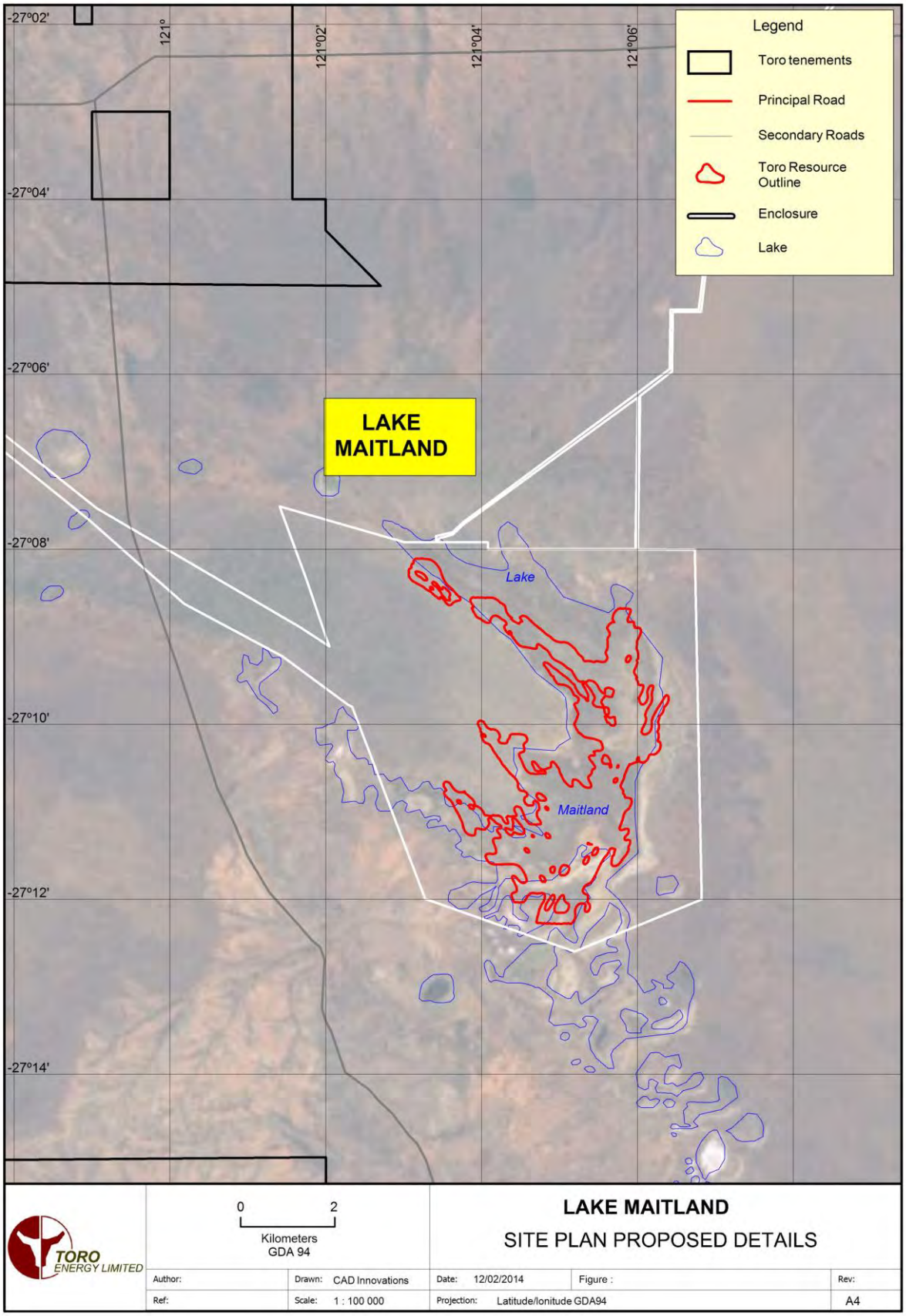
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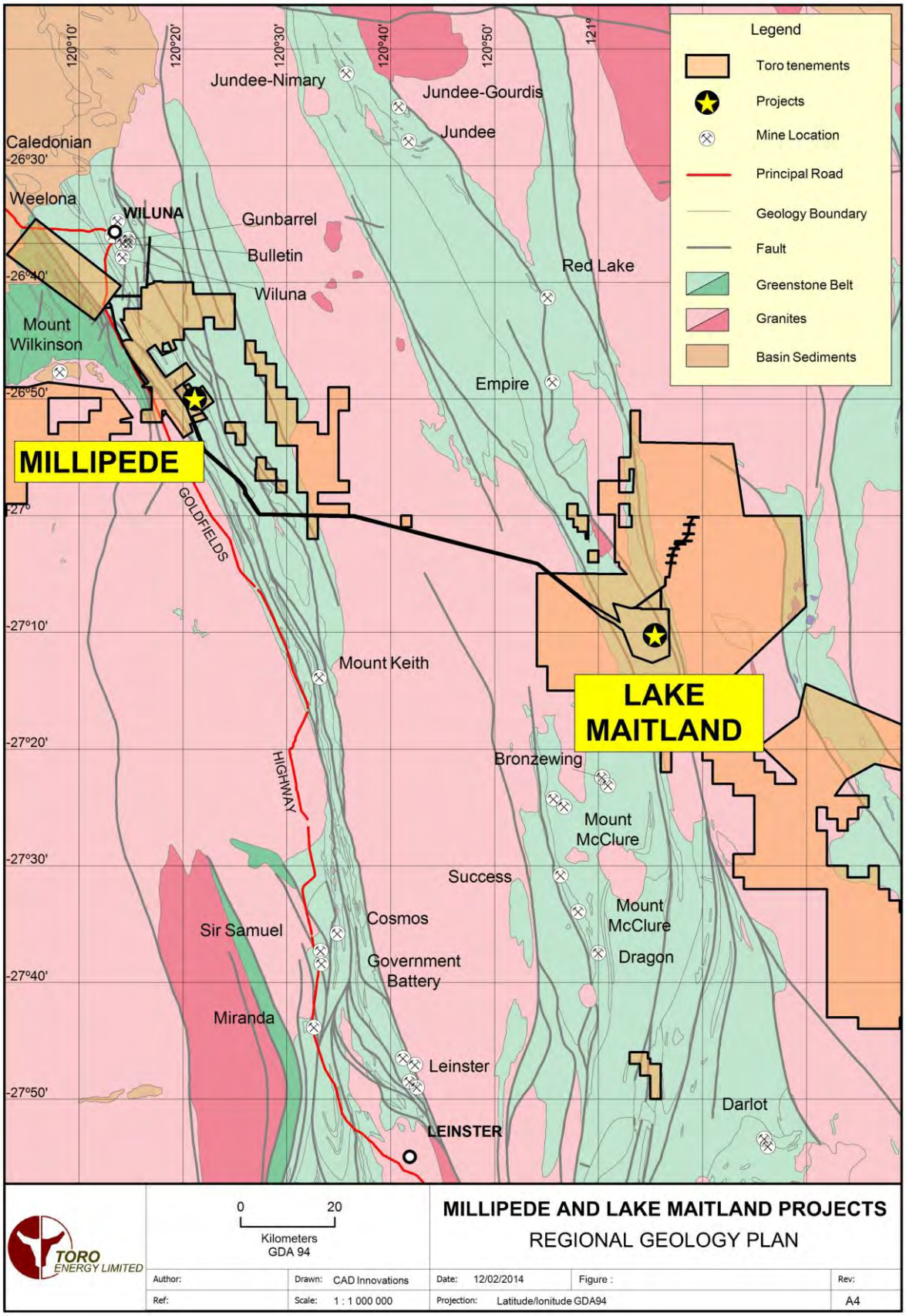
Legend
Toro tenements
Projects
Mine Location
Principal Road
Geology Boundary
Fault
Greenstone Belt
Granites
Basin Sediments
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Bulletin
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Red Lake
Mount Wilkinson
Empire
MILLIPEDE
GOLDFIELDS
Mount Keith
LAKE MAITLAND
HIGHWAY
Bronzewing
Mount McClure
Success
Mount McClure
Cosmos
Sir Samuel
Government Battery
Dragon
Miranda
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MILLIPEDE AND LAKE MAITLAND PROJECTS
REGIONAL GEOLOGY PLAN
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Drawn: CAD Innovations
Date: 12/02/2014
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Project Location – Latitude and Longitude

Location Point	Latitude	Longitude	Easting	Northing
1	121.1232	-27.03	313839	7008043
2.	121.1394	-27.040	315452	7007667
3.	121.039	-27.1634	305696.9	6993952
4.	121.0546	-27.1999	307304	6989927
5.	121.0865	-27.21	310489.8	6988863
6.	121,1138	-27.2	313170.7	6990005
7.	121.1123	-27.1334	312909.8	6997378
8.	121.0333	-27.15	305113.8	6995424
9.	121.05	-27.132	306733.3	6997446
10.	121.1069	-27.099	312320	7001183
11.	121.1071	-27.0877	312320	7002439
12.	121.1088	- 27.0667	312452	7004770
13.	121.1141	-27.0474	312948	7006913
14.	121.1357	-27.0253	315055	7009393
15.	121.1435	-27.0016	315791	7012031
16.	121.1606	-27.0018	317491	7012031
17.	121.1541	-27.0124	316857	7010849
18.	121.1538	-27.0255	316754.9	7009393
19.	121.1497	-27.0363	316462	7008197
20.	121.1293	-27.0478	314459	7006896
21.	121.1255	-27.0563	314099	7005951
22.	121.1235	-27.0672	313911	7004735
23.	121.1136	-27.0881	312968	7002405
24.	121.001	-27.1044	311652	7000575
25.	121.0996	-27.1333	311652	6997373
26.	121.0681	-27.1333	308528.5	6997324
27.	121.0681	-27.132	308526.3	6997471
28.	121.0575	-27.132	307474.9	6997455
29.	121.0605	-27.1305	307771	6997624
30.	121.1105	-27.057	312606	7005851
31.	121.1223	-27.0407	313752	7007667
32.	121.1369	-27.0131	315157	7010749
33.	120.9011	-27.0692	291857.6	7004161
34.	121.003	-27.1437	302101	6996071
35.	120.9027	-27.0677	292914,2	7004338
36.	120.9843	-27.1255	300211.3	6998062
37.	121.0235	-27.1252	304093.5	6998160
38.	120.3652	-26.853	238194.8	7027123
39.	120.3347	-26.8141	235065.3	7031374
40.	120.3347	-26.81	235065.3	7031829
41.	120.3193	-26.8198	233554.4	7030709
42.	120.3389	-26.8444	235561.5	7028026
43.	120.3662	-26.907	238419.6	7021143
44.	120.4318	-26.9684	245073.1	7014471
45.	120.455	-26.9992	247443.6	7011108
46.	120.6078	-27.002	262619.5	7011088
47.	120.3481	-26.8581	236502.1	7026522
48.	120.369	-26.9057	238696.5	7021291
49.	120.4342	-26.9615	245300.9	7015239
50.	120.6091	-26.9995	262743.1	7011375

Attachment 2 - Additional Documents

- Lake Way and Centipede Baseline Vegetation and Flora Survey, unpublished report prepare for Toro Energy Limited, October 2007. Outback Ecology Services, Western Australia
- Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project; Lake Way, Centipede and borefield. Draft, unpublished report prepared for Toro Energy Limited, July 2011. Niche Environmental Services.
- Lake Maitland Uranium Project Baseline Survey: Vegetation and Flora Surveys, May and November 2007 and May 2009. Outback Ecology Services, Western Australia.
- Baseline Terrestrial Fauna Survey, Lake Way. Unpublished report prepared for Toro Energy Limited, May 2008. Outback Ecology Services, Western Australia.
- Terrestrial Fauna Assessment. Unpublished report prepared for Toro Energy Limited, January 2011. Outback Ecology Services, Western Australia.
- Lake Maitland Baseline Terrestrial Fauna Survey. Report prepared for Mega Uranium Pty Ltd. Outback Ecology Services, Western Australia.
- Lake Maitland Terrestrial Fauna Habitat Assessment. Report for Mega Uranium Pty Ltd. Outback Ecology Services, Western Australia.

Attachment 3 – CONSULTATION WITH NATIVE TITLE HOLDERS

CENTRAL DESERT NATIVE TITLE SERVICES

28th May 2012

MEDIA STATEMENT

The Wiluna 'Martu' People are the traditional owners of the land on which Toro Energy Ltd's **(Toro)** proposed Wiluna Uranium Mine **(Wiluna Uranium Mine)** is situated.

They issue this media statement to outline their position on Toro's proposed Wiluna Uranium Mine.

Background

Toro's Wiluna Uranium Mine is situated on the traditional lands of the Wiluna based 'Martu' People. There are two complementary native title claims that seek to have those traditional lands recognised under the Native Title Act: the Wiluna Native Title Claim and the Tarlpa Native Title Claim **(Native Title Claims)**. Those Native Title Claims are at an advanced stage towards a consent determination of native title.

History of uranium exploration in the Wiluna region

The Martu People have been dealing with uranium exploration in the Wiluna region since the 1970's, both on their traditional hunting grounds and in areas close to where traditional owners and other Martu families resided at the old Wiluna Nganggawili mission. This early uranium exploration was conducted without any consultation with the traditional owners and with little government regulatory supervision.

The Wiluna Martu People's previous experience with uranium exploration in the Wiluna region has left them with serious and genuine concerns about the health effects of radiation. It also raised questions for them about the government's capacity to properly regulate uranium exploration and mining on their traditional lands.

Since the recommencement of uranium exploration in the Wiluna region in 2005, the Wiluna Martu People have raised their concerns about the state regulatory regime and radiation safety with the government of Western Australia.

The Native Title Claimants have in particular been seeking for the right to negotiate directly with uranium explorers so that their unique concerns as traditional owners and traditional land users can be properly recognised and their native title rights protected.

Despite mounting evidence to the contrary, The Western Australian Government's position remains that the state regulatory regime is sufficient to protect the rights and interests of the Wiluna Martu People. The Western Australian Government continues to vigorously deny Martu a direct right to negotiate in relation to uranium exploration. The Commonwealth Government (through the National Native Title Tribunal) have also been obstructive and disallowed the Martu to engage directly with uranium explorers. These circumstances leave the Martu People in a position where they are not in control of their country and their cultural obligations to country cannot be fulfilled in an appropriate way.

In late 2008 the newly elected State Government changed the long held policy of 'no uranium' mining in Western Australia. This change in policy has put the Wiluna Martu People in an increasingly difficult position as it has bought a renewed interest in the mining of uranium to their country.

The issue of uranium mining is not something that Martu have invited. Rather, under the current policy and state regulatory environment, it is something they are forced to confront in order to ensure that their traditional lands and their people are sufficiently recognised and protected.

Toro and the Wiluna Uranium Mine

In 2009, Toro approached the Wiluna Martu People indicating they may have a minable deposit of uranium at their 'Lakeway' project. Toro sought to engage with Martu about a 'mining agreement' that would allow their Wiluna Uranium Mine to proceed.

Toro's proposed Wiluna Uranium Mine is located in an area of highly significant cultural value to both the Wiluna Martu People as well as other Western Desert people.

Due to the cultural nature of this area, in accordance with the traditional law and customs of the Wiluna based Martu, all issues relating to the proposed Wiluna Uranium Mine may only be dealt with by senior initiated men who have high-level, and recognised, cultural standing and authority for the Lakeway area (**Senior Lawmen**).

Since 2009, the appropriate Senior Lawmen have been dealing with Toro in relation to two primary threshold concerns around heritage and radiation protection (**Threshold Conditions**). Toro have been required to address these Threshold Conditions before these Senior Lawmen would consider any formal negotiations in relation to the Wiluna Uranium Mine.

The Threshold Condition of heritage protection required Toro to limit its mining activity and associated infrastructure. This pre-condition was established in order to minimize the mining footprint and avoid areas of significant cultural value.

The Threshold Condition of radiation protection required Toro to agree to the Martu undertaking a private regulatory role in relation to the management and safety of radiation at the Wiluna Uranium Mine. This private regulatory regime includes appropriately trained Martu to undertake monitoring as well as enforceable penalties against Toro should the mining activity exceed agreed

baseline levels of radiation. The Wiluna Martu People's own independent radiation expert will support them in this private regulatory role.

Discussion around these Threshold Conditions has been extensive and painstakingly thorough and has taken place over some three (3) years.

The Senior Lawmen believe that Toro have listened to their concerns. By modifying their mine planning and agreeing to a private regulatory regime, Toro have recognised the Martu People's cultural responsibilities and unique position as traditional land users. As a consequence the Senior Lawmen consider that Toro has now met the Threshold Conditions and the time has come to commence formal discussions about a mining agreement.

The Senior Lawmen are keen to emphasize that the beginning of formal discussions about a mine agreement does not mean they, or other Wiluna Martu People generally, support the proposed Wiluna Uranium Mine. Rather, the move into formal discussions reflects they are encouraged by Toro's approach over the last three (3) years and the concessions Toro have made to date in relation to the Threshold Conditions.

The future

Formal negotiations between the Wiluna Martu People, represented by the appropriate Senior Lawmen, and Toro are expected to commence shortly.

These negotiations are expected to be wide ranging and will build on the Threshold Conditions already agreed.

The Senior Lawmen acknowledge that there are divergent views about uranium mining within the wider Martu community and that these divergent views have to be accommodated in this negotiation.

The Senior Lawmen also recognise that individuals within the wider Martu community have in recent times come under intense pressure from outsiders; both from pro-uranium and anti-uranium camps. They are concerned that this outside pressure has the potential to fracture the Martu Community.

The Senior Lawmen request that these outsiders respect their position as the traditional landowners and allow them to continue to engage and make decisions about the protection of their country and their people in accordance with their traditional law and customs.

A spokesman for the Senior Lawmen, Mr Darren Farmer, summed up the future situation this way:

"Because of the history of uranium in Wiluna, the mob have many concerns about uranium exploration and mining. On top of that the old men have a cultural responsibility to look after that area where Toro want to mine and must deal with that area properly otherwise this may lead to serious repercussions for them.

For the first time, a mining company has come to talk to the mob about their concerns. This is good and the old men are happy that Toro will keep away from their sites. There is a long way to go, but at least the men who are

baseline levels of radiation. The Wiluna Martu People's own independent radiation expert will support them in this private regulatory role.

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The future

Formal negotiations between the Wiluna Martu People, represented by the appropriate Senior Lawmen, and Toro are expected to commence shortly.

These negotiations are expected to be wide ranging and will build on the Threshold Conditions already agreed.

The Senior Lawmen acknowledge that there are divergent views about uranium mining within the wider Martu community and that these divergent views have to be accommodated in this negotiation.

The Senior Lawmen also recognise that individuals within the wider Martu community have in recent times come under intense pressure from outsiders; both from pro-uranium and anti-uranium camps. They are concerned that this outside pressure has the potential to fracture the Martu Community.

The Senior Lawmen request that these outsiders respect their position as the traditional landowners and allow them to continue to engage and make decisions about the protection of their country and their people in accordance with their traditional law and customs.

A spokesman for the Senior Lawmen, Mr Darren Farmer, summed up the future situation this way:

"Because of the history of uranium in Wiluna, the mob have many concerns about uranium exploration and mining. On top of that the old men have a cultural responsibility to look after that area where Toro want to mine and must deal with that area properly otherwise this may lead to serious repercussions for them.

For the first time, a mining company has come to talk to the mob about their concerns. This is good and the old men are happy that Toro will keep away from their sites. There is a long way to go, but at least the men who are

responsible for that area have been able to sit down and talk about that country on behalf of all the Wiluna mob and be listened to and be involved in decisions about that country. This hasn't happened before"

Contact details

The Senior Lawmen have appointed, Mr Darren Farmer as their representative who can speak in more detail on their perspective and position in relation to the Wiluna Uranium Mine.

Any persons interested in seeking contact with Mr Farmer, or in discussing this media statement further, should contact Central Desert's Major Projects Coordinator, Michelle Alexander on 9425 2000 or by email, michellealexander@centraldesert.org.au.

TORO ENERGY LIMITED

EPA Referral Information

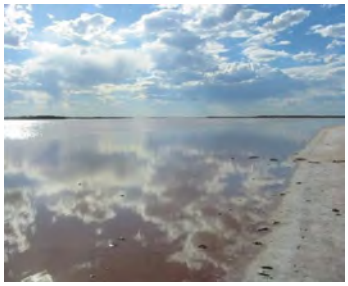
Extension to the Wiluna Uranium Project

Australia's Leading Development Stage Uranium Company

Attachments 2
Additional Documents

February 2014

toroenergy.com.au



Toro Energy Ltd

Lake Way and Centipede Baseline Vegetation and Flora Survey

October 2007

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Lake Way and Centipede Baseline Vegetation and Flora Survey

Distribution:

Company	Copies	Contact Name
Toro Energy Ltd	2	Mr Ashley Jones

Document Control for Job Number:

Author	Reviewer	Signature	Date of Issue
BN	MH		

EXECUTIVE SUMMARY

Toro Energy Ltd (Toro) is currently undertaking a Pre-Feasibility Study (PFS) in respect to conducting detailed explorative surveys over a series of prospective uranium exploration tenements located at Lake Way (E53/1132 and E53/1168) and Centipede (M53/224) project areas, located near the town of Wiluna. Toro commissioned Outback Ecology Services (Outback) to undertake a baseline flora and vegetation survey over areas containing ore bodies at the Lake Way (E53/1132 and E53/1168) and Centipede (M53/224) project areas, which was commenced in October 2007. The flora and vegetation surveys were one component of a broader assessment undertaken concurrently by Outback that also considered vertebrate and invertebrate fauna, aquatic ecology, stygofauna and soils.

During the October 2007 survey, a total of 132 taxa (including subspecies and variants) from 65 genera and 32 families were recorded across the Centipede and Lake Way Project Areas. The flora was dominated by the Chenopodiaceae, with 32 taxa from 10 genera. No Declared Rare or Priority Flora were observed during the survey. One record of an alien taxon, **Anagallis arvensis*, was made at a single site. In addition to this record, one species from the Aizoaceae family (tentatively identified as *Carpobrotus* sp.) may potentially be an alien taxon.

A total of 108 quadrats were assessed during the survey, with 46 located at the Centipede project area and 62 located at the Lake Way project area. Based on data collected from these quadrats, a total of 22 vegetation associations were described. The vegetation associations were defined based on floristic affinities that were conspicuously influenced by location within the landscape. Vegetation associations were broken up into five distinct groupings:

- Playa Vegetation
- Claypan Vegetation
- Fringing Vegetation
- Calcrete Vegetation
- Dune and Plains Vegetation

The majority of vegetation associations observed during the October 2007 survey were located across both project areas and were relatively widespread; however, a limited number of associations were restricted to one project area and had narrow distributions when observed.

No Threatened Ecological Communities are known to occur within the areas surveyed. A total of 17 'at risk' ecosystems have been identified within the Murchison 1 Bioregion. One of these, "*Melaleuca* sp nov (*M. xerophila*) Low Closed to Open Forest Strand Community near Wiluna" was identified as occurring within the Centipede and Lake Way project areas.

The majority of vegetation within the areas surveyed was assessed as being in very good to excellent condition according to the scale of Keighery (1994). No vegetation was assessed as being degraded or completely degraded. The most commonly observed disturbances to vegetation were due to the

activities of cattle or rabbits. There were several observations of disturbance due to the development of vehicle tracks, the majority of which were noted in the Centipede project area.

It is recommended that any future works that may cause further disturbance to the recognized ‘at risk’ ecosystem of “*Melaleuca* sp. nov (*M. xerophila*) Low Closed to Open Forest Strand Community near Wiluna” recorded in the Lake Way and Centipede project areas should be avoided. Current disturbances to this fringing vegetation should be minimized by using alternate access tracks to avoid further dissection of the vegetation. Halting track development and unnecessary usage of multiple tracks will improve vegetation condition in areas degraded by current track usage. Due to the presence of weed species in the Lake Way and Centipede project areas, it is recommended that cleaning of vehicles and appropriate precaution in movement of soil and materials between sites should be taken to minimise further spread of these weeds.

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1.0 INTRODUCTION

1.1 Project Background

Toro Energy Ltd. (Toro Energy) is currently undertaking a Pre-feasibility Study (PFS) in respect to the development of the Wiluna Uranium Assets, which comprise the Lake Way and Centipede uranium deposits. Wiluna is located approximately 750km northeast of Perth and 180km east of Meekatharra in the East Murchison Mineral Field. The two deposits of Lake Way and Centipede are located on the northern and western edges of Lake Way, which is a large temporary salt lake.

Toro Energy commissioned Outback Ecology Services (Outback) to commence baseline flora and vegetation surveys over the two project areas during 2007. The flora and vegetation survey was a component of a broader assessment undertaken concurrently by Outback that also considered fauna, aquatic ecology, stygofauna, and soils.

1.2 Scope and Objectives of the Study

This report documents the results of the flora and vegetation survey over the Lake Way (E53/1132 and E53/1168) and Centipede (M53/224) Project Areas. The methods used in the survey were consistent with a Level 2 survey as described in the Environmental Protection Authority (EPA) Position Statement No 3. “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA, 2002), and Guidance Statement No 51 “Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004).

The overall objectives of the baseline flora and vegetation survey were to:

i. Undertake a review of databases to determine significant flora species (including Declared Rare and Priority Flora) and Threatened Ecological Communities (TECs) known from, or likely to occur within or in close proximity to, the project areas;
ii. Undertake a census and develop an inventory of flora located in, or in close proximity to, the project areas. This would incorporate a desktop review of available information for the project areas and a detailed quadrat-based field survey and opportunistic sampling;
iii. Define, describe and map vegetation associations across the survey area, based on data collected during the detailed quadrat-based field survey, interpretations of aerial photography of the project areas and the results of statistical analyses;
iv. Provide an initial assessment of the local and regional conservation value of the flora and vegetation; and
v. Provide quantitative data that can form a baseline against which future impacts and rehabilitation can be assessed, and provide the basis of a monitoring programme.

1.3 Location of Project Areas

The Lake Way project area consists of an exploration lease (E53/1132) and a mining lease (M53/832) and is located along the northern edge of Lake Way, approximately 16km SE of the town of Wiluna in Western Australia (**Figure 1**). The Centipede project area consists of a single mining lease (M53/224) and is located in the south west corner of Lake Way, approximately 28km SE of the town of Wiluna (**Figure 1**).

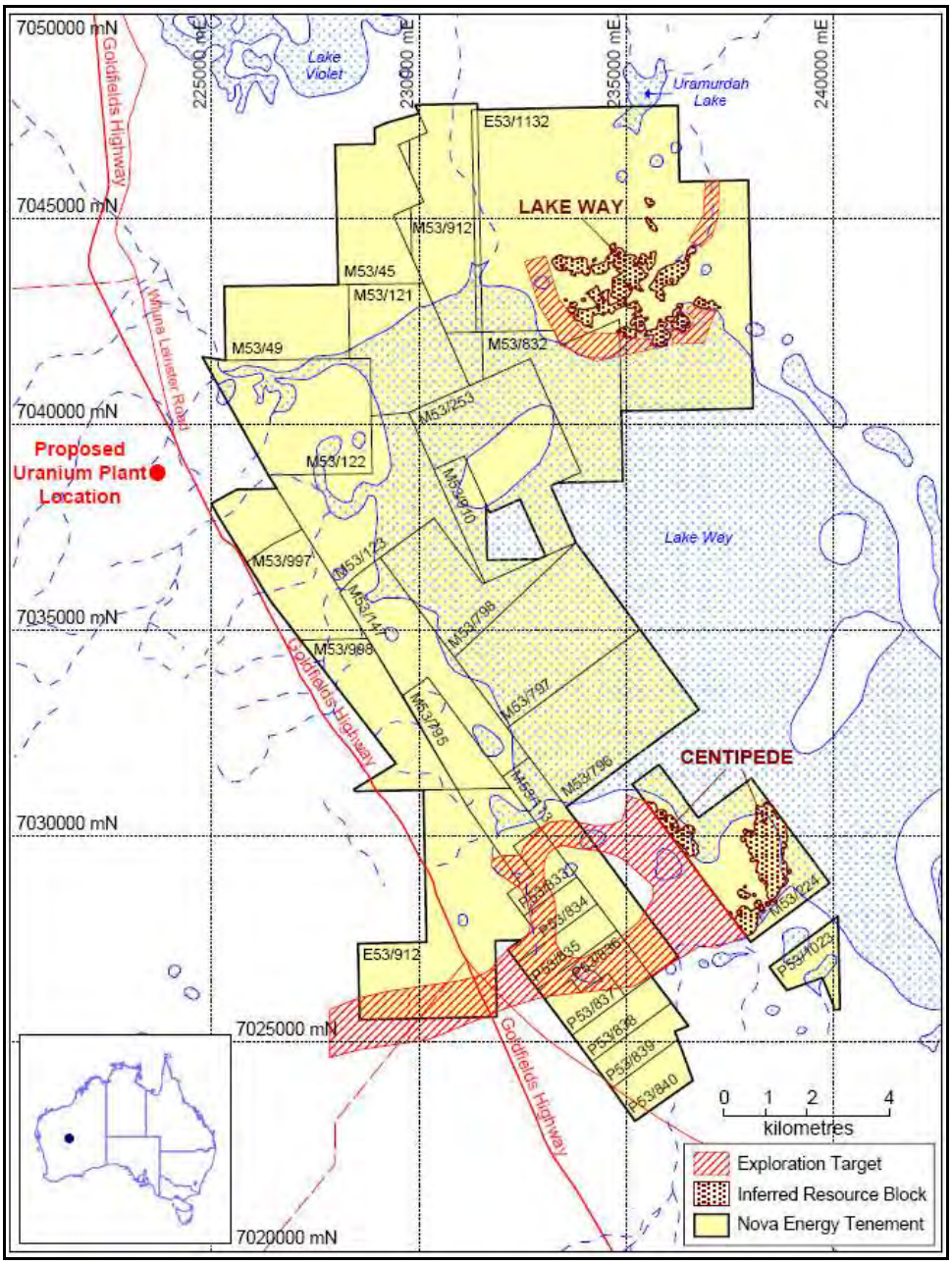

Figure 1 Map showing location of Lake Way and Centipede project areas surveyed in November 2007. The town of Wiluna is located NW of Lake Way. The inset shows the location of the project area within Western Australia

2.0 EXISTING ENVIRONMENT

2.1 IBRA Region – Murchison 1 Biogeographic Region

The Lake Way and Centipede project areas are located near Wiluna, which is situated in the semi-arid to arid Eyrean Sub-region, one of three very broad sub-regions defined by Heatwole (1987) covering the entire Australian continent, with the others being the tropical Torresian sub-region and the temperate Bassian sub-regions.

Thackway and Cresswell (1995) describe a system of 85 bioregions covering the whole of Australia in the Interim Biogeographic Regionalisation of Australia (IBRA); the result of collaboration between all state conservation agencies with co-ordination by the Australian Government Department of Environment and Heritage (now the Department of Environment, Heritage and Water Resources). Biogeographic regions (bioregions) are defined on the basis of climate, geology, landforms, vegetation and fauna.

The Lake Way and Centipede project areas are located within the Murchison bioregion of the IBRA (Thackway and Cresswell, 1995). The Murchison bioregion comprises the northern part of the Yilgarn Craton and includes two major components, or subregions; the Eastern Murchison (MUR1), and the Western Murchison (MUR2).

The Lake Way and Centipede project areas lie within the Eastern Murchison (MUR1) subregion, which is characterised by internal drainage, red sandplains, salt lake systems that are associated with an occluded paleodrainage system, plains of red-brown soils, and breakaways (Cowan, 2001). The Eastern Murchison subregion is 7,847,996 ha in size and comprises the “Southern Cross” and “Eastern Goldfields” terranes of the Yilgarn Craton (Cowan, 2001; NLWRA, 2002). Vegetation is dominated by Mulga woodlands, frequently rich in ephemeral species, hummock grasslands, saltbush and samphire shrublands (Cowan, 2001).

2.2 Climate

The nearest Bureau of Meteorology (BOM) weather station to the Lake Way and Centipede project areas is Wiluna. Daily temperatures recorded at Wiluna range from 21°C to 38°C during summer and 5.5°C to 22°C during winter (BOM, 2007) (**Figure 2**). Rainfall within the survey area is unreliable. The long-term mean annual rainfall is 257.3mm, the majority of which falls during the summer-autumn months. Occasional remnant tropical depressions and more isolated storms cause Lake Way to become temporarily inundated, which occurred as recently as 2006. Winter weather patterns are directly influenced by the anticyclone system which results in the generation of westerly winds and rain-bearing frontal systems (Gilligan 1994). Winter rains are usually heaviest around late May into July, and subside during the months of September and October as the anticyclone conditions stabilise.

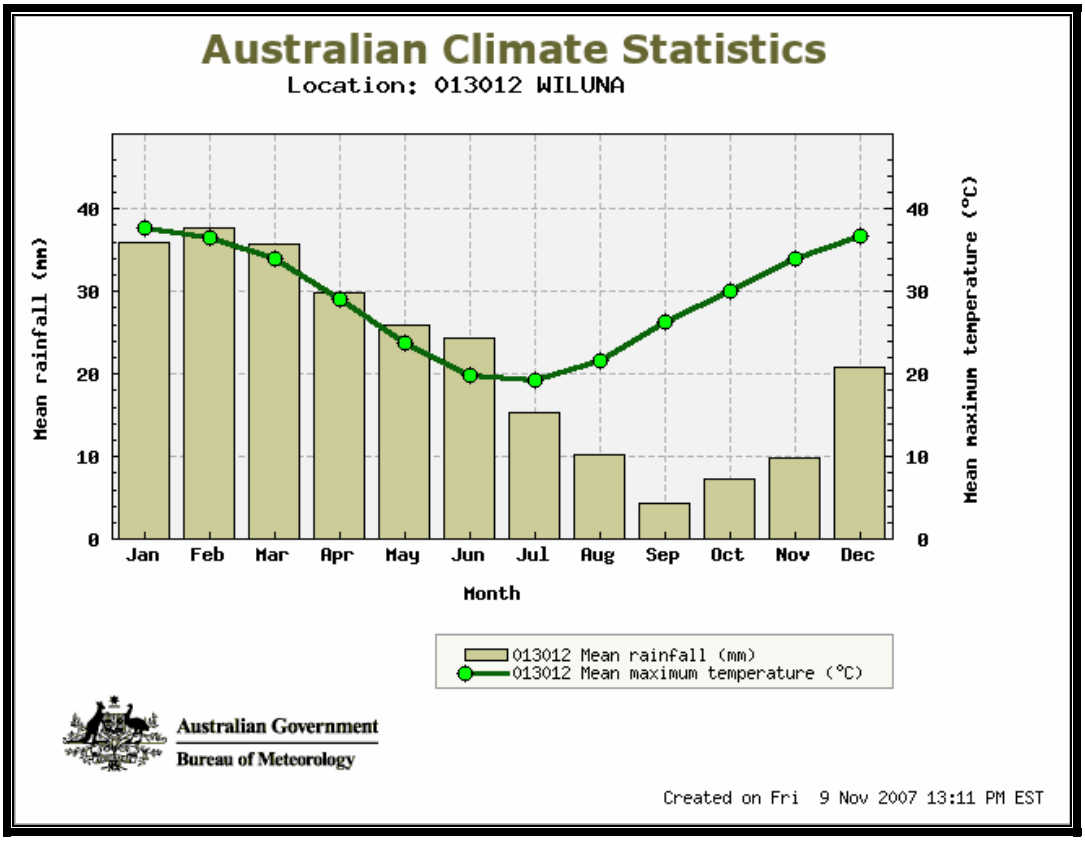

Figure 2 Climate data for Wiluna (BOM, 2007).

3.0 METHODS

3.1 EPA Survey Guidelines

The methods adopted for the survey were formulated as far as practicable in context with the Environmental Protection Authority (EPA) Position Statement No 3. "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA, 2002), and Guidance Statement No 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia" (EPA, 2004). The purpose of Guidance Statement No 51 (EPA, 2004) is to provide an overarching guide to the principles employed by the EPA when assessing the potential environmental impacts of an activity. Within the Position Statement, two levels of biological survey (fauna and flora) are detailed. The requirements of the two levels of survey are summarised below:

Level 1 survey

- Desktop review – incorporating a literature review, database searches and reviews of maps of proposed area of disturbance; and
- Reconnaissance survey – a site visit by suitably qualified personnel to:
    - Verify desktop review;
    - Catalogue flora, with a focus on the potential sensitivity of flora to disturbance; and
    - Broad-scale vegetation and vegetation condition mapping based on selected sites.

Level 2 survey

- Desktop review;
- Reconnaissance survey; and
- Comprehensive flora survey – comprehensive survey of the site and surrounding area, if appropriate, to assess vegetation in a local – regional context. Key features:
    - Quadrat-based survey
    - Application of statistical analyses to data
    - Multi-seasonal surveys, with a minimum of one survey conducted in the season following the majority of rainfall for the region.

Guidance Statement No 51 (EPA, 2004) provides proponents with a guide to the instances within which the different levels of survey would be considered appropriate. The suitability of the two levels of surveys is a product of the location (bioregion) of the project and the proposed scale and nature of the impact. Where the scale and nature of impact is low, a Level 1 survey is considered adequate (EPA, 2002). Where the scale and nature of the impact is moderate to high, a Level two survey is required (EPA, 2002). In light of the scale and nature of the proposed activities at Lake Way and Centipede, a Level 2 survey was deemed the correct level of survey. The survey to which this report relates was a first survey over the area and was based on the methods prescribed by the EPA (2004). Additional surveys would be required to meet the requirements of a Level 2 survey.

3.2 Desktop Review

A review of databases and publicly available information was conducted prior to the field surveys. The desktop review consisted of the following:

- A search of the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database for flora of conservation significance and Threatened Ecological Communities (TEC) known, or likely, to occur within the survey areas;
- A search of the Department of Environment and Conservation (DEC) Threatened (Declared Rare) Flora database, the Western Australian Herbarium (WAHERB) database and the Declared Rare and Priority Flora List for rare and priority flora known, or likely, to occur within the survey areas;
- A search of the DEC TEC database for listings of communities known, or likely, to occur within the survey areas;
- A limited review of publicly available ecological information pertaining to the survey areas and surrounds.

3.2.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

The *EPBC Act* is a federal government act with a focus on matters of National Environmental Significance (DEWHA, 2008). The act serves to provide a means to manage threats to the natural environment by:

- providing for the protection of biodiversity conservation through the identification of threatening processes, protecting critical habitat, preparation of management plans and issuing conservation orders;
- providing for compliance and enforcement through a range of actions including court injunctions and environmental auditing; and
- providing for an additional level of approval for activities likely to impact on aspects of the natural environment protected under the Act.

The Protected Matters database has been established to manage listings under the Act. A search of the Commonwealth *EPBC Protected Matters* database was undertaken for an area within a radius of 100km around a centre of S 26°45' 57.59" and E 120 °20' 22.24" (WGS84) (the approximate centre of Lake Way) to determine whether there were any listings under the Act for the Lake Way and Centipede project areas. In particular, the search was employed to determine whether there were any Threatened Ecological Communities or protected flora known or likely to occur within the project areas. Threatened Ecological Communities (TECs) classified as threatened are protected under Schedule 2 of the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999.* Approval from the Minister for the Environment and Heritage must be sought to undertake any action that is likely to have a significant impact on a listed threatened ecological community. There are three categories of TECs under the *EPBC Act 1999* – 'Critically Endangered', 'Endangered' and 'Vulnerable'.

3.2.2 Declared Rare and Priority Flora – DEC Database Search

Rare Flora are gazetted under subsection 2 of section 23F of the Western Australian *Wildlife Conservation Act 1950* and it is an offence to disturb rare flora. The Priority Flora list does not have the same legal status as the DRF Schedule, however Priority Flora are considered under the *Environmental Protection Act 1986* as enforced by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, when determining biodiversity value of an area (DoIR, 2006). Definitions of Declared Rare and Priority Flora categories are provided in **Appendix A**.

Prior to the field survey, a search was conducted of the Department of Environment and Conservation's *Threatened (Declared Rare) Flora* database, the *Western Australian Herbarium Specimen* database and the Declared Rare and Priority Flora List for rare and priority species opportunistically collected within a radius of approximately 100km surrounding the Lake Way and Centipede Project Areas, using the following centre co-ordinates:

- S 26°45' 57.59" and E 120°22' 22.24" (WGS84)

3.2.3 Threatened Ecological Communities – DEC Database Search

In Western Australia, the Department of Environment and Conservation (DEC) recognizes four categories of TEC within WA, as developed by English and Blyth (1997). These are – 'Presumed Totally Destroyed', 'Critically Endangered', 'Endangered' and 'Vulnerable' (**Appendix B**). Other ecological communities that are considered to possibly be under threat but do not meet the survey criteria associated with TECs, are listed under the Department's Priority Ecological Community List under Priorities 1, 2 and 3. Those ecological communities considered to be adequately known and are rare but not threatened, or that have been recently removed from the threatened list, are classified as Priority 4 and require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (Naturebase, 2006).

In addition to TECs, ecosystems are also described as being 'at risk'. The status of 'at risk' is recognised by the DEC and the Department of Environment, Water, Heritage and the Arts. Whilst not conferring any form of legislative protection, the application of the 'at risk' status is a useful tool that highlights ecosystems that may be subject to threatening processes and as such, could potentially become a Threatened Ecological Community in the future.

A search of the DEC TEC-PEC (Priority Ecological Community) database was undertaken for an area of approximately 100km around a centre of S 26° 45' 57.59" and E 120° 22' 22.24". In addition to the database search for TECs and PECs, the potential presence of 'at risk' ecosystems within the survey areas was determined by reviewing listings in the DEC biodiversity audit report for the Murchison 1 bioregion (Cowan, 2001).

3.2.4 Review of Existing Reports

The following reports were reviewed:

- Mabbutt *et al* (1963) *General report on the lands of the Wiluna-Meekatharra area, Western Australia, 1958.*
- Lancaster and Associates (1981). Lake Way Joint Venture: Environmental Review and Management Programme. Draft Environmental Impact Statement. (Incorporating a summary of the findings of Blackwell, M.I. and Trudgen, M.E. (1980) *Report on the flora and vegetation of the Lake Way Joint Venture uranium project area together with an assessment of the impact of this project upon the landscape, flora and vegetation of this area and its regeneration potential*.
- Bennett Environmental Consulting Pty. Ltd. (2002) *Vegetation of areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold Mine*
- Outback Ecology (2004) *Wiluna Gold Mine: Lake Way Baseline Study*

3.3 Field Survey

3.3.1 Timing of Surveys

The survey was undertaken between October 15th – 22nd, 2007. Rainfall in the month (September) immediately preceding the survey was below average with 0.4mm recorded (**Figure 3**). Two rainfall events occurred during the survey; however, these would have had no immediate obvious impact on vegetation.

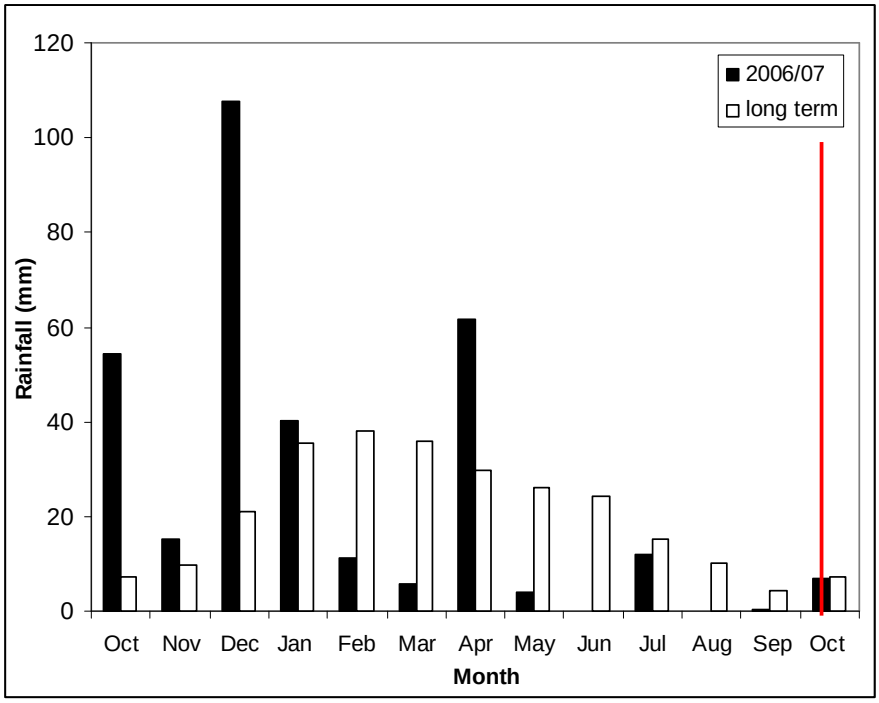

Figure 3 Monthly rainfall received at Wiluna from October 2006 – October 2007 in comparison to the long-term mean monthly rainfall. The red line indicates the timing of survey.

3.3.2 Survey personnel

Personnel involved in the flora and vegetation survey over the Lake Way and Centipede Project Areas were:

Mr Brett Neasham	BSc. (Biol) Hons (Env. Man)	Botanist/Environmental Scientist
Ms Belinda Jeanes	BSc. Env Biol	Botanist/Environmental Scientist

Specimen identifications:

Mr Brett Neasham	BSc. (Env Man) Hons	Botanist/Environmental Scientist
Ms Belinda Jeanes	BSc. Env Biol	Botanist/Environmental Scientist

Specialist identifications:

Mrs Bindy Datson, a botanist specialising in salt lake ecology.

Mr Russell Barrett

Mr Malcolm Trudgen – consulted regarding *Melaleuca* sp. nov (Trudgen)

3.3.3 Survey Methods

A total of 46 30m x 30m quadrats were sampled at the Centipede project area (**Figure 4**) (summary in **Appendix G**) and 62 30m x 30m quadrats were sampled at the Lake Way project area during the October 2007 survey (**Figure 5**) (summary in **Appendix G**). Initial site selection was based on interpretations of aerial photography, with further refinement in the field, with the aim of ensuring that each vegetation unit observed was surveyed using a minimum of two quadrats. A minimum of one quadrat was located in small vegetation units.

In each quadrat, the following was recorded:

- Location (recorded in WGS84 UTM)
- Estimated height and percentage foliar cover of all flora species. Minimum cut-off cover value was 2%, below 2% was scored as <2%. Height values were derived based on an approximate mean height value. Where species had a significant disparity in heights, values were based on the most commonly observed range of heights.
- Topographic position.
- Slope.
- Soil type.
- Type of litter and percent cover.
- Type and percent cover of exposed rock or surface rocks (where appropriate).
- Assessment of the condition of vegetation, based on the scale developed by Keighery (1994) (**Appendix D**).
- A photograph of the vegetation

All specimens collected were assigned a sample number in the field, with a sample collected for identification and a sample placed in a field herbarium. Where possible, multiple samples were collected to allow for variation between populations to be accounted for. Fruit was collected when possible. A tag was attached to each specimen, identifying location, date of collection, height, presence of flowers/fruit and brief description, specimen number and additional information to aid description of habitat if required. Specimens collected were identified by reference to taxonomic guides and Western Australian Herbarium samples. Where specimens could not be identified by botanists from OES, a specialist botanist was utilized. A complete list of species identified during the surveys is presented in **Appendix C**. Nomenclature follows Paczkowska and Chapman (2000) except for name changes, which were sourced from the Western Australian Herbarium (2007).

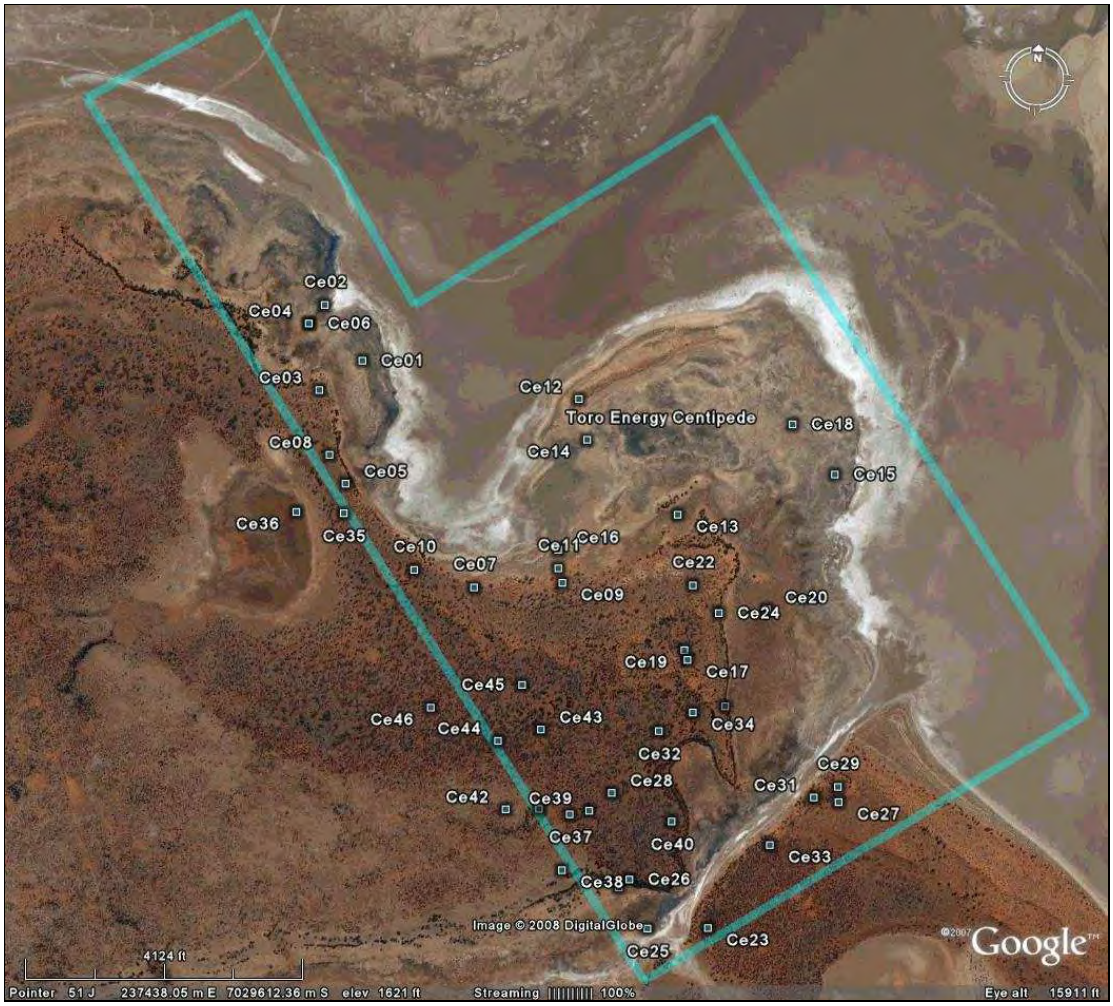

Figure 4 Location of quadrats at Centipede project area surveyed during October 2007.

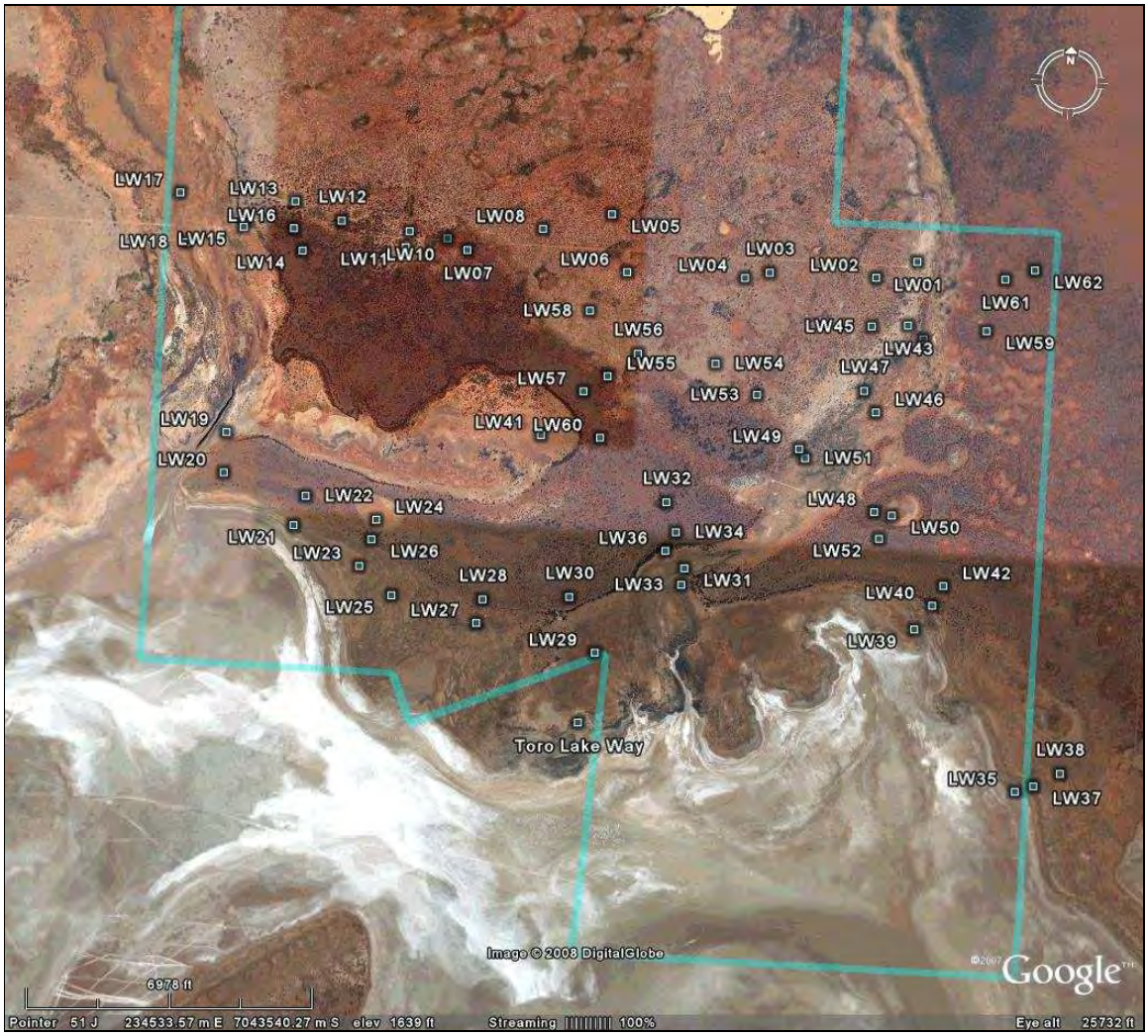

Figure 5 Location of quadrats at Lake Way project area surveyed during October 2007.

3.3.4 Assessment of Conservation Significance

The conservation significance of vegetation observed at the Centipede and Lake Way project areas was assessed in the field based on the following factors:

i. The presence of a previously identified TEC or 'at risk' vegetation community;
ii. The observation of a potentially unique and previously un-described vegetation association;
iii. The extent (local significance) of any vegetation association, irrespective of whether it was perceived as a TEC, 'at risk' or novel assemblage;
iv. The condition of any vegetation;
v. The presence of any priority flora, new species or range extensions

3.4 Data Analysis and Interpretation

3.4.1 Analysis of Floristic Data

Data were entered into excel spreadsheets to facilitate analysis in PRIMER, with nil and <2% cover values scored as 0 and all other values entered as recorded. Data were square root transformed prior to performing a resemblance analysis between samples using Bray-Curtis similarity as the measure. The resemblance output was then further analysed using CLUSTER and MDS (Multi-Dimensional Scaling). During the first pass MDS, two clear outliers were observed, Ce16 and Ce17 (both from the Centipede project area), which prevented any separation of the remaining quadrats. These quadrats were removed and the MDS and CLUSTER analyses were re-run.

3.4.2 Vegetation Mapping

Vegetation mapping was based on the outputs from the PRIMER analysis, field observations and interpretations of aerial photography of the project areas. The boundaries of vegetation types were identified and marked on aerial photography for plotting. Mapping of vegetation over the two project areas was undertaken at a scale of 1:10,000.

3.5 Limitations of Survey

The EPA (2004) lists a number of possible limitations that may limit the adequacy of flora and vegetation surveys. These are replicated in **Table 1** with an assessment of the current survey.

Table 1 Summary of Potential Flora and Vegetation Survey Constraints

Aspect	Constraint?	Comment Regarding Current Survey
Competency/experience of consultants	No	The senior botanist on this project had 8 years experience
Scope	No	The scope was clearly defined and realistically achievable within the designated timeframe.
Proportion of flora identified	Limited	A limited number of species were not able to be identified due to insufficient structures present to facilitate identification
Information sources (eg historic or recent)	Limited	No historical data was available for the Centipede project area, but there was data available for areas to the north of this site
Proportion of task achieved, and further work which might be needed	Limited	Sampling across the project areas was considered to be adequate. Additional surveying is recommended to enhance census data
Timing / weather / season / cycle	Limited	The survey was conducted in an area with bimodal rain. Additional surveys should be conducted to complement this survey
Disturbances	Limited	Whilst the majority of the survey areas were disturbed due to grazing and vehicular movement, these disturbances were not considered to be of such a magnitude that describing and assessing vegetation was affected. Some areas had been burnt, but the fires were not recent and the vegetation was in an advanced state of recovery.
Intensity	Limited.	The area was intensively surveyed; with 46 quadrats located within the Centipede project area and 62 quadrats located within the Lake Way project area. The majority of vegetation, as far as could be reasonably assessed, was surveyed.
Completeness	Limited	The census of flora was constrained by the effects of poor rainfall prior to the survey
Resources	No	
Remoteness / access problems	No	
Availability of contextual information	Limited	Some survey work conducted over Lake Way Project Area was conducted by Lancaster and Associates (1981) whilst smaller areas of Lake Way were surveyed by Eleanor Bennett in 2002) and Outback Ecology (2004).

4.0 RESULTS

4.1 Desktop Review

4.1.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

One threatened species, *Pityrodia augustensis* (Lamiaceae), was listed in the Protected Matters database search (**Appendix F**). This species was listed as being vulnerable. Western Australian Herbarium records list this species as Declared Rare (Western Australian Herbarium, 2007). The herbarium information indicates that this species is distributed to the north west of the survey areas (Western Australian Herbarium, 2007).

There were no TECs as defined under the Act within the search area. There were no World Heritage areas, National Heritage areas or RAMSAR wetlands within the search area. There were three places on the Register of the National Estate, one of which was Wanjarri, which is an A Class Reserve vested in the DEC (refer 2.3 for details). Wanjarri was also listed as a State Reserve.

4.1.2 Declared Rare and Priority Flora – DEC Database Search

No Declared Rare Flora, as defined under the Western Australian *Wildlife Conservation Act 1950*, have been recorded from within the DEC database search area as defined within this report. A total of 17 priority taxa have previously been collected and vouchered at the WA Herbarium from within the search area (**Table 2**). Of these, six taxa were Priority 1, two were Priority 2, six were Priority 3 and the remaining three were Priority 4 (**Table 2**). No record of the DRF *Pityrodia augustensis* was returned in this database search.

The known habitat of these species was reviewed to determine the likelihood of occurrence within the two project areas (**Table 3**). The majority of priority taxa were considered unlikely to occur within the project areas. The majority of priority flora recorded in the database searches were associated with banded ironstone formations (BIF), laterite or quartz breakaways. These landforms do not occur within the areas surveyed

Table 2 Priority Flora identified within the Wiluna area (DEC, 2007; Western Australian Herbarium, 2007) and a preliminary habitat assessment to determine potential occurrence within Centipede and Lake Way project areas

Cons. Code	Species	Habitat	Likelihood of occurrence in survey areas
P4	*Acacia balsamea*	Occurs on red earth & gravel. Associated with rocky hills, granite breakaways.	Unlikely in salt lake and fringing areas; however, records have been made close to Centipede project area
P3	*Baeckea* sp. Melita Stn	Occurs on dark red rocky soil over ironstone. Found in Mulga shrubland.	Unlikely, habitat not in survey areas
P2	*Beyeria* sp. Murchison	Found on BIF outcrop.	Unlikely, habitat not in survey areas
P3	*Calytrix uncinata*	Occurs on white or red sand and sandy clay. Associated with granite or sandstone breakaways and rocky rises.	Unlikely in salt lake or fringing areas; however, records have been made close to the Centipede Project Area
P1	*Eremophila congesta* ms	Found on lateritic outcrops in greenstone hills and stony quartzite slopes.	Unlikely, habitat not in survey areas
P1	*Eremophila flaccida* subsp. *attenuata*	Occurs on stony clay over quartzite. Found on hillslopes and ridges.	Unlikely, habitat not in survey areas
P4	*Eremophila pungens* ms	Occurs on sandy loam and clayey sand over laterite. Associated with plains, ridges and breakaways.	Unlikely in salt lake and fringing areas; however, records have been made close to Centipede project area
P1	*Euryomyrtus inflata*	Occurs on deep red sand on flat plains.	Unlikely, habitat and vegetation not in survey areas
P4	*Hemigenia exilis*	Found on laterite, breakaways and slopes.	Potential to occur in project area, mainly due to proximity of Lake Way to record
P3	*Homalocalyx echinulatus*	Occurs on red sands. Found on sandplains.	Unlikely, local records appear to be on BIF ridges or remnants
P3	*Maireana prosthecochaeta*	Occurs on sand and clay. Associated with the margins of lakes and watercourses.	Habitat is suitable for this species, local record is at base of a breakaway, none of which were observed during surveys
P3	*Myriocephalus appendiculatus*	Occurs on sand & clay soils. Associated with moist depressions, swamps, claypans.	Habitat is suitable for this species. Local record on Kopi ridges, non of which occurred within areas surveyed
P2	*Olearia mucronata*	Found on schistose hills and along drainage channels.	Potential to occur within project areas. Local records note occurrence on ironstone and quartz ridges
P3	*Prostanthera ferricola*	Local records on banded ironstone ridges	Unlikely to occur within project areas
P1	*Ptilotus astrolasius* var. *luteolus*	Found on red sandy soils, basalt and stony hills.	Unlikely to occur in project area. Local records from low quartz ridge, which do not occur within project areas.
P1	*Ptilotus chrysocamus*	Brown sandy clays. Bases of breakaways, rocky scree slopes.	Unlikely to occur within project area. Local record is at the base of a rocky breakaway
P1	*Stackhousia clementii*	Found on skeletal soils and sandstone hills. Recorded near watercourse.	Unlikely, habitat does not occur within the project areas.

4.1.3 Threatened Ecological Communities – DEC database search

One TEC was listed as occurring within the DEC search parameters; the Wiluna West vegetation complexes on banded ironstone formation. This TEC does not occur within the areas surveyed in October 2007. A total of 17 'at risk' ecosystems have been identified within the Murchison 1 bioregion, of which one, "*Melaleuca* sp. nov (*M. xerophila*) Low Closed to Open Forest Strand Community near Wiluna" (Cowan, 2001) was considered as occurring within the Centipede and Lake Way Project Areas. Details on the distribution and conservation significance of this association are discussed in the vegetation results section.

4.1.4 Review of Existing Reports

Mabbutt *et al* (1963) *General report on the lands of the Wiluna-Meekatharra area, Western Australia, 1958.*

The Wiluna – Meekatharra area, within which the project areas are located, was surveyed in 1958 by personnel from the CSIRO Division of Land Research and Regional Survey (Mabbutt *et al.,* 1963). The objective of the survey was to map and describe sections of Australia. The main descriptive unit employed during the survey was the land system, which was essentially an area within which patterns of vegetation, soil and landforms were observed. The land systems were developed to provide a means of assessing the potential use of land for pastoral activities across large survey areas.

The surveys conducted by the CSIRO Division of Land Research and Regional Survey utilise the same descriptive terminologies and survey methodologies as those employed in the inventory and condition surveys subsequently undertaken by the Department of Agriculture and Food (formerly Department of Agriculture). This provides for a degree of confidence and relevance in the broad descriptions of Mabbutt *et al.* (1963) datasets, in spite of the age of the surveys. Any assessments regarding condition of vegetation or soils were ignored due to the lack of recent supporting data.

The Lake Way Project Area was located over three land systems (**Table 3**). Of the land systems noted for the Lake Way Project Area, the Carnegie and Cunyu systems are the most widespread. The Centipede Project Area was located over the same two land systems (**Table 3**). The comparative dominance of these two land systems within the project areas is a reflection of the location of the ore bodies in calcrete paleochannels.

Table 3 Summary of Land Systems over the Lake Way and Centipede Project Areas (adapted from Mabbutt *et al.,* 1963).

Land Type (broad descriptive unit)	Land System	Description.	Total area and % of Wiluna – Meekatharra survey area*	Occurrence over Project Areas
Depositional Surfaces – Calcreted valley fills	Cunyu	The Cunyu Land System is comprised of tertiary calcrete in the form of valley fills with a mosaic of calcrete platforms and alluvial floors and plains. The Land System has a low gradient. The majority of vegetation within the Cunyu Land System is mulga or *Acacia* spp grading to fringing communities or halophytic vegetation.	1554km^2 (2.4%)	Widespread at Lake Way, small occurrence at Centipede
Depositional Surfaces – Partly saline alluvial plains	Barwidgee	The Barwidgee Land System is comprised of fine-textured saline alluvium in the form of partly saline plains, tributary plains and small clay-pans. Vegetation is variable but is dominated by halophytic shrublands with the remaining areas ranging from eucalpyt and mulga communities to bare areas.	674km^2 (1%)	Lake Way Project Area.
Depositional Surfaces – Mainly non-saline alluvial plains	Mitchell	The Mitchell Land System is comprised of quarternary alluvium and aeolian sands in the form of non-saline alluvial sandy plains grading to saline alluvial flats in lower areas. Vegetation ranges from mulga on sand plains and groves to halophytic shrublands on saline plains and intergroves and wanderrie flats.	466km^2 (0.7%)	Restricted to a small area on the northern edge of Lake Way Project Area.
Depositional Surfaces – Sand plain and dunes	Bullimore	The Bullimore Land System is comprised of quarternary aeolian sand in the forms of depositional sand plains and dunes and occasional breakaways. Vegetation is predominately spinifex with a canopy of mallee or mulga grading to spinifex and forbs. A small percentage of the Land System is host to mulga with mallee over mixed grasses and forbs.	13985km^2 (21.6%)	Lake Way Project Area
Depositional Surfaces – Salt lakes and dunes	Carnegie	The Carnegie Land System is comprised of quarternary lacustrine saline clay and sand, saline alluvium and aeolian sand in the form of salt lakes and fringing dunes, with kopi banks to the south and east of lakes. Vegetation ranges from samphire or halophytic shrublands to fringing communities of *Melaleuca* spp or mulga to mulga over chenopods to mainly bare.	3625km^2 (5.6%)	Main Land System at Centipede, widespread at Lake Way

* area converted from square miles – conversion factor of 2.5899 used to derive area in square kilometres

Lancaster B, and Associates (1981). Lake Way Joint Venture: Environmental Review and Management Programme. Draft Environmental Impact Statement. (Incorporating a summary of the findings of Blackwell, M.I. and Trudgen, M.E. (1980) *Report on the flora and vegetation of the Lake Way Joint Venture uranium project area together with an assessment of the impact of this project upon the landscape, flora and vegetation of this area and its regeneration potential*.

The Lake Way project area was surveyed by Blackwell and Trudgen (1980) as a component of the Lake Way Joint Venture environmental review. In the course of the survey, a total of 204 species were collected from the broader survey area, with 141 species collected from within the detailed study area. A number of the specimens collected during the survey were considered vulnerable but could not be

identified to the species level. However, the species in question were not considered to be severely impacted by the proposed development. Species named included:

- *Melaleuca* sp nov – subsequently confirmed as *M. xerophila*, a species that does not currently occur in any conservation listing
- *Amyema* sp (Loranthaceae) – undescribed species
- *Rhagodia sp* (Chenopodiaceae) – undescribed species
- *Lawrencia* sp (Malvaceae) – undescribed species. This species is described as a small herb and is potentially *L. densiflora*
- *Swainsona* cf *unifoliata* – similar to *S. unifoliata*.
- *Eremophila arachnoides* – an undescribed subspecies. This is potentially a reference to *E. arachnoides* subsp. *arachnoides*, which is a Priority 3 taxon and the only *E. arachnoides* subspecies recorded within the Murchison bioregion (Western Australian Herbarium, 2007); however, no record of this species exists within the survey areas. The closest confirmed record of this species is over 100km north of Wiluna (Western Australian Herbarium, 2007).

Vegetation observed during the survey by Blackwell and Trudgen (1980) was considered to be typical of salt lake edges within the Austin botanical province – with the exception of the low closed to open forest *Melaleuca* sp. nov, located in fringing areas between halophytic flats and upslope vegetation units (Lancaster and Associates, 1981). *Melaleuca* sp. nov has been confirmed as *M. xerophila* (M. Trudgen, pers. comm.). This association has been classed as 'at risk' and is referred to in the biodiversity audit for the East Murchison bioregion (Cowan, 2001). Fringing vegetation was dominated by Chenopodiaceae, consistent with halophytic vegetation communities. Inland from the lake's edge, vegetation is comprised of Low Open Calcrete Woodlands and Mallee – Spinifex or Mulga – Spinifex Hummock Grassland Associations (Lancaster and Associates, 1981).

The Low Open Calcrete Associations were considered to be diverse but with a comparatively poor ground cover layer (Lancaster and Associates, 1981). This was considered to be due to a mix of drought, grazing and the effects of erosion. The Hummock Grassland Associations were highly variable, with cover of emergent species ranging from scattered to 30% cover (Lancaster and Associates, 1981). The development of individual and clusters of spinifex were similarly variable.

Bennett Environmental Consulting Pty. Ltd. (2002) *Vegetation of areas impacted by construction of a causeway for exploration drilling at Lake Way Wiluna Gold Mine*

This survey was focused on an island located within Lake Way and an area adjacent to the island. Vegetation within the areas surveyed was dominated by *Halosarcia* Low Heath and *Acacia* Shrubland or Woodland (Bennett Environmental Consulting, 2002). None of the vegetation was identified as having conservation significance. The vegetation within the Lake Way Project Area was described as being in very good condition. Whilst there was some evidence of degradation due to grazing, the area had been destocked at the time of the survey.

Bennett Environmental Consulting (2002) recorded flora from 26 families, 54 genera and 97 taxa (species and subspecies) during the survey. The dominant families were Chenopodiaceae (10 genera, 24 species), Poaceae (11 species, 18 genera), Myoporaceae (1 genus, 7 species), Amaranthaceae (2 genera, 6 species) and Malvaceae (2 genera, 6 species). No DRF or Priority Flora were recorded during this survey.

Outback Ecology (2004) *Wiluna Gold Mine: Lake Way Baseline Study*

Flora and vegetation in this report was located on the fringing areas of Lake Way to the north of the Centipede project area and was described as samphire vegetation (Outback Ecology, 2004). During the survey, Outback Ecology (2004) recorded eight species, of which five were species of *Halosarcia* (Chenopodiaceae). Other species recorded were *Maireana brevifolia* (Chenopodiaceae)*, Frankenia cinerea* (Frankeniaceae) and *Lawrencia helmsii* (Malvaceae).

4.2 Field Survey

4.2.1 Vegetation – Statistical Analysis

A cutoff line to determine similarity between quadrats was set at 25% on the CLUSTER dendrogram (**Figure 6**). Whilst a higher level of similarity would typically be employed, this was considered unnecessary as it would have led to the delineation of more vegetation units within the survey area than was considered accurate. The effects of a high number of quadrats and a comparatively low number of species (for the number of quadrats) were also considered in determining the cutoff. The ordination produced in the MDS analysis had a stress value of 0.16 (**Figure 7**), indicating that the representation of the relationship between quadrats in the ordination was due to an underlying similarity. The output in the MDS was considered to be consistent with the delineation of vegetation from the CLUSTER analysis.

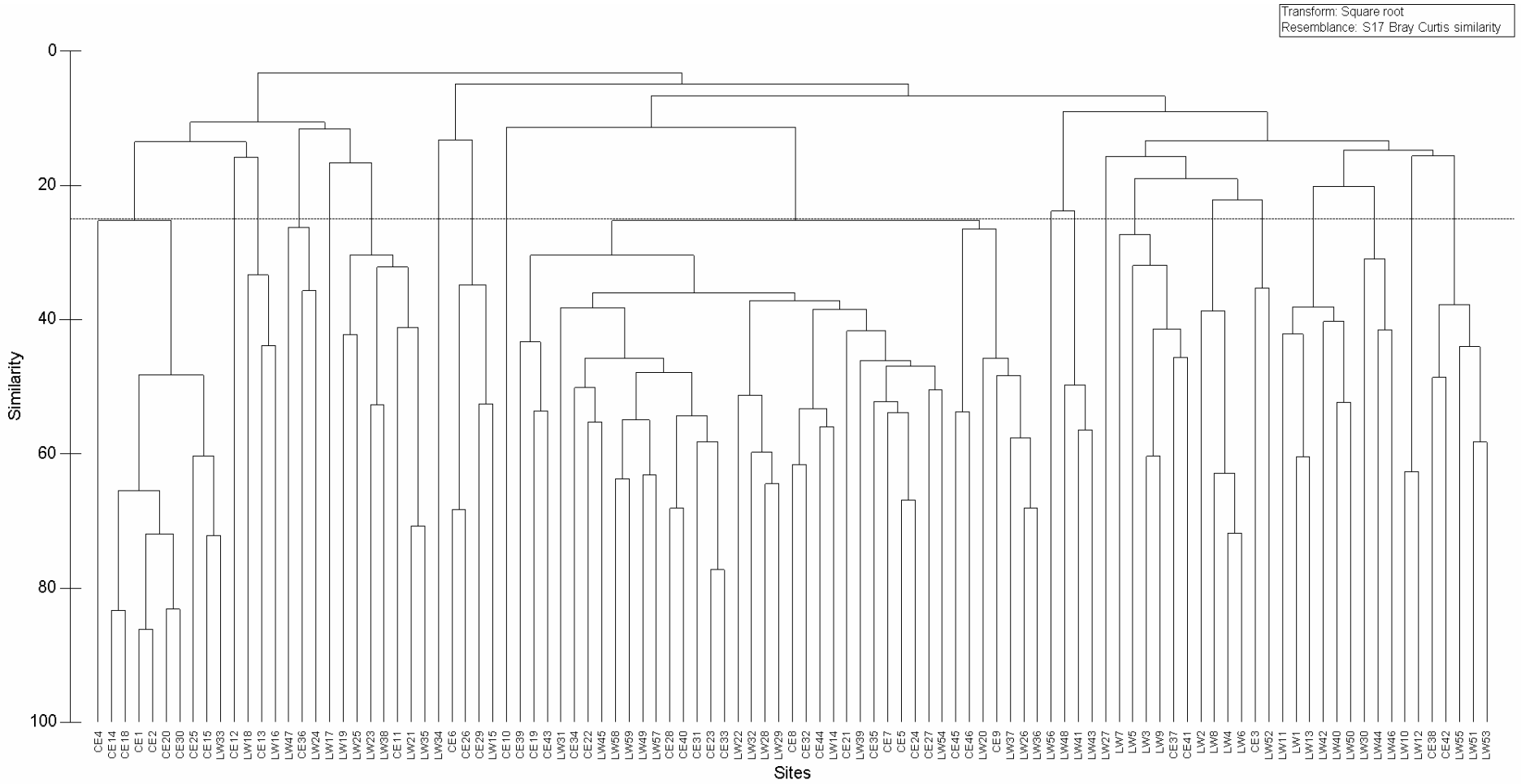

Figure 6 Dendrogram produced from CLUSTER analysis in PRIMER, showing the relationship between quadrats at the Centipede and Lake Way project areas as surveyed in October 2007, based on cover adjusted (<2% removed) square root transformed species composition.

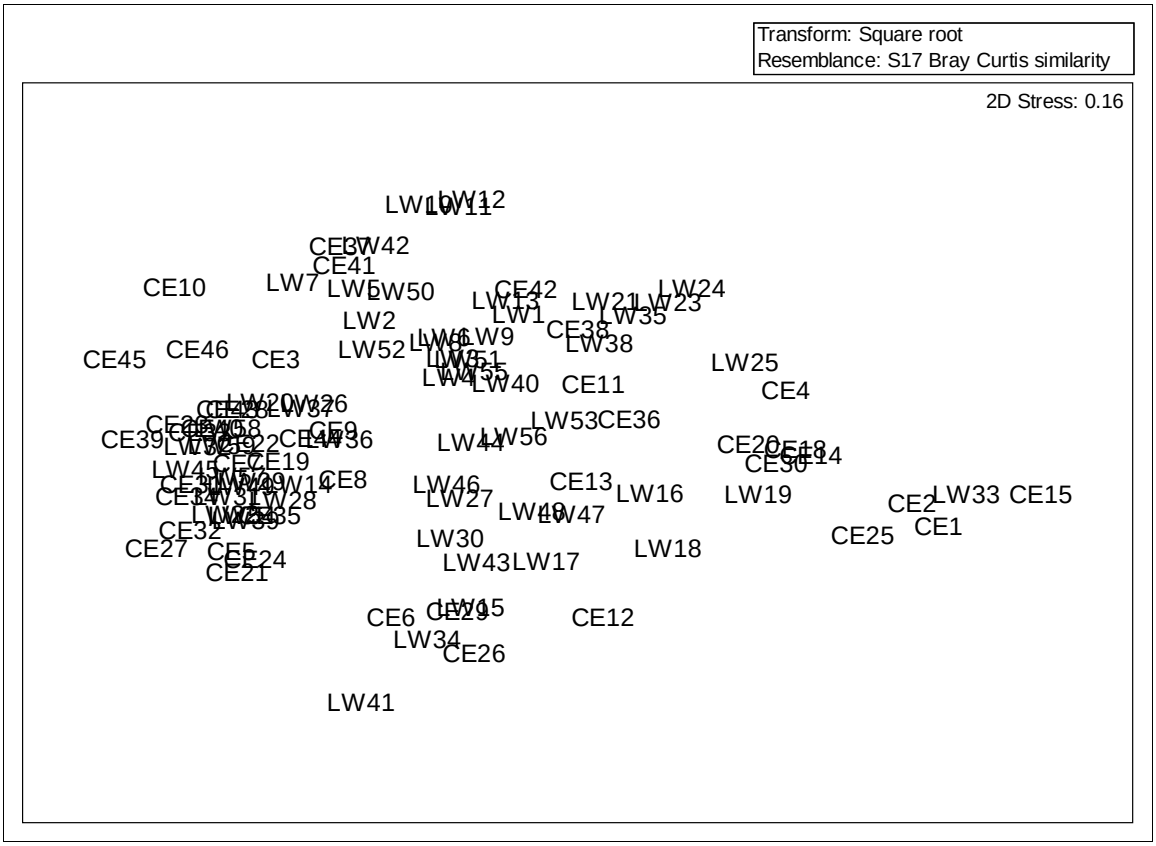

Figure 7 Multi-dimensional scaling (MDS) ordination produced from analysis in PRIMER showing the relationship between quadrats at the Centipede and Lake Way Project Areas as surveyed in October 2007, based on cover adjusted (<2% removed) square root transformed species composition.

4.2.2 Vegetation – Descriptions

A total of 22 vegetation units were described and delineated within the Centipede and Lake Way project areas based on analysis and interpretation of data collected during the October 2007 survey. The delineation of vegetation within the survey areas was affected by edaphic variables, with the distribution of many taxa and, subsequently, vegetation clearly delineated by underlying geology, hydrology and salinity or a combination of all these factors, which led to the definition of five key groups:

- Playa Vegetation
- Fringing Vegetation
- Dune and Plains Vegetation
- Calcrete Vegetation
- Clay-Pan Vegetation

Vegetation maps were produced for Centipede (Figure 8) and Lake Way (Figure 9)

Salt Lake (playa) Vegetation

Ha1 – *Halosarcia indica* subsp. *leiostachya* and *Halosarcia auriculata* Dense Low Heath over *Eragrostis* spp. Very Sparse Grass

This vegetation was widely observed at the Centipede project area but was only recorded in one quadrat at the Lake Way project area. This association was recorded in Ce1, Ce2, Ce14, Ce15, Ce18, Ce20, Ce25, Ce30 and LW33. This vegetation association was dominated by the two *Halosarcia* species, which change in relative abundance across the area in which they occur. Abundances and relative ratios of the two species change quite abruptly, and as such, it was considered appropriate to view changes in abundance as secondarily significant and not adequate to justify further delineation. .

Ha2 – *Halosarcia indica* subsp. *bidens, Atriplex bunburyana* and *Frankenia* sp1 Mid Density Low Heath.

This vegetation was recorded in one quadrat, LW17. Whilst not technically occurring on the playa, this association was recorded in a low lying area which was considered to act as a drainage channel into Lake Way. The halophytic nature of the species recorded is consistent with playa vegetation.

Ha3 – *Halosarcia* spp., *Frankenia* spp. Mid Density Low Heath over *Eragrostis* spp. and *Aristida contorta* Sparse Open Grass.

This vegetation was widespread at the Lake Way project area, but was only recorded once at the Centipede project area. This association was recorded in LW19, LW21, LW23, LW25, LW35, LW38 and Ce11.

Te1 – *Tecticornia tenuis* and *Halosarcia auriculata* Mid Density Low Heath over *Eragrostis* spp. Very Sparse Grass.

This vegetation was recorded at both project areas, but was not widespread where it occurred. It was recorded in Ce12, Ce13, LW16 and LW18.

Fr1 – *Frankenia* spp. and *Muellerolimon salicorniaceum* and mixed species Low Density Heath over *Aristida contorta* Sparse Grass

This vegetation was recorded in one quadrat, LW27.

La1 – *Lawrencia helmsii* and *Halosarcia indica* subsp. *leiostachya* Very Sparse Dwarf Scrub over *Ptilotus obovatus* var. *obovatus* Very Sparse Herbs over *Eragrostis* spp. Very Open Grass.

This vegetation was recorded in one quadrat at the Centipede project area, Ce4 and was noted as a discrete patch within Ha1.

Claypan Vegetation

Fr2 – *Frankenia* spp. and *Halosarcia calyptrata* Mid Density Low Heath over *Eragrostis* spp. Very Sparse Grass.

This vegetation was recorded in one large isolated claypan at Centipede (Ce36) (not included in vegetation map), one isolated claypan at Lake Way (LW24) and in one claypan that was a part of a chain of claypans located to the east of the Lake Way project area (LW47).

Te2 – *Tecticornia arbuscula, Maireana amoena* and mixed species Sparse Dwarf Scrub over *Triodia melvillei* Sparse Hummock Grass and *Eragrostis* spp. Sparse Grass.

This vegetation was recorded in a chain of claypans located to the east of the Lake Way project area in three quadrats, LW41, LW43 and LW48.

Ly1 – *Lycium australe, Cratystylis spinescens* and mixed species Mid Density Heath over *Eragrostis* spp. Mid Density Grass.

This vegetation was recorded in one quadrat, LW56, at the Lake Way project area in an isolated claypan.

Fringing Vegetation

Me1 – *Melaleuca xerophila* Mid Density Low Forest

This vegetation was recorded in three quadrats at the Centipede project area, Ce6, Ce26 and Ce29 and one quadrat at the Lake Way project area, LW15. This is an 'at risk' vegetation association referred to in Cowan (2001).

Calcrete Vegetation

Ac1 – *Acacia* spp., *Eucalyptus striaticalyx* subsp. *striaticalyx* and *Casuarina pauper* Mid Density Low Forest over *Maireana villosa* Mid Density Low Heath and *Ptilotus obovatus* var. *obovatus, Aristida contorta* and *Eragrostis* spp. Mid Density Herbs and Grass.

This vegetation was recorded only on areas of calcrete located at the Lake Way project area. This association was recorded in quadrats LW2, LW4, LW6 and LW8.

Ac2 – *Acacia ramulosa* var. *linophylla* and *Acacia victoriae* Sparse Low Woodland over mixed species Very Sparse Open Dwarf Scrub over *Neurachne munroi* and *Eragrostis dielsii* Mid Density Grass

This vegetation was widespread across the Lake Way project area and was recorded in LW1, LW11, LW13, LW40, LW42 and LW50.

Plains and Dune Vegetation

Hu1 – Mixed species Sparse Scrub over *Triodia melvillei* Mid Density Hummock Grass over *Eragrostis* spp and *Aristida contorta* Open Grass.

This vegetation was recorded in one quadrat, LW34.

Ca1 – *Callitris preissii* and *Acacia jennerae* Sparse Low Woodland over *Halgania* aff. *cyanea* Very Sparse Open Dwarf Scrub over *Triodia basedowii* Mid Density Hummock Grass.

This vegetation was recorded in one quadrat, Ce10.

Ca2 – *Callitris preissii* Woodland over *Triodia basedowii* Mid Density Hummock Grass.

This vegetation was recorded in one quadrat, Ce17 (not included in vegetation map).

Ac3 – *Acacia* spp., *Eucalyptus eremicola* subsp. *peeneri* and *Grevillea sarissa* subsp. *succincta* Sparse Low Woodland over *Eremophila* spp. and *Dodonaea viscosa* subsp. *angustissima* Very Sparse Open Dwarf Scrub and *Triodia melvillei* Mid Density Hummock Grass.

This was a very widespread and highly variable vegetation unit that was recorded at Centipede and Lake Way. This association was recorded on dunes and plains. This vegetation was recorded in Ce5, Ce7, Ce8, Ce19, Ce21, Ce22, Ce23, Ce24, Ce27, Ce28, Ce31, Ce32, Ce33, Ce34, Ce35, Ce39, Ce40, Ce43, Ce44, LW14, LW22, LW28, LW29, LW31, LW32, LW39, LW45, LW49, LW54, LW57, LW58 and LW59.

Ac4 – *Acacia ayersiana* var. *latifolia, Acacia aneura* var. *aneura* and *Acacia aneura* var. *major* Sparse Low Woodland over mixed species Sparse Low Scrub and *Triodia* spp. Mid Density Hummock Grass.

This vegetation was observed at both project areas. The association was recorded in Ce9, CE45, Ce46, LW20, LW26, LW36 and LW37.

Ac5 – *Acacia* spp. Very Sparse Open Low Woodland over *Eremophila* spp., *Senna* spp. and *Maireana pyramidata* Sparse Low Scrub and *Ptilotus obovatus* var. *obovatus* and *Eragrostis* spp. Very Sparse Herbs and Grass.

This vegetation was recorded in Ce37, Ce41, LW3, LW5, LW7 and LW9.

Ac6 – *Acacia* spp. Sparse Low Woodland over mixed species Very Sparse to Very Open Dwarf Scrub.

This vegetation was recorded at both project areas; however, it was noted in only quadrat at each (Ce3 and LW52).

Ac7 – *Acacia jennerae* and *Grevillea sarissa* subsp. *succincta* Sparse Low Woodland over *Cratystylis spinescens* Mid Density Low Heath and *Triodia melvillei* Dense Hummock Grass.

This vegetation was only observed at the Lake Way project area, in LW30, LW44 and LW46.

Ac8 – *Acacia* spp. Sparse Low Woodland over *Senna artemisioides* subsp. *filifolia* and *Eremophila* spp. Mid Density Heath over *Eragrostis dielsii* and *Neurachne munroi* Sparse Grass.

This vegetation was observed at both project areas, in CE38, CE42, LW51, LW53 and LW55.

Eu1 – *Eucalyptus striaticalyx* subsp. *striaticalyx* and *Acacia* spp Mid Density Forest over *Senna artemisioides* subsp. *filifolia* and *Eremophila* spp. Sparse Low Scrub.

This vegetation was only observed at the Lake Way project area, in LW10 and LW12.

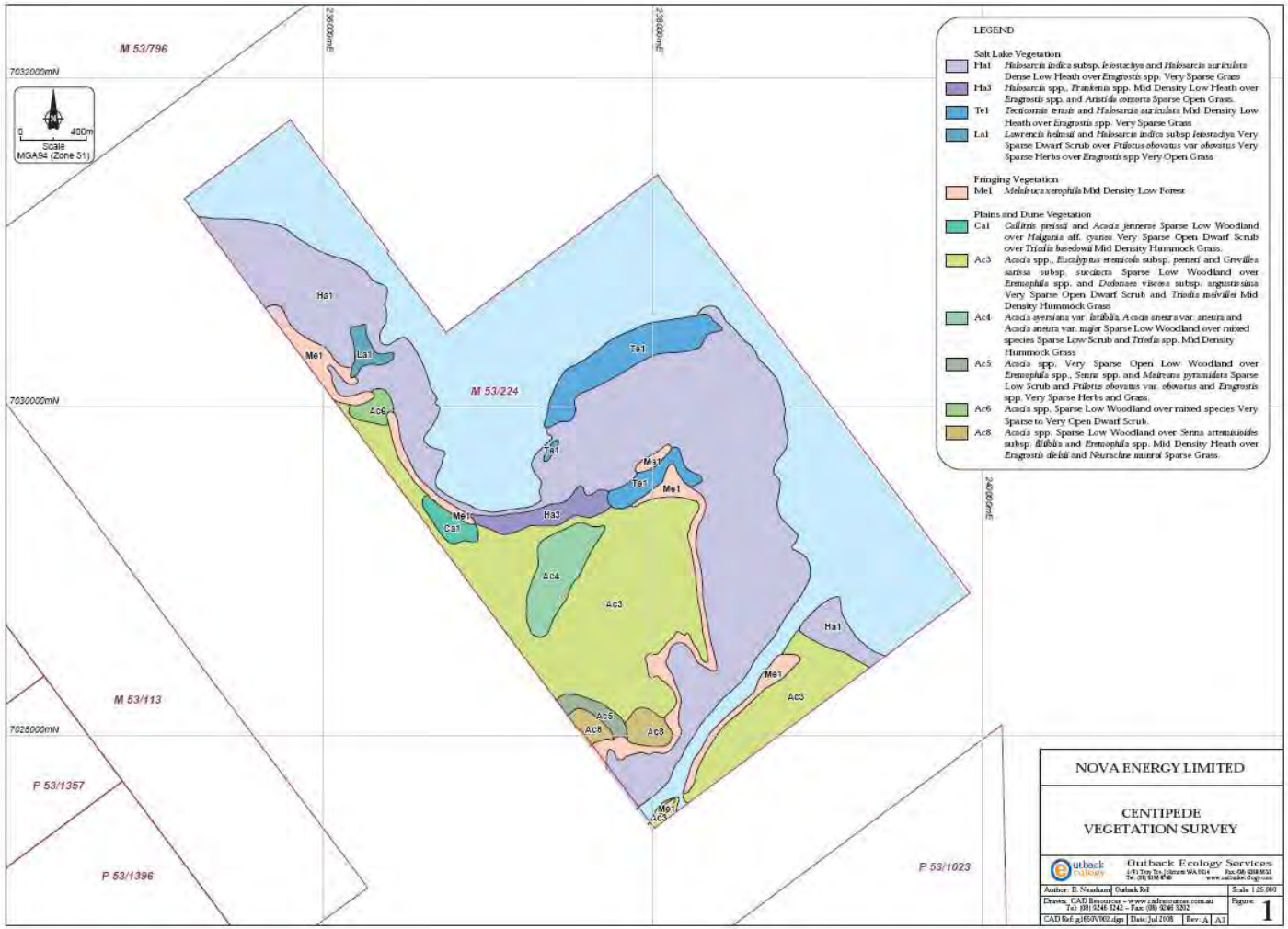

Figure 8 Vegetation map of the Nova Energy Centipede project area

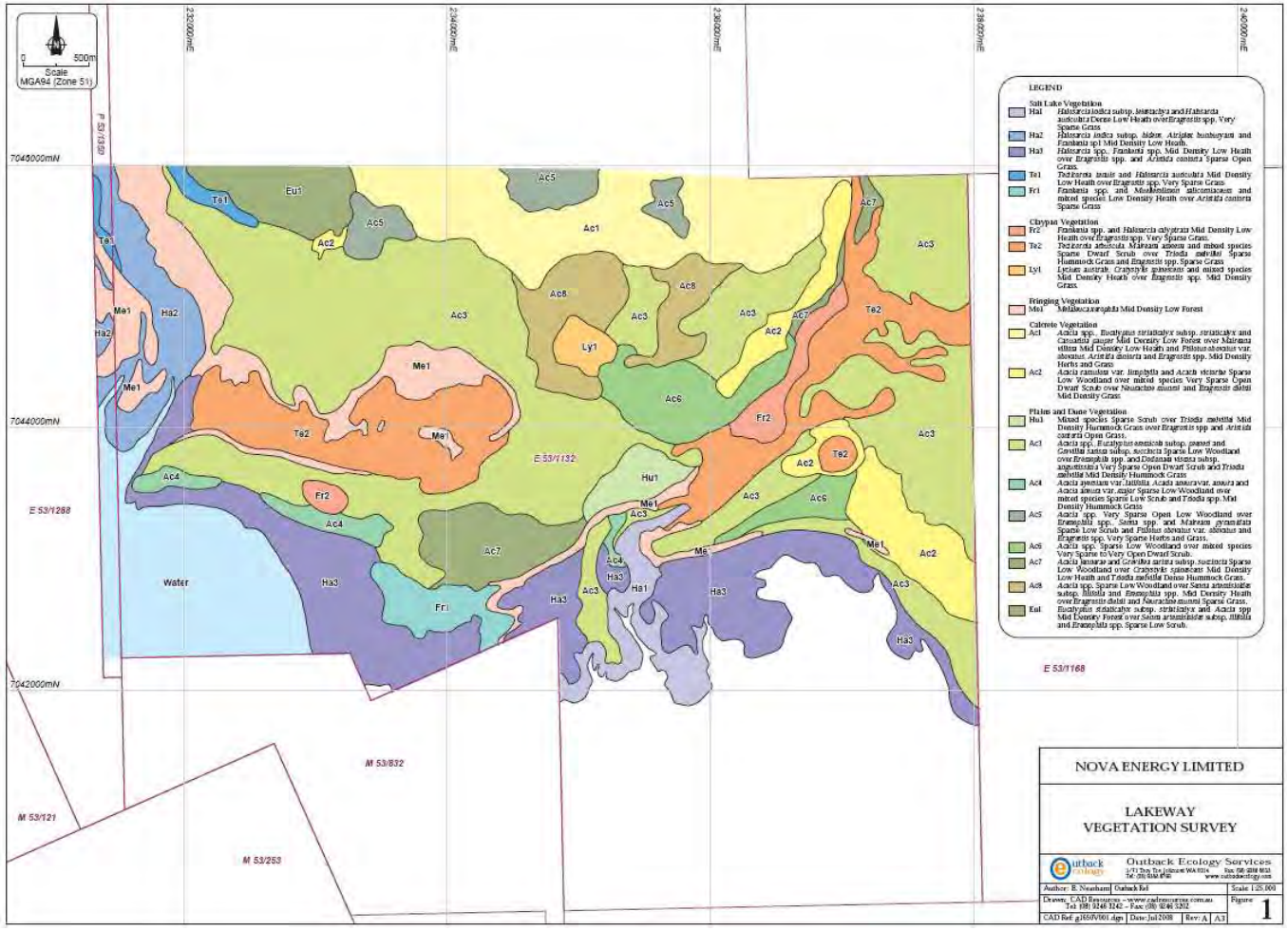

Figure 9 Vegetation map of the Nova Energy Lake Way project area

4.2.3 Vegetation Condition Assessment

The majority of vegetation surveyed during the October 2007 survey of the Lake Way and Centipede project areas was assessed as being in very good to excellent condition (**Table 4**), according to the scale of Keighery (1994) (**Appendix D**). No vegetation was assessed as being degraded or completely degraded (**Table 4**). One quadrat at the Centipede project area, Ce23, was assessed as being in pristine condition. The absence of any vegetation in the assessment categories degraded and completely degraded is a reflection of sampling bias, with quadrats located to best capture vegetation representative of the area. In areas where frequently used vehicle tracks were located, the vegetation was either degraded or completely degraded.

Table 4 Summary of assessment of condition of vegetation according to the scale of Keighery (1994) in quadrats surveyed at Lake Way and Centipede project areas in October 20007

Condition assessment	Lake Way project area	Centipede project area
Pristine	0%	2.2%
Excellent	57.6%	69.6%
Very Good	40.7%	26%
Good	1.7%	2.2%
Degraded	0%	0%
Completely degraded	0%	0%

The main causes of disturbance of vegetation at both the project areas were related primarily to the activities of cattle and, to a lesser extent, rabbits (**Table 5**). Impacts related to cattle activities ranged from cattle pats through to complete grazing to ground level of grass species, most notably *Eragrostis eriopoda* (Woolly Butt). Impacts from rabbits were typically in the form of scratchings, burrows and the presence of latrines. The impact of vehicles on vegetation is rated comparatively low at Lake Way, but was more widespread at the Centipede project area (**Table 5**), where numerous vehicle tracks were noted across the samphire vegetation on the playa and through the dune systems.

Table 5 Summary of main causes of disturbance to vegetation in quadrats surveyed at Lake way and Centipede project areas in October 2007.

Disturbance	Lake Way project area	Centipede project area
Cattle (grazing, tracks, scats)	55%	50%
Rabbits (burrows, scratchings, scats)	22%	18.9%
Vehicle tracks	6.6%	24.3%
Kangaroos (tracks, scats)	1.3%	4%
Clearing	1.3%	1.4%
Fire	6.6%	0%
Drill lines/drill holes	0%	1.4%

4.2.4 Conservation Significance of Vegetation

The 'at risk' vegetation association, "*Melaleuca* sp nov Low Closed to Open Forest Strand Community Near Wiluna" (Cowan, 2001) was considered to be the *Melaleuca* vegetation observed at both the Centipede and Lake Way project areas. *Melaleuca* sp nov has been confirmed as *M. xerophila* by Malcolm Trudgen (pers. comm.), who recommended that this association was 'at risk'. This association occurs on both the Centipede and Lake Way project areas. This association, where observed, was typically in narrow bands located between the playa and the dune or plains vegetation.

There is also the potential that the halophytic vegetation located at the Centipede and Lake Way project areas are potentially unique assemblages. Samphire specimens collected during this survey were identified by Bindy Datson, a specialist salt lake biologist, who observed that the samphire assemblages at Centipede and Lake Way were considered to be somewhat unique when compared to other assemblages located on similar habitat in the general area (Bindy Datson, pers. comm.). In the absence of additional evidence, this would qualify this association as having some level of conservation significance, although this is most likely to be a local significance.

The remaining vegetation at the Centipede and Lake Way project areas was not considered to have any conservation significance. Whilst there is a listing in Cowan (2001) noting that calcrete platform woodlands of the north-eastern Goldfields are 'at risk', this is a broad description and may not encompass all calcrete vegetation. In the absence of further evidence, the calcrete vegetation at the Lake Way project area as observed during this survey was not considered to be of conservation value consistent with being placed in the 'at risk' category.

No Declared Rare Flora or Priority Flora were recorded during the survey, and as such the vegetation does not have conservation significance as a host to protected flora. The remaining vegetation was considered to be locally widespread and as such was not assessed as having high conservation value.

4.3 Summary of Flora

A total of 132 taxa (including subspecies and variants) from 65 genera and 32 families were recorded across the Centipede and Lake Way Project Areas. The flora was dominated by the Chenopodiaceae, with 32 taxa from 10 genera (**Table 6**). The Poaceae and Mimosaceae were the next two most speciose families, with 14 taxa. However, the figure for Poaceae should be considered as the minimum for this family. This assertion is based on the *Eragrostis* group, within which several species are known to have been recorded in the area (Bennett, 2002) but the condition of samples limited identification with high levels of accuracy. For the purposes of this report, this group is listed as *Eragrostis* spp. Within this group, *E. dielsii* is considered to be the dominant species. *Eragrostis eriopoda* is not included within *Eragrostis* spp. as this species was readily identifiable.

In addition to the identified taxa, four records could not be identified, eight samples could only be identified to genus and a further eight have been tentatively identified to species. Further sampling will be required to confirm identification of these samples

One record of an alien taxon, **Anagallis arvensis,* was made at a single site. In addition to this record, an Aizoaceae (tentatively identified as *Carpobrotus* sp) may potentially be an alien taxon. Further samples are required to confirm the identification of this record.

Table 6 Summary of dominant flora within the Centipede and Lake Way Project Areas, based on data collected in October 2007.

Family	Number of taxa	Number of genera
Chenopodiaceae	32	10
Poaceae	14*	10
Mimosaceae	14	1
Myoporaceae	7	1
Asteraceae	7	6

* this figure includes *Enneapogon* spp, which is considered to potentially be more than one species

It is important to note that the figure of 132 taxa recorded in this survey is higher than the records of Bennett Environmental Consulting (2002) with 92 taxa but lower than the Lancaster and Associates (1981) survey with 141 taxa. It should be noted that Bennett Environmental Consulting (2002) is a survey over areas including Peanut Island, whilst the survey by Blackwell and Trudgen (1980) outlined by Lancaster and Associates (1981) is only reporting on the Lake Way area. Therefore, the number of taxa recorded in this survey represents a record that should be considered as a low figure.

5.0 DISCUSSION AND RECOMMENDATIONS

The majority of vegetation at both the Lake Way and Centipede project areas has been affected by historic and current exploration and pastoral activities. Impacts directly related to exploration are the proliferation of tracks, the presence of drill holes and the concomitant clearing for drill rig access. Moving forward, these impacts will need to be monitored and managed. In particular, the development and use of the area between the playa and the fringing *Melaleuca xerophila* vegetation will need to be limited. Continued pressure on this 'at risk' association and demonstrated loss of cover may be sufficient to elevate this association to the rating of Threatened Ecological Community.

The *Melaleuca xerophila* vegetation, where observed, was typically narrow in width but continued over long distances. In many areas, the width of the association was 1-2 plants deep. The spatial arrangement of this association within the landscape is potentially an artifact of an underlying edaphic variable rather than a side effect of human activity. Notwithstanding this, the association should be viewed as potentially susceptible to the effects of prolonged disturbance. The association is essentially a long corridor, which may create the potential for invasion by alien taxa should they be introduced into the project area.

In addition to the problems associated with the development of tracks in close proximity to the *Melaleuca xerophila* fringing associations, there are also likely to be issues associated with changes to hydrological properties within the project area and surrounds. *Melaleuca xerophila* is a phreatophytic species and will be affected by any alterations to local hydrology. In the short term, compacting soil in the root zones of *Melaleuca xerophila* by the ongoing use of tracks may lead to alterations in infiltration and run-off patterns. This may lead to a loss of vigour or, in the worst case scenario, high levels of mortality. Pit dewatering during mining may also have a pronounced impact on this association. Monitoring of this association will help to ensure that any impacts associated with altered hydrology is detected and managed.

The development of tracks is having an impact on the halophytic vegetation located on the playa. As a consequence of exploration across this area, a network of tracks is evident, with a corresponding noticeable impact on vegetation. Given the location of the ore body, disturbance of this vegetation is unavoidable. In light of the inability to avoid further disturbance of the halophytic vegetation, it may be prudent to undertake further sampling of the rest of the playa vegetation of Lake Way, with the specific focus of finding analogous vegetation. This vegetation may then be managed and may serve as an offset for vegetation disturbed as a consequence of exploration in the immediate future and future mining activities.

In light of the results of this survey it is recommended that any disturbance to the *Melaleuca xerophila* fringing vegetation should be avoided or minimized where disturbance is inevitable. It is also recommended that the proliferation of tracks through vegetation is stopped, particularly where there are multiple tracks in close proximity. Halting track development and unnecessary usage of multiple

tracks will improve vegetation condition in areas degraded by current track usage. Track usage should be addressed and rectified in the area between the playa and fringing *Melaleuca xerophila* vegetation. It is recommended that vehicles be cleaned and appropriate precaution be taken to minimize the spread of weed species throughout vegetation associations.

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Appendix A

Definitions of Declared Rare and Priority Flora

Definition of Declared Rare and Priority Flora Species (CALM, 2005)

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

Appendix B

Definitions of Threatened Ecological Community Classifications

Definition of Threatened Ecological Community classifications (English, 2003)

TEC Classification	Description
Presumed Totally Destroyed	Community is unlikely to be able to be rehabilitated.
Critically Endangered	There are immediate threats throughout its range.
Endangered	Threatened throughout most of its range in near future.
Vulnerable	Vulnerable to threatening processes/may move into higher threat category.

Appendix C

Flora Species Recorded over the Project Area

Family	Genus	Species		CE1	CE2	CE3	CE4	CE5	CE6	CE7	CE8	CE9	CE10
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		CE1	CE2	CE3	CE4	CE5	CE6	CE7	CE8	CE9	CE10
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		CE1	CE2	CE3	CE4	CE5	CE6	CE7	CE8	CE9	CE10
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		CE1	CE2	CE3	CE4	CE5	CE6	CE7	CE8	CE9	CE10
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		CE11	CE12	CE13	CE14	CE15	CE16	CE17	CE18	CE19	CE20
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

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Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
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	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		CE21	CE22	CE23	CE24	CE25	CE26	CE27	CE28	CE29	CE30
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
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	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		CE21	CE22	CE23	CE24	CE25	CE26	CE27	CE28	CE29	CE30
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		CE21	CE22	CE23	CE24	CE25	CE26	CE27	CE28	CE29	CE30
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		CE21	CE22	CE23	CE24	CE25	CE26	CE27	CE28	CE29	CE30
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		CE31	CE32	CE33	CE34	CE35	CE36	CE37	CE38	CE39	CE40
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		CE31	CE32	CE33	CE34	CE35	CE36	CE37	CE38	CE39	CE40
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		CE31	CE32	CE33	CE34	CE35	CE36	CE37	CE38	CE39	CE40
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		CE31	CE32	CE33	CE34	CE35	CE36	CE37	CE38	CE39	CE40
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		CE41	CE42	CE43	CE44	CE45	CE46	CE47	LW1	LW2	LW3
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		CE41	CE42	CE43	CE44	CE45	CE46	CE47	LW1	LW2	LW3
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		CE41	CE42	CE43	CE44	CE45	CE46	CE47	LW1	LW2	LW3
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		CE41	CE42	CE43	CE44	CE45	CE46	CE47	LW1	LW2	LW3
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW4	LW5	LW6	LW7	LW8	LW9	LW10	LW11	LW12	LW13
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		LW4	LW5	LW6	LW7	LW8	LW9	LW10	LW11	LW12	LW13
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		LW4	LW5	LW6	LW7	LW8	LW9	LW10	LW11	LW12	LW13
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		LW4	LW5	LW6	LW7	LW8	LW9	LW10	LW11	LW12	LW13
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW14	LW15	LW16	LW17	LW18	LW19	LW20	LW21	LW22	LW23
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		LW14	LW15	LW16	LW17	LW18	LW19	LW20	LW21	LW22	LW23
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		LW14	LW15	LW16	LW17	LW18	LW19	LW20	LW21	LW22	LW23
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		LW14	LW15	LW16	LW17	LW18	LW19	LW20	LW21	LW22	LW23
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*									`	
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW24	LW25	LW26	LW27	LW28	LW29	LW30	LW31	LW32	LW33
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*			■	■	■		■				■
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]		■				■					
	Eragrostis	*eriopoda*			■		■		■		■		■
	Eriachne	*helmsii*			■		■		■				■
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*			■		■		■		■		■
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*						■		■		■
	Grevillea	*stenobotyra*							■				
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*									■		
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*			■								
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*			■		■			■	■		
	Atriplex	*bunburyana*			■								
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*	■		■							
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*		■									
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		LW24	LW25	LW26	LW27	LW28	LW29	LW30	LW31	LW32	LW33
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		LW24	LW25	LW26	LW27	LW28	LW29	LW30	LW31	LW32	LW33
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		LW24	LW25	LW26	LW27	LW28	LW29	LW30	LW31	LW32	LW33
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW34	LW35	LW36	LW37	LW38	LW39	LW40	LW41	LW42	LW43
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*					■		■				
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*					■						
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]				■				■		■	
	Eragrostis	*eriopoda*					■		■				
	Eriachne	*helmsii*					■		■		■		
	Neurachne	*munroi*										■	
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*					■		■		■		
Casuarinaceae	*Casuarina*	*pauper*										■	
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*								■		
	Grevillea	*stenobotyra*									■		
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*			■		■					■	
	Atriplex	*bunburyana*				■							
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*								■			
	Enchylaena	*tomentosa*					■				■		
	Halosarcia	*auriculata*		■									

Family	Genus	Species		LW34	LW35	LW36	LW37	LW38	LW39	LW40	LW41	LW42	LW43
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		LW34	LW35	LW36	LW37	LW38	LW39	LW40	LW41	LW42	LW43
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		LW34	LW35	LW36	LW37	LW38	LW39	LW40	LW41	LW42	LW43
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW44	LW45	LW46	LW47	LW48	LW49	LW50	LW51	LW52	LW53
Cupressaceae	*Callitris*	*preissii*											
Poaceae	*Aristida*	*contorta*											
	Aristida	*holathera*	subsp *holathera*										
	?Austrostipa	sp											
	Enneapogon	*caerulescens*											
	Enteropogon	*ramosus*											
	Eragrostis	spp[1]											
	Eragrostis	*eriopoda*											
	Eriachne	*helmsii*											
	Neurachne	*munroi*											
	Panicum	*laevinode*											
	Paspalidium	sp											
	?Themeda	sp											
	Triodia	*basedowii*											
	Triodia	*melvillei*											
Casuarinaceae	*Casuarina*	*pauper*											
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*										
	Grevillea	*nematophylla*	subsp *supraplana*										
	Grevillea	*sarissa*	subsp *succincta*										
	Grevillea	*stenobotyra*											
	Hakea	*francissiana*											
Santalaceae	*Exocarpos*	*aphyllus*											
	Santalum	*spicatum*											
Loranthaceae	*Amyema*	*gibberula*											
	Amyema	*maidenii*											
	Amyema	*microphylla*											
Chenopodiaceae	*Atriplex*	*amnicola*											
	Atriplex	*bunburyana*											
	Atriplex	*holocarpa*											
	Atriplex	*nummularia*	subsp *spathulata*										
	Dissocarpus	*paradoxus*											
	Dysphania	*kalpari*											
	Enchylaena	*tomentosa*											
	Halosarcia	*auriculata*											

Family	Genus	Species		LW44	LW45	LW46	LW47	LW48	LW49	LW50	LW51	LW52	LW53
Chenopodiaceae	*Halosarcia*	*calyptrata*											
	Halosarcia	*indica*	subsp *bidens*										
	Halosarcia	*indica*	subsp *leiostachya*										
	Halosarcia	sp											
	Maireana	*amoena*											
	Maireana	*georgei*											
	Maireana	*luehmannii*											
	Maireana	*pentatropis*											
	Maireana	*pyramidata*											
	Maireana	*thesioides*											
	Maireana	*tomentosa*	subsp *tomentosa*										
	Maireana	*triptera*											
	Maireana	*villosa*											
	Rhagodia	*drummondii*											
	Rhagodia	*eremaea*											
	Salsola	*australis*											
	Salsola	*tragus*											
	Sclerolaena	*articulata*											
	Sclerolaena	*bicornis*											
	Sclerolaena	*dicantha*											
	Sclerolaena	*fimbriolata*											
	Tecticornia	*arbuscula*											
	Tecticornia	*disarticula*											
	Tecticornia	*tenuis*											
Amaranthaceae	*Ptilotus*	*exaltatus*											
	Ptilotus	*obovatus*	var *obovatus*										
Aizoaceae	*?Carpobrotus*	sp											
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*											
Pittosporaceae	*Pittosporum*	*phylliraeoides*											
Mimosaceae	*Acacia*	*aneura*	var *aneura*										
	Acacia	*ayersiana*	var *latifolia*										
	Acacia	*aneura*	var *intermedia*										
	Acacia	*aneura*	var *major*										
	Acacia	*aneura*	var *tenuis*										
	Acacia	*burkittii*											

Family	Genus	Species		LW44	LW45	LW46	LW47	LW48	LW49	LW50	LW51	LW52	LW53
Mimosaceae	*Acacia*	*jennerae*											
	Acacia	*minyura*											
	Acacia		aff *oswaldii*										
	Acacia	*quadrimarginea*											
	Acacia	*ramulosa*	var *linophylla*										
	Acacia	*tetragonophylla*											
	Acacia	*victoriae*											
	Acacia	*?xanthocarpa*											
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*										
	Senna	*artemisioides*	x sturtii										
	Senna	sp Billabong											
Papilionaceae	*Leptosema*	*chambersii*											
Zygophyllaceae	*Zygophyllum*	*aurantiacum*											
	Zygophyllum	*compressum*											
Euphorbiaceae	*Euphorbia*	*boophthana*											
Celastraceae	*Psammomoya*	sp											
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*										
Malvaceae	*Alyogyne*	*pinoniana*											
	Lawrencia	*densiflora*											
	Lawrencia	*helmsii*											
	Sida	*ammophila*											
	Sida	*calyxhymenia*											
Frankeniaceae	*Frankenia*	*cinerea*											
	Frankenia	*cordata*											
	Frankenia	*punctata*											
	Frankenia	sp1											
	Frankenia	sp2											
	Frankenia	*sp3*											
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*										
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*										
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*										
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*										
	Melaleuca	xerophila											
	Melaleuca	*uncinata*											

Family	Genus	Species		LW44	LW45	LW46	LW47	LW48	LW49	LW50	LW51	LW52	LW53
Primulaceae	*Samolus*	sp											
	Aanagallis	*arvensis**											
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*											
Asclepiadaceae	*Marsdenia*	*australis*											
	Rhyncharrhena	*linearis*											
Boraginaceae	*Halgania*		aff *cyanea*										
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*										
	Spartothamnella	*?tuecriiflora*											
Solanaceae	*Lycium*	*australe*											
	Solanum	*lasiophyllum*											
	Solanum	*nummularium*											
	Solanum	*orbiculatum*											
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*										
	Eremophila	*georgei*											
	Eremophila	*glabra*	subsp *glabra*										
	Eremophila	*latrobei*	subsp *latrobei*										
	Eremophila	*?maculata*	subsp *brevifolia*										
	Eremophila	*oppositifolia*	subsp *angustifolia*										
	Eremophila	sp											
Rubiaceae	*Psydrax*	*suaveolens*											
Goodenia	*Goodenia*	sp	aff *corynocarpa*										
	Scaevola	*spinescens*											
Asteraceae	*Angianthus*	*cyanifera*											
	Chrysocephalum	*apiculatum*											
	Cratystylis	*spinescens*											
	Myriocephalus	*rudallii*											
	Olearia	*stuartii*											
	Podolepis	*capillaris*											
	Podolepis	*kendallii*											

Family	Genus	Species		LW54	LW55	LW56	LW57	LW58	LW59	LW60	LW61
Cupressaceae	*Callitris*	*preissii*									
Poaceae	*Aristida*	*contorta*									
	Aristida	*holathera*	subsp *holathera*								
	?Austrostipa	sp									
	Enneapogon	*caerulescens*									
	Enteropogon	*ramosus*									
	Eragrostis	spp[1]									
	Eragrostis	*eriopoda*									
	Eriachne	*helmsii*									
	Neurachne	*munroi*									
	Panicum	*laevinode*									
	Paspalidium	sp									
	?Themeda	sp									
	Triodia	*basedowii*									
	Triodia	*melvillei*									
Casuarinaceae	*Casuarina*	*pauper*									
Proteaceae	*Grevillea*	*nematophylla*	subsp *nematophylla*								
	Grevillea	*nematophylla*	subsp *supraplana*								
	Grevillea	*sarissa*	subsp *succincta*								
	Grevillea	*stenobotyra*									
	Hakea	*francissiana*									
Santalaceae	*Exocarpos*	*aphyllus*									
	Santalum	*spicatum*									
Loranthaceae	*Amyema*	*gibberula*									
	Amyema	*maidenii*									
	Amyema	*microphylla*									
Chenopodiaceae	*Atriplex*	*amnicola*									
	Atriplex	*bunburyana*									
	Atriplex	*holocarpa*									
	Atriplex	*nummularia*	subsp *spathulata*								
	Dissocarpus	*paradoxus*									
	Dysphania	*kalpari*									
	Enchylaena	*tomentosa*									
	Halosarcia	*auriculata*									

Family	Genus	Species		LW54	LW55	LW56	LW57	LW58	LW59	LW60	LW61
Chenopodiaceae	*Halosarcia*	*calyptrata*									
	Halosarcia	*indica*	subsp *bidens*								
	Halosarcia	*indica*	subsp *leiostachya*								
	Halosarcia	sp									
	Maireana	*amoena*									
	Maireana	*georgei*									
	Maireana	*luehmannii*									
	Maireana	*pentatropis*									
	Maireana	*pyramidata*									
	Maireana	*thesioides*									
	Maireana	*tomentosa*	subsp *tomentosa*								
	Maireana	*triptera*									
	Maireana	*villosa*									
	Rhagodia	*drummondii*									
	Rhagodia	*eremaea*									
	Salsola	*australis*									
	Salsola	*tragus*									
	Sclerolaena	*articulata*									
	Sclerolaena	*bicornis*									
	Sclerolaena	*dicantha*									
	Sclerolaena	*fimbriolata*									
	Tecticornia	*arbuscula*									
	Tecticornia	*disarticula*									
	Tecticornia	*tenuis*									
Amaranthaceae	*Ptilotus*	*exaltatus*									
	Ptilotus	*obovatus*	var *obovatus*								
Aizoaceae	*?Carpobrotus*	sp									
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*									
Pittosporaceae	*Pittosporum*	*phylliraeoides*									
Mimosaceae	*Acacia*	*aneura*	var *aneura*								
	Acacia	*ayersiana*	var *latifolia*								
	Acacia	*aneura*	var *intermedia*								
	Acacia	*aneura*	var *major*								
	Acacia	*aneura*	var *tenuis*								
	Acacia	*burkittii*									

Family	Genus	Species		LW54	LW55	LW56	LW57	LW58	LW59	LW60	LW61
Mimosaceae	*Acacia*	*jennerae*									
	Acacia	*minyura*									
	Acacia		aff *oswaldii*								
	Acacia	*quadrimarginea*									
	Acacia	*ramulosa*	var *linophylla*								
	Acacia	*tetragonophylla*									
	Acacia	*victoriae*									
	Acacia	*?xanthocarpa*									
Caesalpiniaceae	*Senna*	*artemisioides*	subsp *filifolia*								
	Senna	*artemisioides*	x sturtii								
	Senna	sp Billabong									
Papilionaceae	*Leptosema*	*chambersii*									
Zygophyllaceae	*Zygophyllum*	*aurantiacum*									
	Zygophyllum	*compressum*									
Euphorbiaceae	*Euphorbia*	*boophthana*									
Celastraceae	*Psammomoya*	sp									
Sapindaceae	*Dodonaea*	*viscosa*	subsp *angustissima*								
Malvaceae	*Alyogyne*	*pinoniana*									
	Lawrencia	*densiflora*									
	Lawrencia	*helmsii*									
	Sida	*ammophila*									
	Sida	*calyxhymenia*									
Frankeniaceae	*Frankenia*	*cinerea*									
	Frankenia	*cordata*									
	Frankenia	*punctata*									
	Frankenia	sp1									
	Frankenia	sp2									
	Frankenia	*sp3*									
Thymelaceae	*Pimelea*	*microcephala*	subsp *microcephala*								
Myrtaceae	*Eucalyptus*	*eremicola*	subsp *peeneri*								
	Eucalyptus	*striaticalyx*	subsp *striaticalyx*								
	Eucalyptus	*?transcontinentalis*	subsp *transcontinentalis*								
	Melaleuca	xerophila									
	Melaleuca	*uncinata*									

Family	Genus	Species		LW54	LW55	LW56	LW57	LW58	LW59	LW60	LW61
Primulaceae	*Samolus*	sp									
	Aanagallis	*arvensis**									
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*									
Asclepiadaceae	*Marsdenia*	*australis*									
	Rhyncharrhena	*linearis*									
Boraginaceae	*Halgania*		aff *cyanea*								
Lamiaceae	*Dicrastylis*	*exsuccosa*	var *tomentosa*								
	Spartothamnella	*?tuecriiflora*									
Solanaceae	*Lycium*	*australe*									
	Solanum	*lasiophyllum*									
	Solanum	*nummularium*									
	Solanum	*orbiculatum*									
Myoporaceae	*Eremophila*	*forestii*	subsp *forestii*								
	Eremophila	*georgei*									
	Eremophila	*glabra*	subsp *glabra*								
	Eremophila	*latrobei*	subsp *latrobei*								
	Eremophila	*?maculata*	subsp *brevifolia*								
	Eremophila	*oppositifolia*	subsp *angustifolia*								
	Eremophila	sp									
Rubiaceae	*Psydrax*	*suaveolens*									
Goodenia	*Goodenia*	sp	aff *corynocarpa*								
	Scaevola	*spinescens*									
Asteraceae	*Angianthus*	*cyanifera*									
	Chrysocephalum	*apiculatum*									
	Cratystylis	*spinescens*									
	Myriocephalus	*rudallii*									
	Olearia	*stuartii*									
	Podolepis	*capillaris*									
	Podolepis	*kendallii*									

Appendix D
Vegetation Condition Scale

Vegetation Condition Scale (Keighery, 1994).

Code	Description
Pristine	Pristine or nearly so. No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as ‘parkland cleared’ with the flora comprising weed or crop species with isolated native trees or shrubs.

Appendix E

Classification of Vegetation Structural Formation and Height Classes

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE **70% - 100%**	**MID DENSE** **30% - 70%**	**SPARSE** **10% - 30%**	**VERY SPARSE** **2% - 10%**
Trees > 30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15m	Dense Low Forest A	Low Forest A	Low woodland A	Open Low Woodland A
Trees < 5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee Tree Form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee Shrub Form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 – 1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 – 0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat Plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock Grass	Dense Hummock Grass	Mid-dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5m	Dense Low Grass	Low Gras	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

Appendix F

Environment Protection and Biodiversity Conservation (EPBC) Act Protected Matters Database Search

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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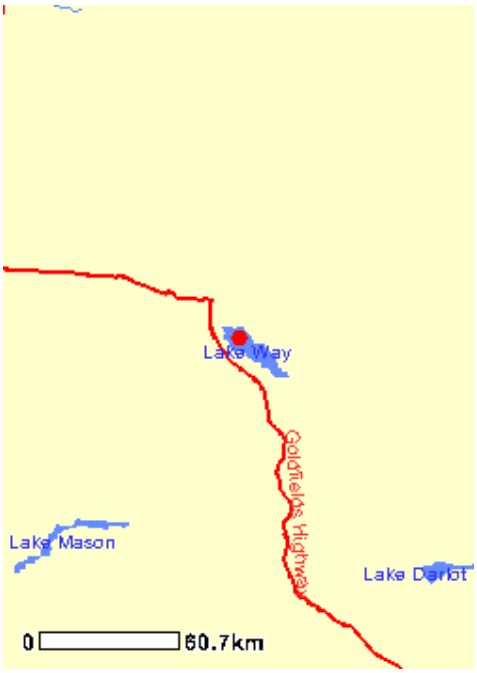


Search Type: Point

Buffer: 100 km

Coordinates: -26.76583,120.3394

Report Contents: Summary

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	6
Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	3
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Acanthiza iredalei iredalei ** Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata ** Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae ** Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Rhinonicteris aurantius (Pilbara form) ** Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Egernia kintorei ** Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis ** Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Leipoa ocellata ** Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus ** Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus ***** Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area

Commonwealth Lands [Dataset Information]

Unknown

Places on the RNE [Dataset Information]

Note that not all Indigenous sites may be listed.

Indigenous

Yeelirrie Pool Mythological and Occupation Site WA

Yeelirrie Station Mythological Site WA

Natural

Wanjarri Nature Reserve WA

Extra Information

State and Territory Reserves [Dataset Information]

Wanjarri Nature Reserve, WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

threatened species listed as extinct or considered as vagrants

some species and ecological communities that have only recently been listed

some terrestrial species that overfly the Commonwealth marine area

migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

non-threatened seabirds which have only been mapped for recorded breeding sites;

seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

New South Wales National Parks and Wildlife Service

Department of Sustainability and Environment, Victoria

Department of Primary Industries, Water and Environment, Tasmania

Department of Environment and Heritage, South Australia Planning SA

Parks and Wildlife Commission of the Northern Territory

Environmental Protection Agency, Queensland

Birds Australia

Australian Bird and Bat Banding Scheme

Australian National Wildlife Collection

Natural history museums of Australia

Queensland Herbarium

National Herbarium of NSW

Royal Botanic Gardens and National Herbarium of Victoria

Tasmanian Herbarium

State Herbarium of South Australia

Northern Territory Herbarium

Western Australian Herbarium

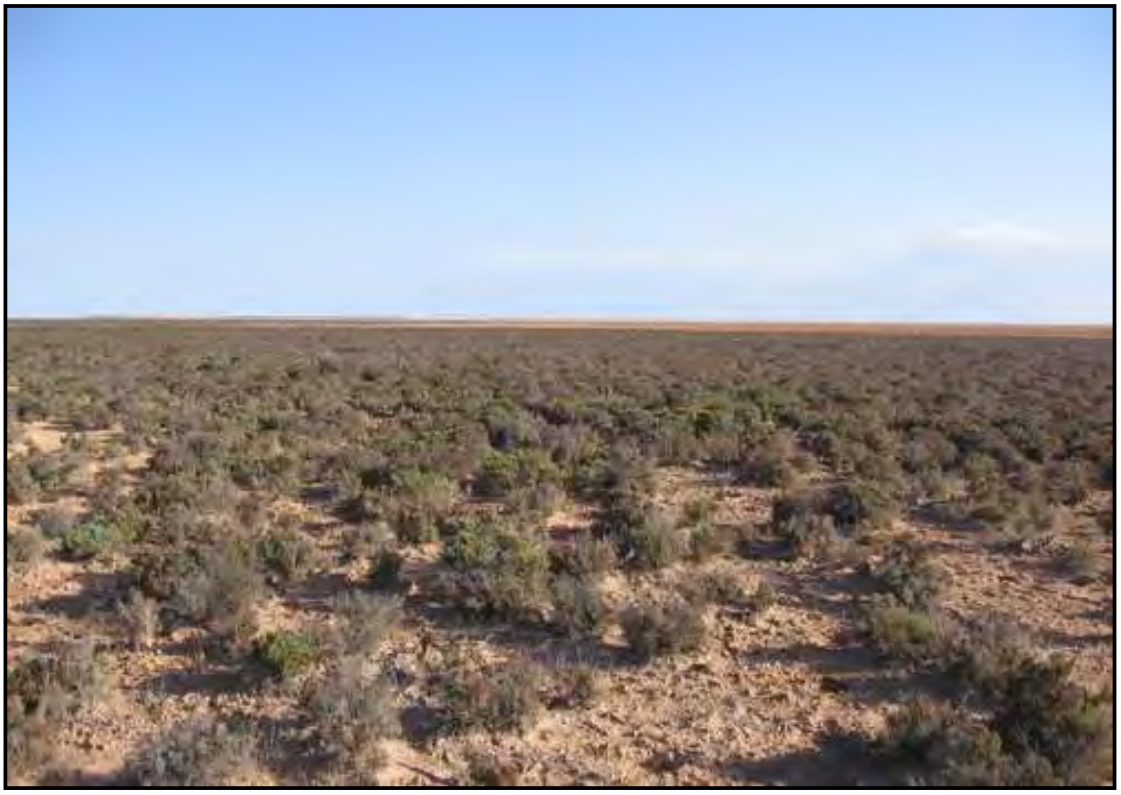
Australian National Herbarium, Atherton and Canberra

University of New England

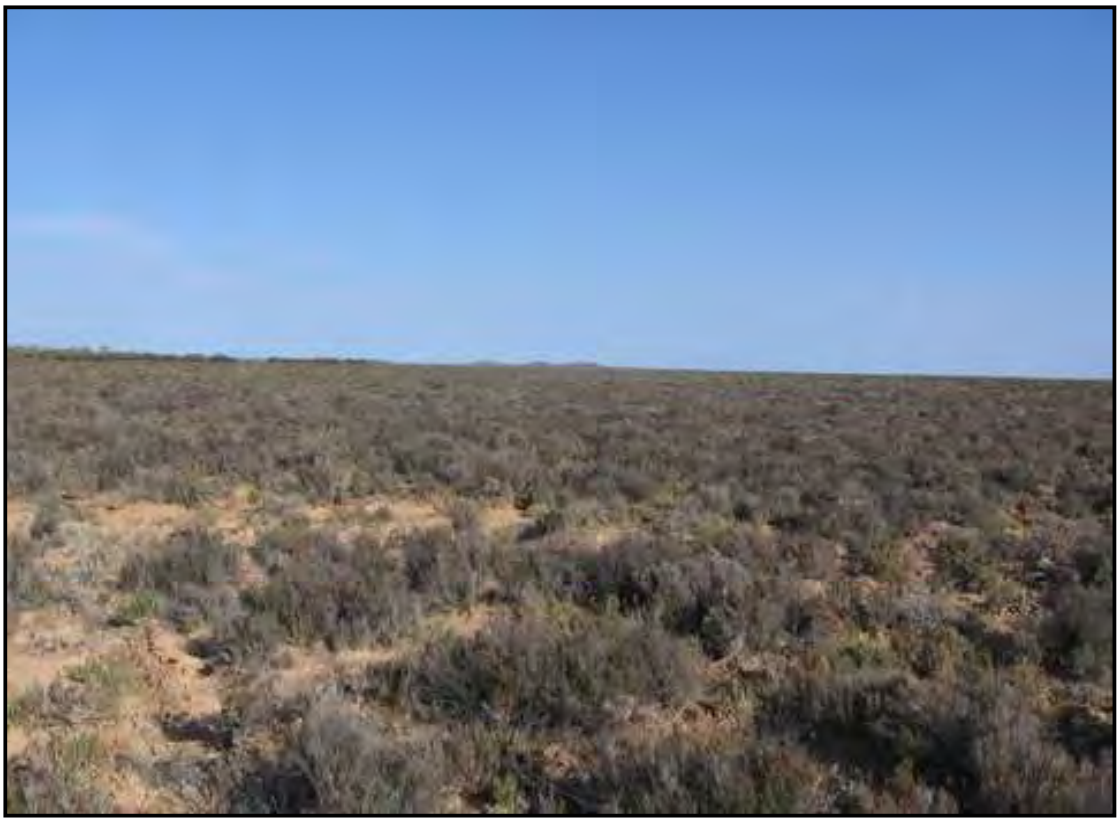
Other groups and individuals

Appendix G
Quadrat Data

Site	Ce01
Coordinates	51 J 236501 7030185
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	lt orange clay
Exposed rock type	nil
Litter cover (%)	*Halosarcia* twigs and branches (6%)
Condition	excellent
Disturbance details	some vehicle tracks in area, rabbit scratchings
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata, Halosarcia* sp
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	*Neurachne* sp, *Eragrostis* spp*, Zygophyllum aurantiacum*



Site	Ce02
Coordinates	51 J 236310 7030423
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	pale brown sand
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia* (10%)
Condition	very good
Disturbance details	vehicle tracks in corner, cattle movement
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata, Frankenia cinerea*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	*Muellerolimon salicorniaceum, Lawrencia helmsii*



Site	Ce03
Coordinates	51 J 236317 7030036
Description	Sparse Woodland over Open Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	leaf litter, twigs and bracnches (15%)
Condition	good-very good
Disturbance details	grazing
Trees	*Acacia aneura* var *aneura*
Shrubs >2m	*Acacia jennerae*
Shrubs 1-2m	*Acacia aneura* var *major, Senna artemisioides* subsp *filfolia*
Shrubs <1m	*Zygophyllum aurantiacum, Ptilotus obovatus* var *obovatus* *Maireana pentatropis, Scaevola spinescens*
Hummock grasses	
Grasses	*Triodia melvillei*
Herbs/creepers	
Parasites	*Amyema maidenii*
Species near plot	*Melaleuca uncinata*

Site	Ce04
Coordinates	51 J 236244 7030334
Description	Sparse Shrubland over Sparse Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	pale brown/cream sand-loam
Exposed rock type	nil
Litter cover (%)	dead plants (5%)
Condition	very good
Disturbance details	cattle tracks, vehicle tracks, rabbit droppings
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Lawqrencia helmsii, Halosarcia indica* subsp *leiostachya, Zygophyllum aurantiacum, Frankenia cinerea*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Zygophyllum compressum, Ptilotus exaltatus*
Species near plot	

Site	Ce05
Coordinates	51 J 236470 7029624
Description	*Acacia ligulata and Pittosporum phylliraeoides* Sparse Shrubland over *Triodia melvillei* Hummock Grassland
Plot size	30 * 30m
Topography	gently sloping
Slope	<2%
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia*, branches and twigs (5%)
Condition	very good-excellent
Disturbance details	minor tracks, kangaroos
Trees	
Shrubs >2m	*Pittosporum phylliraeoides*
Shrubs 1-2m	*Acacia jennerae*
Shrubs <1m	*Olearia stuartii, Alyogyne pinoniana*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Species near plot	*Acacia ayersiana* var *latifolia, Eremophila glabra* subsp *glabra* *Senna artemisioides* subsp *filifolia*

Site	Ce06
Coordinates	51 J 236246 7030334
Description	*Melaleuca xerophila* and *Acacia aneura* var *fuliginea* Open Forest over Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	*Melaleuca* debris (25%)
Condition	very good
Disturbance details	heavy grazing of grasses, cattle pats, rabbit burrows
Trees	*Acacia ayersiana* var *latifolia, Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Sclerolaena bicornis, Sclerolaena dicantha, Salsola tragus*
Hummock grasses	
Grasses	
Herbs/creepers	
Parasites	*Amyema microphylla*
Species near plot	*Atriplex amnicola, Podolepis capillaris*

Site	Ce07
Coordinates	51 J 237090 7029202
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia,* twigs and leaf litter (10%)
Condition	very good
Disturbance details	evidence of grazing
Trees	*Acacia ayersiana var latifolia, Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Acacia jennerae, Eremophila latrobei* subsp *latrobei*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Scaevola spinescens* *Olearia stuartii*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Parasites	*Amyema maidenii*
Species near plot	

Site	Ce08
Coordinates	51 J 236387 7029748
Description	
Plot size	30 * 30m
Topography	gentle
Slope	5-15%
Soil	red/orange sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia, Eucalyptus* litter (30%)
Condition	excellent
Disturbance details	kangaroo tracks, cattle movement, vehicle tracks
Trees	*Eucalyptus eremicola* subps *peeneri*
Shrubs >2m	*Acacia jennerae*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus*
	Atriplex amnicola, Leptosema chambersii, Olearia stuartii
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	*Acacia ayersiana* var *latifolia, Scaevola spinescens, Grevillea stenobotrya*
	Pittosporum phylliraeoides, Halgania aff *cyanea, Eremophila georgei*

Site	Ce09
Coordinates	51 J 237489 7029255
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange sand loam
Exposed rock type	nil
Litter cover (%)	twigs, branches and leaves (12%)
Condition	good-very good
Disturbance details	cattle grazing, pats
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Eremophila latrobei* var *latrobei*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Atriplex bunburyana, Maireana thesioides*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Arisitda contorta*
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	*Acacia minyura, Melaleuca xerophila*

Site	Ce10
Coordinates	51 J 236812 7029260
Description	
Plot size	30 * 30m
Topography	gentle
Slope	5-15%
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (20%)
Condition	excellent
Disturbance details	evidence of limited cattle damage
Trees	*Callitris preissii*
Shrubs >2m	*Acacia jennerae, Senna artemisioides* subsp *filifolia*
Shrubs 1-2m	
Shrubs <1m	*Scaevola spinescens, Halgania* aff *cyanea*
Hummock grasses	*Triodia basedowii*
Grasses	
Herbs/creepers	
Species near plot	

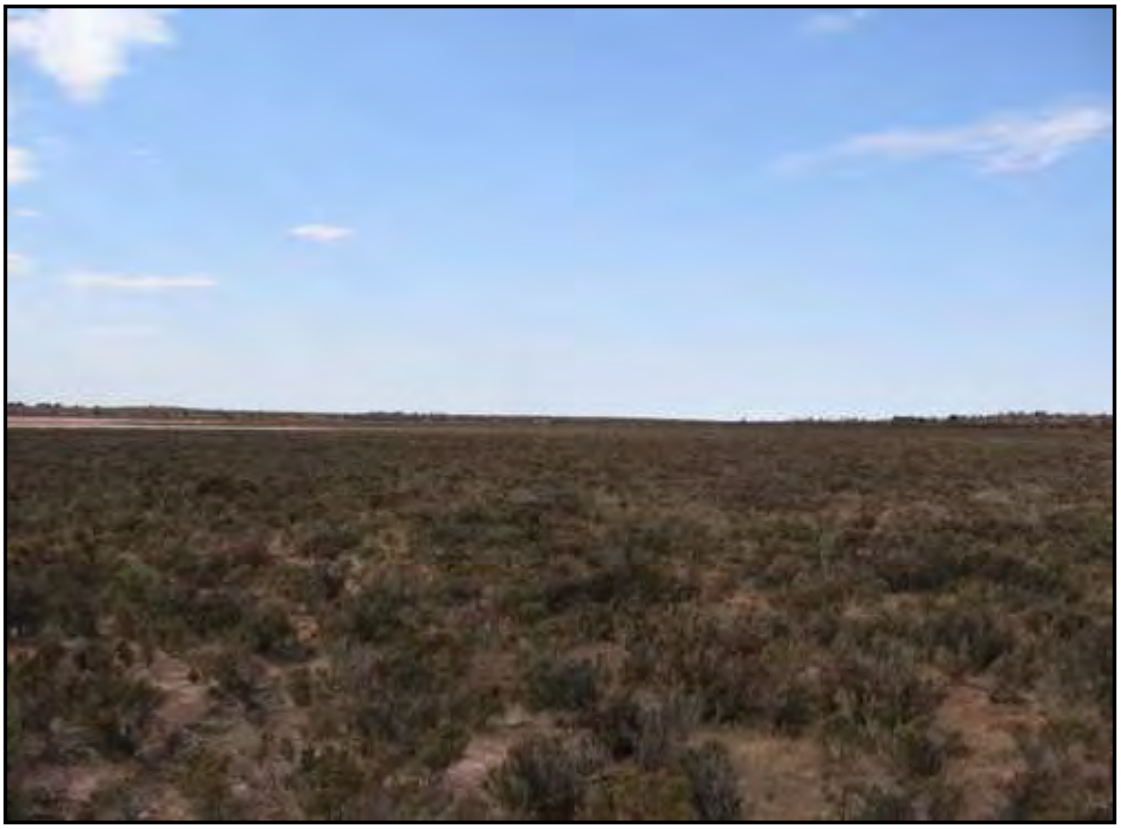
Site	Ce11
Coordinates	51 J 237465 7029318
Description	Samphire Sparse - Open Shrubland and Sparse Chenopod Shrubland over Sparse Frobland over Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	range loam-clay
Exposed rock type	nil
Litter cover (%)	dead grass, *Halosarcia* and *Carpobrotus (8%)*
Condition	good-very good
Disturbance details	cattle grazing
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Maireana villosa, Halosarcia* sp. *Solanum nummularium, Rhagodia eremaea* *Sclerolaena fimbriolata*
Hummock grasses	
Grasses	*Eragrostis* spp, *Neurachne* sp
Herbs/creepers	*Muellerolimon salicorniaceum, ?Carpobrotus* sp
Species near plot	

Site	Ce12
Coordinates	51 J 237499 7030089
Description	Open Shrubland over Samphire Open Shrubland and Sparse Chenopod Shrubland over Forbland over Open Grassland
Plot size	30 * 30m
Topography	gentle slope-flat
Slope	<1%
Soil	pale red/orange sand
Exposed rock type	nil
Litter cover (%)	dead grasses (30%)
Condition	very good
Disturbance details	rabbit burrows, cattle grazing (grasses) and trampling
Trees	
Shrubs >2m	*Grevillea stenobtotrya*
Shrubs 1-2m	*Lycium australe*
Shrubs <1m	*Halosarcia auriculata, Zygophyllum aurantiacum, Atriplex amnicola*
Hummock grasses	
Grasses	*Aristida holathera* subsp *holathera*
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	

Site	Ce13
Coordinates	51 J 237988 7029603
Description	Samphire Sparse-Open Shrubland and Sparse Chenopod Shrubland over Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass, *Halosarcia* (50%)
Condition	very good-excellent
Disturbance details	evidence of grazing
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Sclerolaena articulata, Atriplex amnicola, Atriplex bunburyana Tecticornia tenuis, Rhagodia eremaea*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*?Carpobrotus* sp
Species near plot	

Site	Ce14
Coordinates	51 J 237550 7029908
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	cream/brown sand-clay-loam
Exposed rock type	nil
Litter cover (%)	dead annuals and *Halosarcia* (5%)
Condition	excellent
Disturbance details	vehicle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarca auriculata*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Zygophyllum compressum*
Species near plot	*Frankenia cinerea*

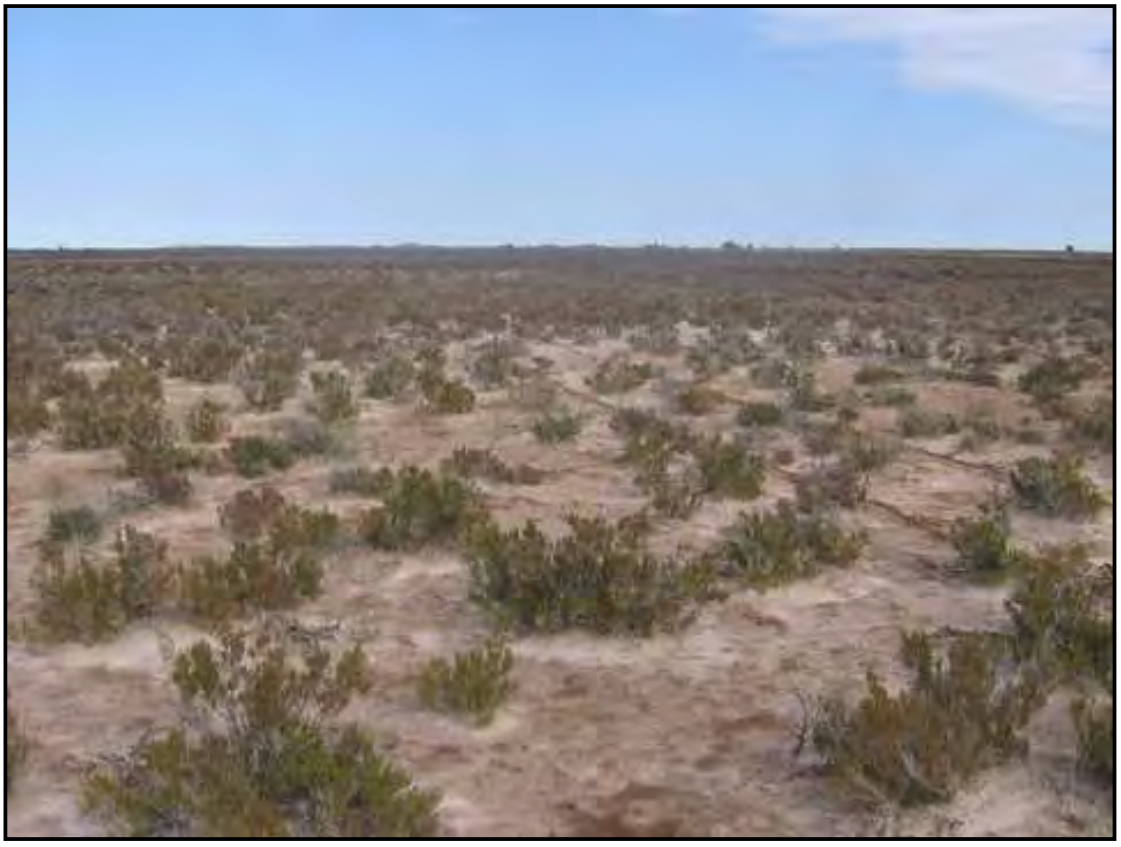
Site	Ce15
Coordinates	51 J 238688 7029840
Description	Open Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	lt orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia* (35%)
Condition	very good
Disturbance details	vehicle tracks, drillholes
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subps *leiostachya, Halosarcia* sp
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	



Site	Ce16
Coordinates	51 J 237457 7029402
Description	
Plot size	30 * 30m
Topography	sloping
Slope	gentle (5-15%)
Soil	pale brown/red coarse sand-sand-loam
Exposed rock type	nil
Litter cover (%)	*Melaleuca* debris (10%)
Condition	very good (but limited understorey)
Disturbance details	rabbit burrows, grazing by cattle, cattle tracks
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	
Hummock grasses	
Grasses	*Aristida holathera* subsp *holathera*
Herbs/creepers	
Parasites	*Amyema microphylla*
Species near plot	

Site	Ce17
Coordinates	51 J 238084 7028952
Description	
Plot size	30 * 30m
Topography	valley between dunes
Slope	gentle (<5%)
Soil	orange/red sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia*, *Callitris* trunks and needles (8%)
Condition	excellent
Disturbance details	some evidence of cattle/rabbit activity
Trees	*Callitris preissii*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	
Hummock grasses	*Triodia basedowii*
Grasses	
Herbs/creepers	
Species near plot	

Site	Ce18
Coordinates	51 J 238478 7030052
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	brown/cream clay-loam
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia*, some dead annuals (10%)
Condition	excellent
Disturbance details	vehicle tracks through plot
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Angianthus cyathifera*
Species near plot	*Frankenia cinerea*



Site	Ce19
Coordinates	51 J 238066 7028995
Description	
Plot size	30 * 30m
Topography	valley between dunes
Slope	flat
Soil	orange red sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia,* leaf litter (15%)
Condition	excellent
Disturbance details	rabbit scats, some evidence of cattle activity
Trees	*Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Acacia aneura* var *major, Acacia jennerae*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Atriplex amnicola, Maireana thesioides Eremophila forestii* subsp *forestii, Maireana amoena, Rhagodia eremaea*
Hummock grasses	*Triodia melvillei, Triodia basedowii*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	*Marsdenia australis*
Species near plot	

Site	Ce20
Coordinates	51 J 238426 7029206
Description	Samphire Shrubland and Sparse Chenopod and Frankenia Shrubland over Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown clay-loam
Exposed rock type	nil
Litter cover (%)	dead annuals (5%)
Condition	very good-excellent
Disturbance details	rabbit droppings, grasses grazed, vehicle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subps *leiostachya, Halosarcia auriculata Sclerostegia tenuis, Scleroleana fimbriolata, Frankenia cinerea, Maireana* sp
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	Ce21
Coordinates	51 J 238272 7028756
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<5%)
Soil	orange sand loam
Exposed rock type	
Litter cover (%)	dead *Triodia* (10%)
Condition	excellent
Disturbance details	some cattle tracks
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	*Scaevola spinescens*
Shrubs <1m	
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Species near plot	

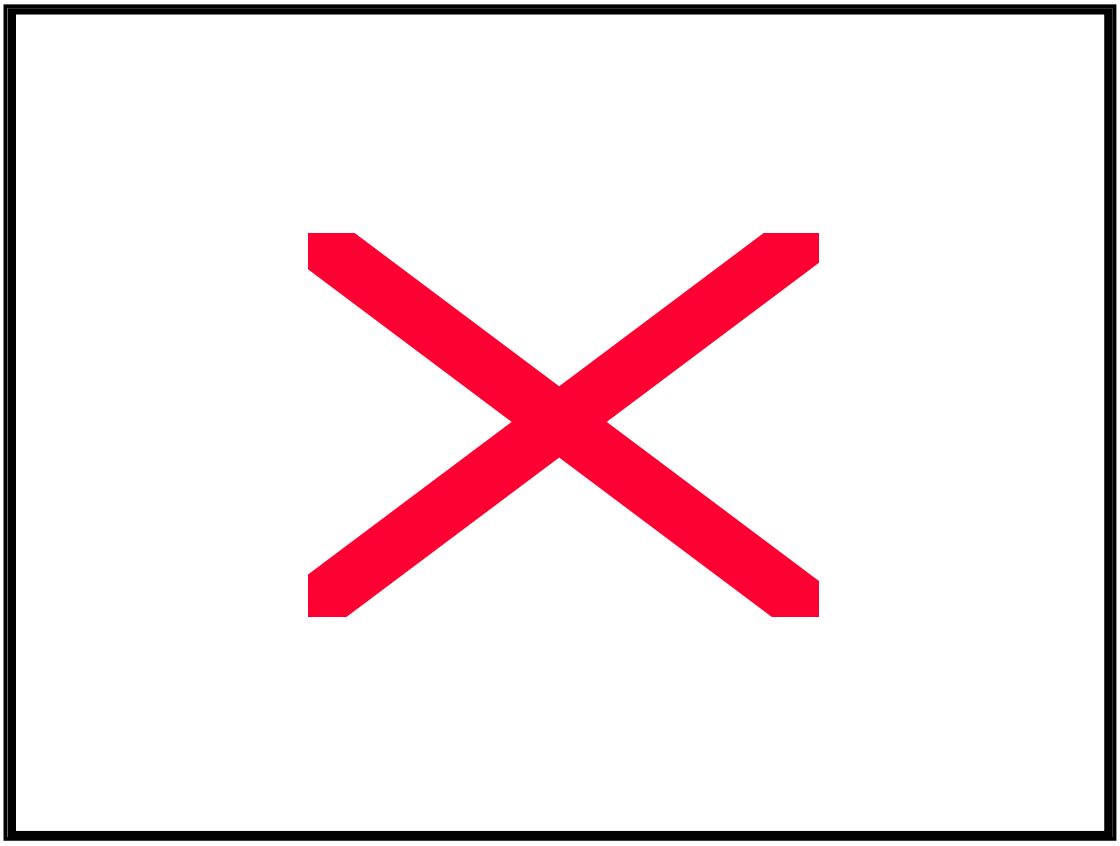
Site	Ce22
Coordinates	51 J 238081 7029290
Description	
Plot size	30 * 30m
Topography	
Slope	gentle (5-15%)
Soil	red/brown sand
Exposed rock type	
Litter cover (%)	dead annuals, *Triodia,* wood (20%)
Condition	very good
Disturbance details	dead Mulgas, heavy grazing, cattle tracks
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Maireana georgei, Maireana pyramidata*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta*
Herbs/creepers	
Species near plot	

Site	Ce23
Coordinates	51 J 238273 7027750
Description	
Plot size	30 *30m
Topography	flat
Slope	nil
Soil	red/orange sand-loam
Exposed rock type	
Litter cover (%)	leaf litter, twigs and branches (18%)
Condition	excellent
Disturbance details	some evidence of disturbance by roos, rabbits
Trees	*Melaleuca uncinata, Acacia ayersiana* var *latifolia*
Shrubs >2m	*Grevillea sarissa* subsp *succincta*
Shrubs 1-2m	*Acacia minyura, Eremophila forestii* subsp *forestii*
Shrubs <1m	*Atriplex bunburyana,*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Species near plot	

Site	Ce24
Coordinates	51 J 238210 7029174
Description	
Plot size	30 * 30m
Topography	dune
Slope	10-20%
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (10%)
Condition	excellent
Disturbance details	cattle dung and tracks, but effect limited, grazing
Trees	
Shrubs >2m	*Acacia jennerae, Grevillea stenobotrya*
Shrubs 1-2m	*Scaevola spinescens, Atriplex amnicola*
Shrubs <1m	
Hummock grasses	*Triodia melvillei*
Grasses	*Aristida holathera* subsp *holathera*
Herbs/creepers	
Species near plot	*Callitris preissii, Melaleuca xerophila*

Site	Ce25
Coordinates	51 J 237999 7027725
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	lt orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcias*, grasses (15%)
Condition	excellent
Disturbance details	vehicle tracks, some evidence of cattle activity
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subps *leiostachya, Halosarcia* sp, *Frankenia* sp *Eremophila ?maculata* subsp *brevilfolia*
Hummock grasses	
Grasses	
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	*Eragrostis* spp*, Neurachne* sp

Site	Ce26
Coordinates	51 J 237900 7027940
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	*Melaleuca* debris (50%)
Condition	excellent
Disturbance details	clearing, proximity to bore, vehicle tracks, dung
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Sclerolaena bicornis, Salsola tragus, Maireana georgei, Enchylaena tomentosa*
Hummock grasses	
Grasses	*Neurachne* sp
Herbs/creepers	
Parasites	*Amyema microphylla*
Species near plot	*Melaleuca uncinata, Acacia ayersiana* var *latifolia*

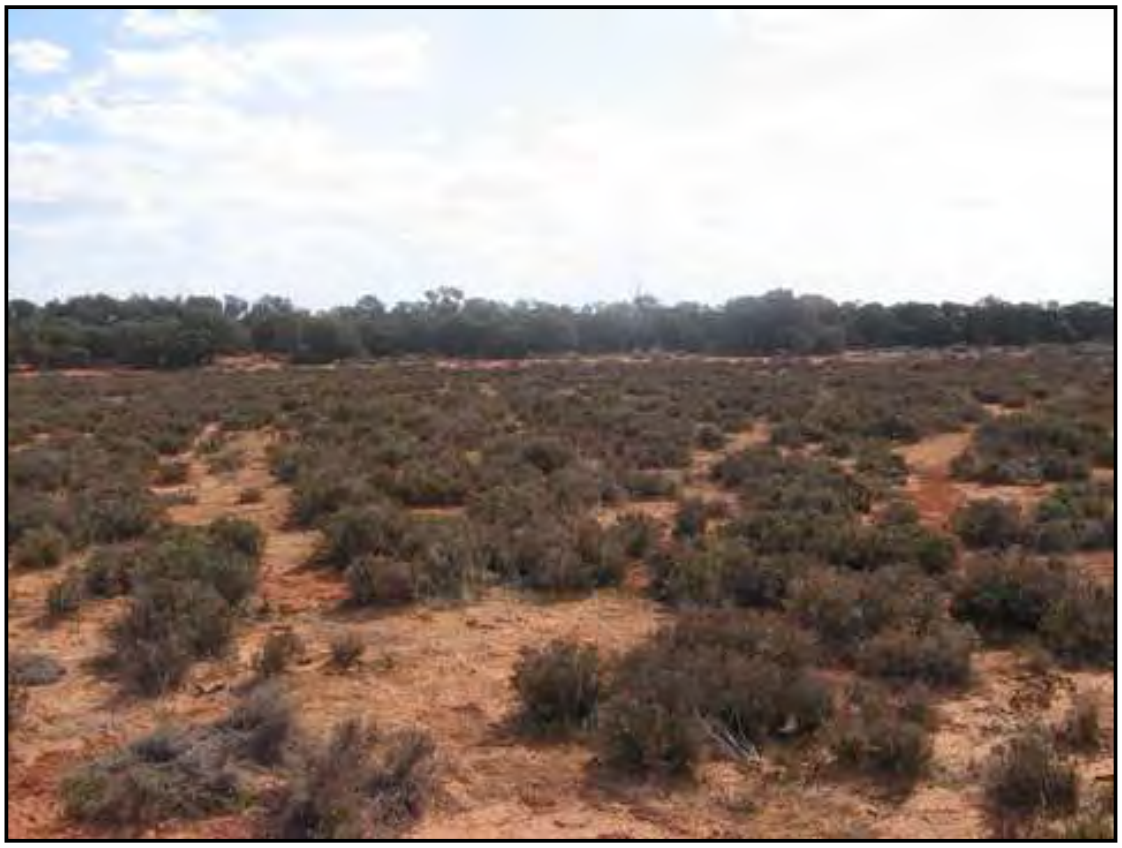


Site	Ce27
Coordinates	51 J 238821 7028365
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia*, branches, twigs, leaf litter (10%)
Condition	excellent
Disturbance details	grazing by cattle, dung
Trees	
Shrubs >2m	*Grevillea sarissa* subsp *succincta, Grevillea stenobotrya*
Shrubs 1-2m	*Acacia jennerae*
Shrubs <1m	*Alyogyne pinoniana, Halgania* aff *cyanea, Eremophila georgei*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Species near plot	*Acacia ayersiana* var *latifolia*

Site	Ce28
Coordinates	51 J 237788 7028326
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	data not recorded
Condition	very good-excellent
Disturbance details	vehicle track, grazing
Trees	*Acacia ayersiana* var *latifolia, Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Acacia aneura* var *aneura*
Shrubs 1-2m	*Eremophila forestii* var *forestii*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Scaevola spinescens* *Rhagodia drummondii*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	*Pittosporum phylliraeoides, Eremophila glabra* subsp *glabra* *Grevillea sarissa* subsp *succincta, Amyema gibberula,* *Acacia* aff *oswaldii, Eremophila oppositifolia* subsp *angustifolia* *Acacia tetragonophylla*

Site	Ce29
Coordinates	51 J 238812 7028433
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	branches, leaf litter (4%)
Condition	excellent
Disturbance details	some evidence of grazing
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Sclerolaena fimbriolata* *Senna artemisioides* subsp x *sturtii*
Hummock grasses	
Grasses	
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	*Senna* sp Billabong

Site	Ce30
Coordinates	51 J 237855 7027900
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	brown/cream clay-loam
Exposed rock type	nil
Litter cover (%)	dead *Halosarcias,* annuals (10%)
Condition	excellent
Disturbance details	grasses grazed, vehicle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata Sclerolaena fimbriolata, Frankenia cinerea*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Podolepis capillaris*
Species near plot	



Site	Ce31
Coordinates	51 J 238707 7028377
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<5%)
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia*, branches (30%)
Condition	excellent
Disturbance details	evidence of cattle activity
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	*Eremophila latrobei* subsp *latrobei, Eremophila forestii* subsp *forestii*
Shrubs <1m	*Scaevola spinescens*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Species near plot	

Site	Ce32
Coordinates	51 J 237980 7028621
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia*, *Eucalyptus* branches (25%)
Condition	excellent
Disturbance details	vehicle tracks in close proximity
Trees	*Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Acacia jennerae, Grevillea sarissa* subsp *succincta*
Shrubs 1-2m	
Shrubs <1m	*Scaevola spinescens, Olearia stuartii*
Hummock grasses	*Triodia melvillei, Triodia basedowii*
Grasses	
Herbs/creepers	
Species near plot	*Callitris preissii, Grevillea stenobotrya*

Site	Ce33
Coordinates	51 J 238524 7028147
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<1%)
Soil	orange/red sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia,* twigs, leaves (8%)
Condition	excellent
Disturbance details	grazing
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	*Grevillea sarissa* subsp *succincta*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Eremophila forestii* subsp *forestii*
Shrubs <1m	*Scaevola spinescens*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	Ce34
Coordinates	51 J 238127 7028717
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (5-15%)
Soil	red/brown sand-loam
Exposed rock type	
Litter cover (%)	dead *Triodia* (20%)
Condition	excellent
Disturbance details	cattle tracks, evidence of grazing
Trees	*Acacia ayersiana* var *latifolia, Callitris preissii, Grevillea stenobotrya*
Shrubs >2m	
Shrubs 1-2m	*Acacia jennerae*
Shrubs <1m	
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta*
Herbs/creepers	
Species near plot	

Site	Ce35
Coordinates	51 J 236472 7029490
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<5%)
Soil	orange sand-loam
Exposed rock type	nil
Litter cover (%)	dead branches, *Triodia* (17%)
Condition	very good
Disturbance details	dissected by tracks, cattle grazing
Trees	*Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Acacia aneura* var *major, Acacia jennerae*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Pittosporum phylliraeoides*
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Eremophila georgei*
Hummock grasses	*Triodia melvillei*
Grasses	*Aristida contorta*
Herbs/creepers	
Species near plot	

Site	Ce36
Coordinates	51 J 236255 7029479
Description	Open Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown clay-loam
Exposed rock type	small calcrete pebbles (<2%)
Litter cover (%)	dead *Frankenia* (2%)
Condition	excellent
Disturbance details	grasses grazed, rabbit dropppings
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Frankenia cinerea, Maireana amoena, Solanum lasiophyllum*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	Ce37
Coordinates	51 J 237605 7028214
Description	Open Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/orange clay loam
Exposed rock type	nil
Litter cover (%)	dead shrubs, tree branches, leaf litter (8%)
Condition	very good
Disturbance details	tracks, evidence of cattle activity
Trees	
Shrubs >2m	*Acacia ramulosa* var *linophylla, Eremophila glabra* subsp glabra
Shrubs 1-2m	*Acacia tetragonophylla, Eremophila forestii* subsp *forestii* *Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Maireana pyramidata, Mairena amoena, Solanum lasiophyllum*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	

Site	Ce38
Coordinates	51 J 237590 7027959
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red brown sand loam
Exposed rock type	nil
Litter cover (%)	dead annuals, *Sclerolaena* (30%)
Condition	very good
Disturbance details	cattle and rabbit dung, grazing of grasses
Trees	
Shrubs >2m	*Eremophila glabra* subsp *glabra, E. oppositifolia* subsp *angustifolia*
Shrubs 1-2m	
Shrubs <1m	*Sclerolaena bicornis*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	*Acacia aneura* var *aneura, Acacia* aff *oswaldii*

Site	Ce39
Coordinates	51 J 237692 7028237
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red clay-loam
Exposed rock type	nil
Litter cover (%)	twigs, branches, leaves (15%)
Condition	excellent
Disturbance details	evidence of grazing, proximity to tracks
Trees	*Acacia anuera* var *major, Pittosporum phylliraeoides* *Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	
Shrubs 1-2m	*Eremophila forestii* subsp *forestii, Grevillea sarissa* subsp *succincta* *Senna* sp Billabong, *Rhagodia drummondii*
Shrubs <1m	*Maireana thesioides, Acacia tetragonophylla*
Hummock grasses	*Triodia melvillei*
Grasses	
Herbs/creepers	
Parasites	*Amyema gibberula*
Species near plot	

Site	Ce40
Coordinates	51 J 238070 7028218
Description	
Plot size	30 * 30m
Topography	flat
Slope	
Soil	red/brown sand-loam
Exposed rock type	
Litter cover (%)	dead *Triodia* (20%)
Condition	excellent
Disturbance details	proximity to track
Trees	*Acacia ayersiana* var *latifolia, Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Eremophila forestii* subsp *forestii*
Shrubs <1m	*Ptilotus obovatus* var *obovatus*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrsotis eriopoda*
Herbs/creepers	
Species near plot	*Solanum lasiophyllum, Acacia ligulata, Alyogyne pinoniana* *Dodonaea viscosa* subsp *angustissima, Santalum spicatum*

Site	Ce41
Coordinates	51 J 237464 7028227
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red orange clay
Exposed rock type	nil
Litter cover (%)	branches, twigs, leaves (25%)
Condition	good
Disturbance details	tracks, grazing, extensive rabbit burrows
Trees	*Acacia aneura* var *aneura, Pittosporum phylliraeiodes*
Shrubs >2m	*Acacia tetragonphylla*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Senna* sp Billabong *Acacia ramulosa* var *linophylla*
Shrubs <1m	*Solanum lasiophyllum, Eremophila forestii* subsap *forestii* *Atriplex bunburyana, Rhagodia eremaea, Maireana pyramidata*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	

Site	Ce42
Coordinates	51 J 237312 7028213
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead grasses, *Sclerolaena* (20%)
Condition	very good-excellent
Disturbance details	dead Mulga, cow dung, tracks, grazing
Trees	*Acacia aneura* var *aneura*
Shrubs >2m	*Eremophila oppositifolia* subsp *angustifolia, Santalum spicatum*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Sclerolaena bicornis, Salsola tragus*
Hummock grasses	
Grasses	*Eragrostis* spp*, Neurachne* sp
Herbs/creepers	*Rhyncharrhena linearis*
Parasites	*Amyema maidenii*
Species near plot	

Site	Ce43
Coordinates	51 J 237444 7028586
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<1%)
Soil	red/orange sand-loam
Exposed rock type	
Litter cover (%)	dead *Triodia, Eucalyptus* debris (25%)
Condition	excellent
Disturbance details	grazing by cattle, rabbits
Trees	*Acacia aneura* var *major, Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Eremophila oppositifolia* subsp *angustifolia*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Maireana thesioides* *Rhagodia eremaea, Eremophila georgei*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	Ce44
Coordinates	51 J 237253 7028520
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia, Eucalyptus* debris (40%)
Condition	Very good-excellen
Disturbance details	cattle tracks, dung, rabbit scratchings, grazing
Trees	*Acacia ayersiana* var *latifolia, Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Senna artemisioides* subsp *filifolia, Eremophila oppositifolia* subsp *angustifolia*
Shrubs 1-2m	*Maireana pyramidata*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Scaevola spinescens, Maireana villosa, Sclerolaena bicornis* *Rhagodia drummondii, Maireana thesioides*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	*Acacia* aff *oswaldii*

Site	Ce45
Coordinates	51 J 237343 7028781
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange sand loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia,* branches, leaves (16%)
Condition	excellent
Disturbance details	some evidence of grazing
Trees	
Shrubs >2m	*Acacia aneura* var *major*
Shrubs 1-2m	*Acacia jennerae, Eremophila forestii* subsp *forestii*
Shrubs <1m	
Hummock grasses	*Triodia melvillei, Triodia basedowii*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	Ce46
Coordinates	51 J 236936 7028645
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	
Litter cover (%)	Mulga litter, Wilcox bush leaves (15%)
Condition	Very good-excellent
Disturbance details	grazing of grasses
Trees	*Acacia aneura* var *aneura, Acacia ayersiana* var *latifolia* *Pittosporum phylliraeoides*
Shrubs >2m	
Shrubs 1-2m	*Eremophila forestii* subsp *forestii*
Shrubs <1m	*Maireana amoena*
Hummock grasses	*Triodia melvillei, Triodia basedowii*
Grasses	*Eragrsotis eriopoda*
Herbs/creepers	
Species near plot	*Acacia jennerae, Eucalyptus eremicola* subsp *peeneri* *Solanum nummularium, Dissocarpus paradoxus* *Grevillea nematophylla* subsp *supraplana, Acacia tetragonophylla*

Site	LW01
Coordinates	51 J 236926 7045640
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	lt orange calcrete
Exposed rock type	calcrete
Litter cover (%)	branches, leaf litter, grass (7%)
Condition	very good-excellent
Disturbance details	cattle tracks, vehicle tracks, grazing, scats
Trees	
Shrubs >2m	*Acacia ramulosa* var *linophylla, Acacia victoriae*
Shrubs 1-2m	*Senna artemisioides* subsp *artemisioides*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Maireana tomentosa* subsp *tomentosa* *Acacia tetragonophylla*
Hummock grasses	
Grasses	*Eragrsotis* spp*, Neurachne* sp
Herbs/creepers	
Species near plot	*Solanum lasiophyllum, Acacia jennerae, Casuarina pauper*

Site	LW02
Coordinates	51 J 236629 7045498
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	calcrete pebbles, caprock (20%)
Litter cover (%)	annual grasses, Mulga wood (15%)
Condition	very good-excellent
Disturbance details	rabbits, grazing of grasses
Trees	
Shrubs >2m	*Acacia burkittii, Acacia tetragonophylla*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Eremophila forestii* subsp *forestii*
Shrubs <1m	*Zygophyllum aurantiacum, Solanum lasiophyllum, Ptilotus obovatus* var *obovatus, Maireana villosa*
Hummock grasses	
Grasses	*Aristida contorta, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	*Scaevola spinescens, Eremophila latrobei* subsp *latrobei, ?Themeda* sp

Site	LW03
Coordinates	51 J 235835 7045473
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red clay
Exposed rock type	small calcrete pebbles (4%)
Litter cover (%)	dead grass, leaf litter (6%)
Condition	data not recorded
Disturbance details	data not recorded
Trees	*Acacia aneura* var *aneura, Pittosporum phylliraeoides, Acacia ramulosa* var *linophylla*
Shrubs >2m	
Shrubs 1-2m	*Maireana pyramidata, Acacia tetragonophylla*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Atriplex bunburyana, Rhagodia eremaea, Dissocarpus paradoxus*
Hummock grasses	
Grasses	*Eragrostis* spp*, Enteropogon ramosus*
Herbs/creepers	
Species near plot	

Site	LW04
Coordinates	51 J 235656 7045420
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	calcrete pebbles (20%)
Litter cover (%)	annual grasses (20%)
Condition	very good
Disturbance details	cattle tracks, dung, grazing of grasses
Trees	*Acacia aneura* var *aneura, Casuarina pauper*
Shrubs >2m	*Eremophila glabra* subsp *glabra*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Eremophila oppositifolia* subsp *angustifolia*
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Maireana villosa Acacia ?xanthocarpa, Rhagodia drummondii, Exocarpos aphyllus Maireana pyramidata, Enchylaena tomentosa, Acacia tetragonophylla*
Hummock grasses	
Grasses	*Eragrostis* spp*, Aristida contorta, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	

Site	LW05
Coordinates	51 J 234630 7045814
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	calcrete pebbles (5%)
Litter cover (%)	branches, twigs, leaf litter (5%)
Condition	excellent
Disturbance details	cattle tracks, scats, evidence of grazing
Trees	*Acacia ramulosa* var *linophylla*
Shrubs >2m	*Eremophila oppositifolia* subsp *angustifolia*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Atriplex bunburyana, Rhagodia eremaea, Dissocarpus paradoxus, Maireana pyramidata*
Hummock grasses	
Grasses	*Neurachne* sp, *Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	LW06
Coordinates	51 J 234776 7045395
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	calcrete pebbles (10%)
Litter cover (%)	dead grass, wood (20%)
Condition	very good
Disturbance details	cattle dung, grazing, rabbit activity
Trees	*Acacia aneura* var *aneura*
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Acacia ?xanthocarpa* *Eremophila oppositifolia* subsp *angustifolia*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus, Maireana* sp *Eremophila glabra* subsp *glabra, Maireana villosa,* *Rhagodia drummondii, Maireana pyramidata*
Hummock grasses	
Grasses	*Eragrostis* spp*, Aristida contorta, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	*Maireana triptera*

Site	LW07
Coordinates	51 J 233577 7045465
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red clay-loam
Exposed rock type	nil
Litter cover (%)	twigs and leaves (3%)
Condition	excellent
Disturbance details	no evidence of disturbance
Trees	*Acacia aneura* var *aneura, Acacia aneura* var *tenuis*
Shrubs >2m	*Acacia aneura* var *major*
Shrubs 1-2m	*Eremophila forestii* subsp *forestii, Acacia ?xanthocarpa, Psydrax suaveolens, Acacia tetragonophylla*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Atriplex bunburyana Rhagodia eremaea*
Hummock grasses	
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	LW08
Coordinates	51 J 234126 7045665
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	fine calcrete gravel/pebbles (<1%)
Litter cover (%)	dead grasses (15%)
Condition	very good
Disturbance details	grazing of grasses
Trees	
Shrubs >2m	*Acacia aneura* var *aneura*
Shrubs 1-2m	*Eremophila oppositifolia* subsp *angustifolia*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus, Mairena villosa, Maireana* sp, *Rhagodia drummondii, Sida ammophila, Salsola tragus*
Hummock grasses	
Grasses	*Eragrostis* spp*, Aristida contorta, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	

Site	LW09
Coordinates	51 J 233423 7045541
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red clay-loam
Exposed rock type	nil
Litter cover (%)	dead grass, branches, leaves (8%)
Condition	excellent
Disturbance details	grazing, cattle dung, proximity to tracks
Trees	*Eucalyptus striaticalyx* subsp *striaticalyx*
Shrubs >2m	*Acacia ramulosa* var *linophylla, Acacia victoriae, Acacia aneura* var *major, Acacia aneura* var *tenuis*
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Atriplex bunburyana, Rhagodia eremaea, Maireana pyramidata*
Hummock grasses	
Grasses	*Eragrsotis* spp*, Enteropogon ramosus*
Herbs/creepers	
Species near plot	*Acacia aneura* var *aneura, Hakea francissiana*

Site	LW10
Coordinates	51 J 233138 7045570
Description	
Plot size	30 * 30m
Topography	flat
Slope	
Soil	red/brown sand-loam
Exposed rock type	caclrete gravel/pebbles (40-50%)
Litter cover (%)	*Eucalyptus* leaf litter (40%)
Condition	excellent
Disturbance details	rabbit burrows
Trees	*Eucalyptus striaticalyx* subsp *striaticalyx*
Shrubs >2m	*Acacia ?xanthocarpa, Acacia aneura* var *tenuis*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Maireana villosa, Dissocarpus paradoxus, Salsola tragus*
Hummock grasses	
Grasses	*Enneapogon caerulsecens*
Herbs/creepers	
Species near plot	*Sclerolaena bicornis, Podolepis capillaris*

Site	LW11
Coordinates	51 J 233118 7045450
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	small calcrete pebbles (1-5%)
Litter cover (%)	dead grass, branches, leaves (55%)
Condition	very good
Disturbance details	evidence of grazing, rabbit burrows
Trees	*Eucalyptus striaticalyx* subsp *striaticalyx*
Shrubs >2m	*Acacia victoriae*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Acacia ?xanthocarpa*
Shrubs <1m	*Atriplex bunburyana, Dissocarpus paradoxus*
Hummock grasses	
Grasses	*Nuerachne* sp
Herbs/creepers	
Species near plot	*Eremophila latrobei* subsp *latrobei*

Site	LW12
Coordinates	51 J 232627 7045608
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-clay-loam
Exposed rock type	nil
Litter cover (%)	*Eucalyptus* leaf litter (40%)
Condition	very good-excellent
Disturbance details	rabbits, evidence of historic logging
Trees	*Eucalyptus striaticalyx* subsp *striaticalyx*
Shrubs >2m	*Acacia victoriae, Acacia ?xanthocarpa, Eremophila oppositifolia* subsp *angustifolia*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Maireana villosa, Maireana* sp, *Salsola tragus*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	*Dissocarpus paradoxus, Ptilotus exaltatus, Solanum nummularium*

Site	LW13
Coordinates	51 J 232272 7045725
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	calcrete pebbles (1-5%)
Litter cover (%)	dead grass, twigs, leaves (15%)
Condition	very good-excellent
Disturbance details	cattle tracks, rabbit burrows, some vehicle tracks
Trees	*Eucalyptus striaticalyx* subsp *striaticalyx*
Shrubs >2m	*Pittosporum phylliraeoides, Eremophila latrobei* subsp *latrobei* *Acacia victoriae, Acacia ramulosa* var *linophylla*
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Dissocarpus paradoxus*
Hummock grasses	
Grasses	*Eragrostis* spp*, Neurachne* sp
Herbs/creepers	
Species near plot	*Acacia ?xanthocarpa*

Site	LW14
Coordinates	51 J 232354 7045364
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia, Eucalyptus* leaf litter (10%)
Condition	excellent
Disturbance details	cattle tracks and dung, grazing of *Enneapogon*
Trees	*Eucalyptus eremicola* subsp *peeneri*
Shrubs >2m	*Dodonaea viscosa* subsp *angustissima*
Shrubs 1-2m	*Eremophila glabra* var *glabra*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus*
	Atriplex amnicola, Maireana thesioides, Enchylaena tomentosa
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	*Acacia jennerae, Scaevola spinescens, Pittosporum phylliraeoides*
	Maireana villosa, Grevillea sarissa subsp *succincta, Ptilotus exaltatus*

Site	LW15
Coordinates	51 J 231901 7045507
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	small calcrete pebbles (5%)
Litter cover (%)	branches, leaves, dead grass (5%)
Condition	excellent
Disturbance details	some evidence of cattle activity
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	*Acacia victoriae, Acacia ?xanthocarpa*
Shrubs <1m	*Atriplex amnicola, Maireana thesioides, Rhagodia eremaea*
Hummock grasses	
Grasses	*Sporobolus carolii*
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	

Site	LW16
Coordinates	51 J 232277 7045526
Description	Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia* (15%)
Condition	very good
Disturbance details	grasses grazed, rabbit activity
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Tecticornia tenuis, Zygophyllum aurantiaucum*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	*Maireana villosa, Lawrencia densiflora*

Site	LW17
Coordinates	51 J 231410 7045725
Description	Sparse Chenopod and Samphire Shrubland over Frankenia Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass (15%)
Condition	excellent
Disturbance details	some evidence of grazing
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Frankenia* sp, *Scaevola spinescens, Atriplex bunburyana* *Halosarcia indica* subsp *bidens*, *Cratystylis spinescens*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	

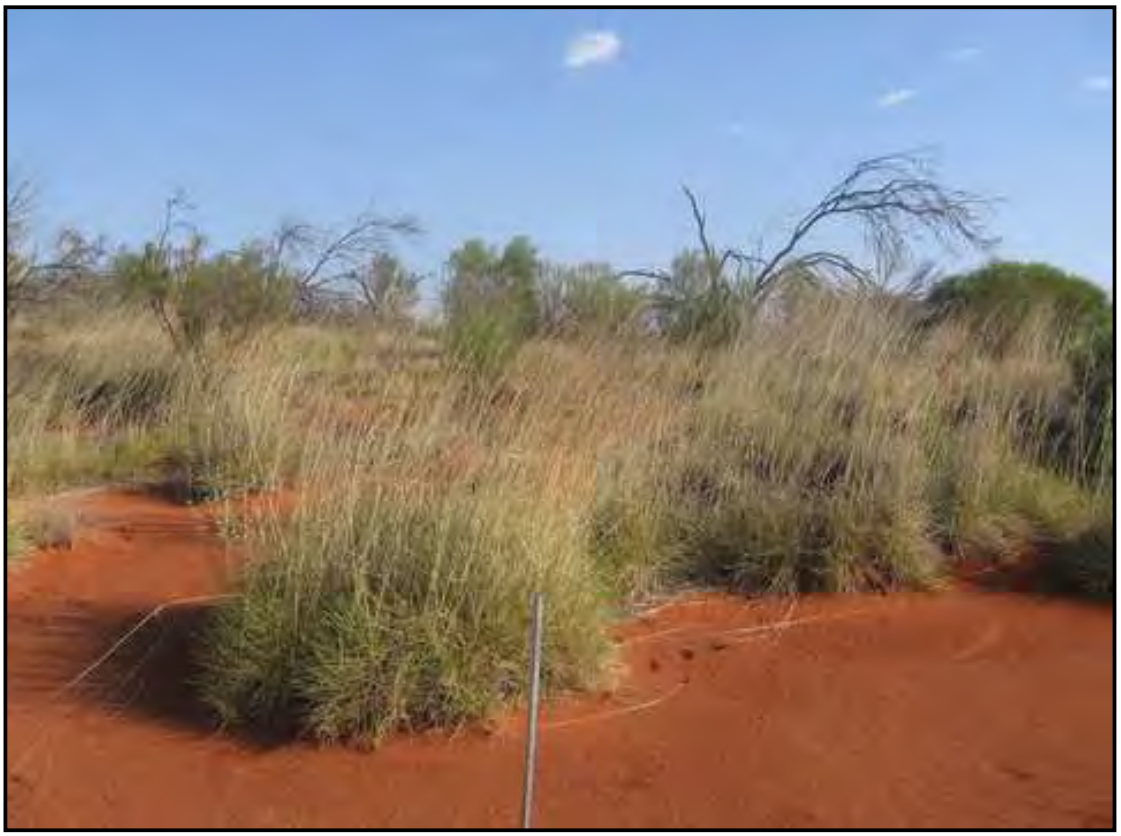
Site	LW18
Coordinates	51 J 231479 7045361
Description	
Plot size	30* 30m
Topography	flat
Slope	nil
Soil	red/brown clay
Exposed rock type	fine calcrete pebbles (<5%)
Litter cover (%)	dead *Halosarcias*, annuals (10%)
Condition	excellent
Disturbance details	none noted
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia auriculata, Atriplex amnicola, Tecticornia tenuis* *Halosarcia indica* subsp *bidens, Frankenia cinerea*
Hummock grasses	
Grasses	*Eragrostis* spp*, Paspalidium* sp
Herbs/creepers	*Lepidium muelleri-ferdinandii, Samolus* sp
Species near plot	*Frankenia cordata*

Site	LW19
Coordinates	51 J 231894 7043978
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia* (10%)
Condition	excellent
Disturbance details	cattle tracks, evidence of rabbit activity
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata* *Frankenia* sp, *Halosarcia* sp, *Halosarcia indica* subsp *bidens*
Hummock grasses	
Grasses	*Eragrsotis* spp
Herbs/creepers	*Muellerolimon salicorniaceum, Myriocephalus rudalii, Lawrencia densiflora*
Species near plot	*Podolepis capillaris, Chrysocephalum apiculatum*

Site	LW20
Coordinates	51 J 231898 7043677
Description	
Plot size	30 * 30m
Topography	dune
Slope	moderate (15-20%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead grasses (30%)
Condition	excellent
Disturbance details	cattle dung, minimal grazing
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	*Pittosporum phylliraeoides*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Olearia stuartii*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta*
Herbs/creepers	*Chrysocephalum apiculatum*
Species near plot	

Site	LW21
Coordinates	51 J 232446 7043328
Description	Samphire Sparse - Open Shrubland and Sparse Chenopod Shrubland over Sparse Forbland over Open Grassland
Plot size	30 * 30m
Topography	undulating
Slope	very gentle (<1%)
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass, *Halosarcia* (15%)
Condition	excellent
Disturbance details	proxmity to tracks, grazing of grass
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Atriplex bunburyana, Maireana villosa, Halosarcia* sp, *Salsola tragus Sclerolaena fimbriolata*
Hummock grasses	
Grasses	*Eragrostis* spp*, Neurachne* sp
Herbs/creepers	*Zygophyllum compressum, Podolepis kendallii*
Species near plot	*Atriplex nummularia* subsp *spathulata,*

Site	LW22
Coordinates	51 J 232520 7043551
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (15%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Acacia, Triodia* (20%)
Condition	excellent
Disturbance details	limited grazing, dead *Grevillea*, cause not clear
Trees	
Shrubs >2m	*Acacia ligulata, Acacia tetragonophylla*
Shrubs 1-2m	*Eremophila georgei, Dodonaea viscosa* subsp *angustifolia*
	Pimelea microcephala subsp *microcephala*
Shrubs <1m	*Atriplex bunburyana, Olearia sturatii, Alyogyne pinoniana*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta*
Herbs/creepers	*Euphorbia boophthana*
Species near plot	*Grevillea stenobotrya*



Site	LW23
Coordinates	51 J 232958 7043064
Description	Open Shrubland over Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass (8%)
Condition	very good-excellent
Disturbance details	cattle tracks, grazing, dung
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Frankenia* sp, *Maireana villosa, Frankenia punctata, Atriplex nummularia* subsp *spathulata, Maireana luehmanii Sclerolaena fimbriolata*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Dysphania kalpari*
Species near plot	

Site	LW24
Coordinates	51 J 233058 7043416
Description	Open Frankenia and Samphire Shrubland over Sparse Grassland and Sparse Forbland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown clay
Exposed rock type	nil
Litter cover (%)	dead grasses (5%)
Condition	very good
Disturbance details	grazing of grasses, cattle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Maireana villosa, Frankenia punctata, Frankenia cinerea Halosarcia calyptrata*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Podolepis kendallii, Dysphania kalpari, Goodenia* sp
Species near plot	

Site	LW25
Coordinates	51 J 233215 7042865
Description	Samphire Sparse - Open Shrubland over Sparse Chenopod Shrubland over Sparse Forbland and Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grasses, *Halosarcia* (8%)
Condition	excellent
Disturbance details	cattle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Frankenia* sp, *Halosarcia* sp *Atriplex nummularia* subsp *spathulata, Maireana luehmannii*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*?Carpobrotus* sp, *Myriocephalus rudallii, Dysphania kalpari*
Species near plot	

Site	LW26
Coordinates	51 J 233033 7043268
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (15%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead grasses, Mulga branches (30%)
Condition	excellent
Disturbance details	minimal grazing
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Senna artemisioides* subsp *filifolia*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Atriplex amnicola, Alyogyne pinoniana Atriplex bunburyana, Maireana pyramidata*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrsotis eriopoda, Aristida contorta, Eriachne helmsii*
Herbs/creepers	
Parasites	*Amyema maidenii*
Species near plot	*Solanum lasiophyllum*

Site	LW27
Coordinates	51 J 233861 7042710
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass (6%)
Condition	excellent
Disturbance details	evidence of cattle activity
Trees	
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Scaevola spinescens*
Shrubs <1m	*Sclerolaena articulata, Solanum lasiophyllum, Rhagodia eremaea* *Atriplex nummularia* subsp *spathulata, Sclerolaena fimbriolata* *Frankenia* sp, *Maireana pyramidata*
Hummock grasses	
Grasses	*Aristida contorta*
Herbs/creepers	*Muellerolimon salicorniaceum, Podolepis capillaris*
Species near plot	

Site	LW28
Coordinates	51 J 233894 7042888
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (15%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead grasses, wood (25%)
Condition	excellent
Disturbance details	limited grazing
Trees	
Shrubs >2m	*Acacia jennerae*
Shrubs 1-2m	*Pimelea microcephala* subsp *microcephala*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus*
	Atriplex amnicola, Alyogyne pinoniana, Olearia stuartii
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta, Eriachne helmsii*
Herbs/creepers	*Chrysocephalum apiculatum*
Species near plot	

Site	LW29
Coordinates	51 J 234760 7042559
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia,* grass (2%)
Condition	excellent
Disturbance details	evidence of cattle movement
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Tecticornia arbuscula*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	LW30
Coordinates	51 J 234536 7042956
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (~8%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia,* wood (35%)
Condition	excellent
Disturbance details	limited grazing
Trees	
Shrubs >2m	*Grevillea sarissa* subsp *succincta, Acacia aneura* var *tenuis* *Dodonaea viscosa* subsp *angustissima, Acacia jennerae*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Olearia stuartii*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta*
Herbs/creepers	
Species near plot	*Acacia ayersiana* var *latifolia, Grevillea stenobotrya*

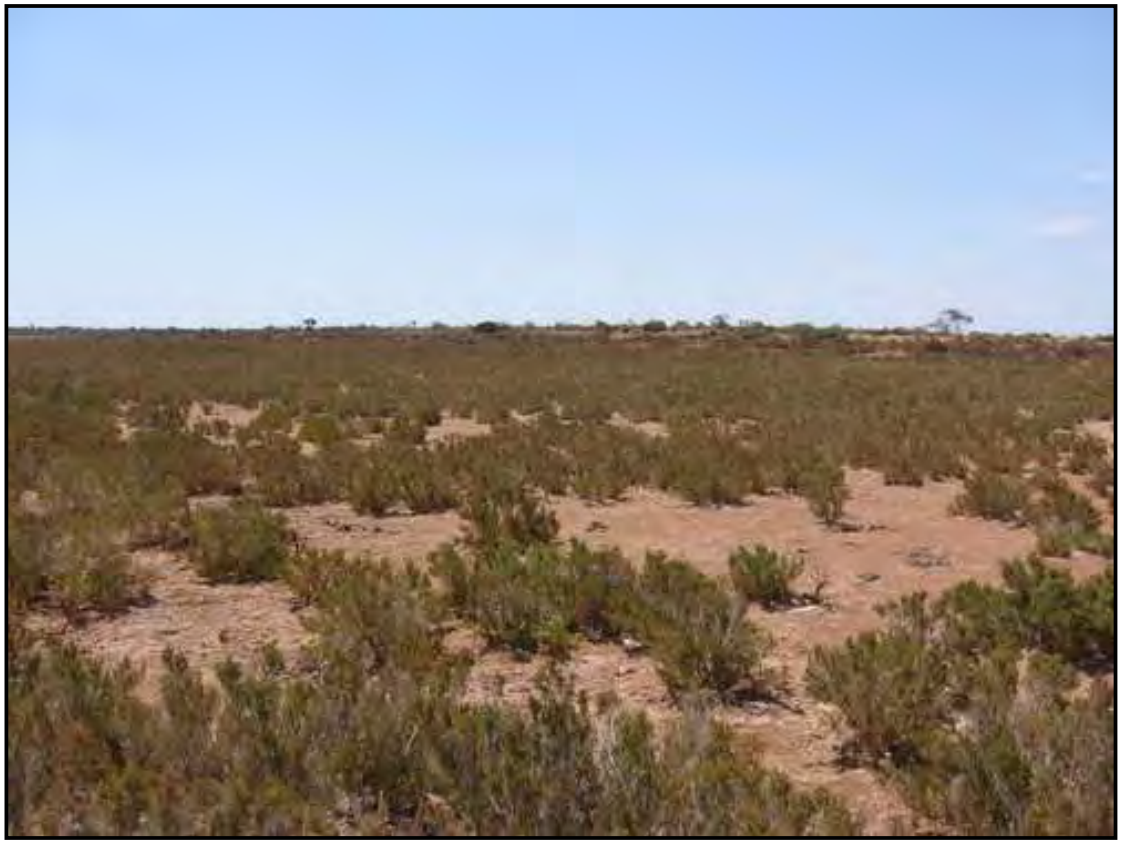
Site	LW31
Coordinates	51 J 235376 7043236
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass (12%)
Condition	very good-excellent
Disturbance details	cattle tracks, dung
Trees	
Shrubs >2m	
Shrubs 1-2m	*Pittosporum phylliraeoides, Eremophila glabra* subsp *glabra*
Shrubs <1m	*Atriplex amnicola, Rhagodia eremaea, Acacia victoriae, Psammomoya* sp *Scaevola spinescens, Frankenia cordata*
Hummock grasses	
Grasses	
Herbs/creepers	*Anagallis arvensis*
Species near plot	

Site	LW32
Coordinates	51 J 235202 7043714
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead *Triodia, Eucalyptus* leaf litter and branches (20%)
Condition	excellent
Disturbance details	limited grazing, heavy on *Rhagodia*
Trees	*Acacia ayersiana* var *latifolia, Eucalytpus transcontinentalis* subsp *transcontinentalis*
Shrubs >2m	*Pittosporum phylliraeoides, Grevillea* sarissa *subsp* succincta *Acacia jennerae, Dodonaea viscosa* subsp *angustissima, Santalum acuminatum*
Shrubs 1-2m	*Eremophila forestii* subsp *forestii*
Shrubs <1m	*Atriplex amnicola, Frankenia cordata, Rhagodia drummondii*
Hummock grasses	
Grasses	*Eragrostis eriopoda*
Herbs/creepers	*Samolus* sp
Species near plot	*Eremophila glabra* subsp *glabra*

Site	LW33
Coordinates	51 J 235361 7043111
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass (20%)
Condition	very good
Disturbance details	extensive cattle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Atriplex amnicola, Frankenia cordata, Halosarcia* sp
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	

Site	LW34
Coordinates	51 J 235291 7043498
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (10%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (25%)
Condition	excellent
Disturbance details	cattle dung, minimal grazing
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	*Eremophila latrobei* subsp *latrobei, Grevillea sarissa* subsp *succincta* *Dodonaea viscosa* subsp *angustissima*
Shrubs 1-2m	
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Olearia stuartii*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta, Eriachne helmsii*
Herbs/creepers	
Species near plot	

Site	LW35
Coordinates	51 J 237960 7041775
Description	Open Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcias* (3%)
Condition	excellent
Disturbance details	some evidence of cattle movement
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Halosarcia auriculata*
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	



Site	LW36
Coordinates	51 J 235224 7043355
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	leaf and wood litter (40%)
Condition	very good-excellent
Disturbance details	cattle tracks, dung, drilling gridlines, vehicle tracks
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Atriplex amnicola, Sclerolaena bicornis*
Hummock grasses	
Grasses	
Herbs/creepers	*Muellerolimon salicorniaceum*
Species near plot	

Site	LW37
Coordinates	51 J 238095 7041825
Description	Samphire Sparse - Open Shrubland and Sparse Chenopod Shrubland over Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia,* grass (10%)
Condition	excellent
Disturbance details	rabbit scats
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Frankenia* sp, *Atriplex bunburyana, Maireana villosa, Halosarcia* sp, *Salsola australis*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Zygophyllum compressum, Podolepis kendallii*
Species near plot	

Site	LW38
Coordinates	51 J 238285 7041934
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	nil
Litter cover (%)	dead grasses, Mulga litter (20%)
Condition	very good
Disturbance details	cow dung, dead Mulga, evidence of fire (not recent)
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Atriplex amnicola* *Eremophila glabra* subsp *glabra, Maireana villosa, Maireana* sp *Maireana pyramidata, Enchylaena tomentosa*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta, Enneapogon caerulescens* *Eriachne helmsii*
Herbs/creepers	
Species near plot	

Site	LW39
Coordinates	51 J 237119 7042918
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia,* grass (10%)
Condition	excellent
Disturbance details	no obvious signs of disturbance
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Halosarcia auriculata, Halosarcia* sp, *Frankenia* sp
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

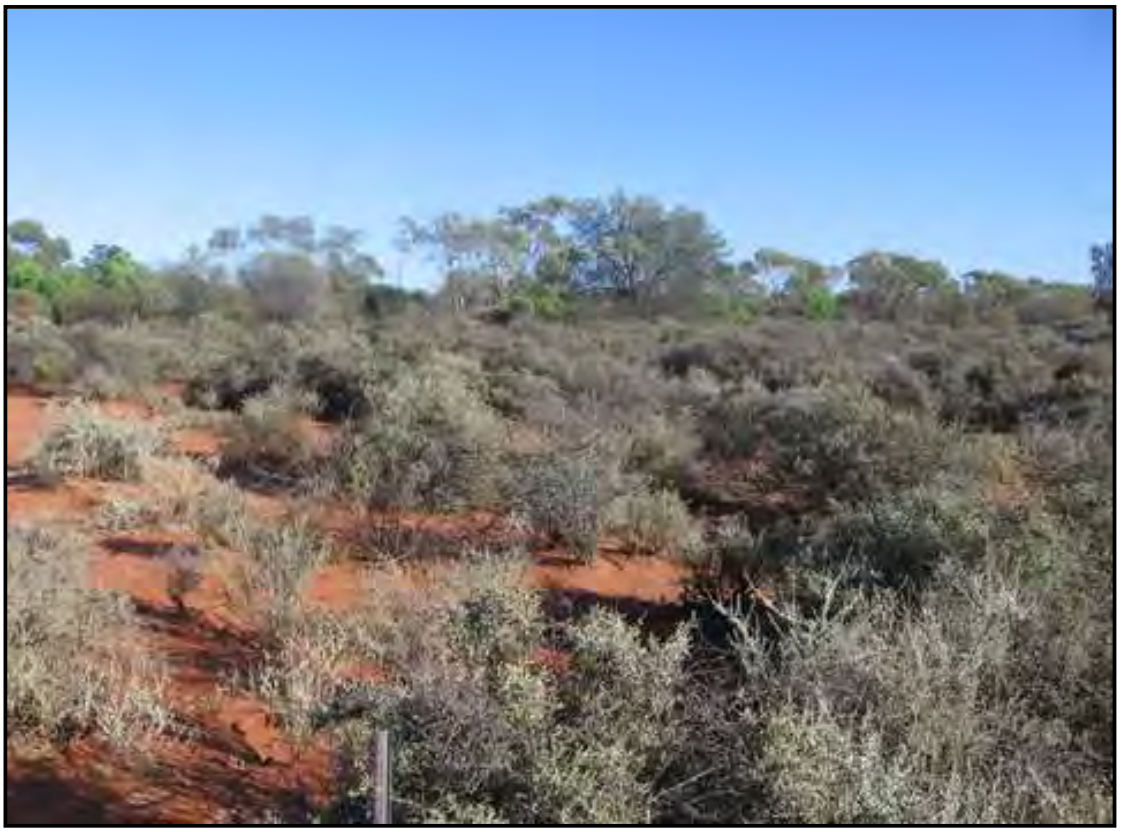
Site	LW40
Coordinates	51 J 237238 7043103
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	Mulga leaf litter (60%)
Condition	very good
Disturbance details	grazing of shrubs, cattle tracks, dead Mulga
Trees	*Melaleuca xerophila, Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	*Eremophila* sp
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Scaevola spinescens, Pittosporum phylliraeoides, Maireana villosa* *Rhagodia drummondii, Maireana thesioides*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida contorta, Eriachne helmsii*
Herbs/creepers	
Species near plot	

Site	LW41
Coordinates	51 J 234231 7044139
Description	Sparse Shrubland over Sparse Samphire Shrubland and Sparse Chenopod Shrubland over Sparse Forbland and Sparse Grassland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange/red clay
Exposed rock type	nil
Litter cover (%)	dead *Halosarcia,* dead grass, twigs (8%)
Condition	very good-excellent
Disturbance details	grazing, cattle dung
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Zygophyllum aurantiacum, Frankenia* sp, *Eremophila glabra* subsp *glabra* *Maireana villosa, Rhagodia eremaea, Tecticornia arbuscula* *Maireana luehmanii, Sclerolaena fimbriolata, Acacia burkittii*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	*Dysphania kalpari*
Species near plot	

Site	LW42
Coordinates	51 J 237309 7043255
Description	
Plot size	30 * 30m
Topography	dune
Slope	gentle (<1%)
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (20%)
Condition	very good
Disturbance details	fire (not recent)
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	*Grevillea stenobotrya*
Shrubs 1-2m	*Acacia jennerae, Dodonaea viscosa* subsp *angustissima* *Eremophila georgei*
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Alyogyne pinoniana* *Enchylaena tomentosa*
Hummock grasses	*Triodia melvillei*
Grasses	*Eriachne helmsii*
Herbs/creepers	
Species near plot	*Grevillea sarissa* subsp *succincta*

Site	LW43
Coordinates	51 J 236894 7045164
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay/calcrete
Exposed rock type	calcrete (25%)
Litter cover (%)	dead grasses, twigs, branches (13%)
Condition	very good
Disturbance details	extensive grazing, rabbit burrows
Trees	*Casuarina pauper*
Shrubs >2m	*Acacia victoriae*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Senna artemisioides* subsp *filifolia, Acacia ?xanthocarpa*
Shrubs <1m	*Scaevola spinescens, Atriplex amnicola, Maireana amoena*
Hummock grasses	
Grasses	*Eragrostis* spp*, Neurachne* sp
Herbs/creepers	
Species near plot	

Site	LW44
Coordinates	51 J 237017 7045071
Description	Shrubland over Sparse Samphire Shrubland
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown clay-loam
Exposed rock type	nil
Litter cover (%)	dead *Cratystylis* (10%)
Condition	excellent
Disturbance details	cattle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Cratystylis spinescens, Scaevola spinescens, Tecticornia disarticulata* *Frankenia* sp
Hummock grasses	
Grasses	
Herbs/creepers	
Species near plot	*Eucalyptus* sp



Site	LW45
Coordinates	51 J 236626 7045136
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay/ calcrete
Exposed rock type	calcrete pebbles (10%)
Litter cover (%)	leaf litter, twigs, branches (15%)
Condition	very good-excellent
Disturbance details	rabbit burrows, droppings, cattle tracks, dung, grazing
Trees	
Shrubs >2m	*Acacia aneura* var *aneura, Acacia ramulosa* var *linophylla*
Shrubs 1-2m	*Eremophila latrobei* subsp *latrobei*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Maireana amoena,* *Sida calyxhymenia*, *Acacia tetragonophylla, Senna* sp Billabong
Hummock grasses	
Grasses	*Neurachne* sp
Herbs/creepers	
Species near plot	

Site	LW46
Coordinates	51 J 236706 7044502
Description	Shrubland over Sparse Shrubland
Plot size	30 * 30m
Topography	drainage flat
Slope	nil
Soil	red/brown clay-loam
Exposed rock type	nil
Litter cover (%)	dead *Cratystylis* (20%)
Condition	excellent
Disturbance details	cattle tracks, rabbits
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Tecticornia tenuis, Dissocarpus paradoxus, Cratystylis spinescens Solanum lasiophyllum, Scaevola spinescens, Atriplex amnicola Spartothamnella ?tuecriflora*
Hummock grasses	
Grasses	*Sporobolus carolii*
Herbs/creepers	
Species near plot	*Enteropogon ramosus, ?Austrostipa* sp

Site	LW47
Coordinates	51 J 236607 7044654
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay/calcrete
Exposed rock type	calcrete pebbles (2%)
Litter cover (%)	twigs, branches, leaves (8%)
Condition	excellent
Disturbance details	rabbits, cattle tracks
Trees	*Melaleuca xerophila*
Shrubs >2m	*Acacia ramulosa* var *linophylla, Acacia victoriae*
Shrubs 1-2m	*Hakea francissiana, Grevillea nematophylla* subsp *nematophylla* *Acacia tetragonophylla*
Shrubs <1m	*Scaevola spinescens, Atriplex amnicola, Maireana villosa* *Atriplex nummularia* subsp *spathulata, Psammomoya* sp
Hummock grasses	
Grasses	*Neurachne* sp, *Austrostipa* sp
Herbs/creepers	
Species near plot	

Site	LW48
Coordinates	51 J 236752 7043763
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	
Litter cover (%)	*Triodia, Melaleuca, Acacia* litter (10%)
Condition	excellent
Disturbance details	cattle tracks, minimal grazing
Trees	*Melaleuca xerophila, Acacia ayersiana* var *latifolia*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Ptilotus obovatus* var *obovatus*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	LW49
Coordinates	51 J 236159 7044186
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	leaf litter, twigs (4%)
Condition	excellent
Disturbance details	cattle tracks, rabbit scats/scratchings
Trees	*Melaleuca xerophila*
Shrubs >2m	*Pittosporum phylliraeoides, Acacia victoriae, Acacia tetragonophylla*
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Exocarpos aphyllus*
Shrubs <1m	*Solanum lasiophyllum, Scaevola spinescens, Atriplex amnicola Eremophila latrobei* subsp *latrobei, Atriplex bunburyana Rhagodia eremaea, Cratystylis spinescens, Spartothamnella teucriflora*
Hummock grasses	
Grasses	*Enteropogon ramosus*
Herbs/creepers	
Species near plot	

Site	LW50
Coordinates	51 J 236885 7043747
Description	Open Shrubland over Sparse grassland
Plot size	30 * 30m
Topography	drainage flat
Slope	flat
Soil	brown clay
Exposed rock type	nil
Litter cover (%)	dead annuals, *Frankenia* (40%)
Condition	very good
Disturbance details	cattle prints, rabbits, grazing of grasses
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Frankenia cinerea, Frankenia* sp, *Tecticornia disarticulata* *Atriplex holocarpa, Atriplex amnicola*
Hummock grasses	
Grasses	*Enneapogon caerulescens, Enteropogon ramosus, Aristida contorta* *Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	LW51
Coordinates	51 J 236208 7044121
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	leaves, twigs (4%)
Condition	excellent
Disturbance details	cattle tracks, rabbit scats
Trees	
Shrubs >2m	
Shrubs 1-2m	*Acacia tetragonophylla*
Shrubs <1m	*Halosarcia indica* subsp *leiostachya, Scaevola spinescens* *Eremophila glabra* subsp *glabra, Atriplex bunburyana* *Cratystylis spinescens*
Hummock grasses	
Grasses	*Enteropogon ramosus*
Herbs/creepers	
Species near plot	

Site	LW52
Coordinates	51 J 236802 7043568
Description	
Plot size	30 * 30m
Topography	base of low dune
Slope	flat
Soil	red/brown sand
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (5%)
Condition	excellent
Disturbance details	historic fires, limited cattle impacts
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	*Acacia jennerae*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Eremophila forestii* subsp *forestii* *Grevillea sarissa* subsp *succincta*
Shrubs <1m	*Atriplex amnicola*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Eriachne helmsii*
Herbs/creepers	
Species near plot	*Pittosporum phylliraeoides*

Site	LW53
Coordinates	51 J 235813 7044562
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	calcrete pebbles (5%)
Litter cover (%)	needles, twigs (20%)
Condition	excellent
Disturbance details	cattle dung, rabbit droppings, grazing
Trees	*Casuarina pauper*
Shrubs >2m	
Shrubs 1-2m	*Acacia jennerae, Senna artemisioides* subsp *filifolia* *Acacia ramulosa* var *linophylla, Acacia victoriae, Acacia ?xanthocarpa* *Acacia quadrimarginea, Maireana pyramidata*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Scaevola spinescens* *Maireana amoena*
Hummock grasses	
Grasses	*Neurachne* sp
Herbs/creepers	
Species near plot	

Site	LW54
Coordinates	51 J 235487 7044769
Description	
Plot size	30 * 30m
Topography	plain
Slope	nil
Soil	red/brown sand-loam
Exposed rock type	calcrete pebbles (10%)
Litter cover (%)	data not recorded
Condition	good
Disturbance details	grasses grazed, rabbit burrows, dead shrubs
Trees	
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides* subsp *filifolia, Acacia ?xanthocarpa*
	Lycium australe, Eremophila oppositifolia subsp *angustifolia*
Shrubs <1m	*Solanum lasiophyllum, Acacia ligulata, Ptilotus obovatus* var *obovatus*
	Maireana amoena, Sclerolaena bicornis, Maireana pyramidata
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	LW55
Coordinates	51 J 234692 7044613
Description	
Plot size	30 * 30m
Topography	flat
Slope	nil
Soil	orange clay
Exposed rock type	
Litter cover (%)	dead *Acacias,*branches, leaves (15%)
Condition	very good-excellent
Disturbance details	cattle tracks, dung, rabbits, grasses heavily grazed
Trees	*Acacia aneura* var *aneura, Pittosporum phylliraeoides* *Grevillea nematophylla* subsp *nematophylla*
Shrubs >2m	
Shrubs 1-2m	*Scaevola spinescens, Senna artemisioides* subsp *filifolia* *Acacia tetragonophylla, Exocarpos aphyllus*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus* var *obovatus* *Eremophila glabra* subsp *glabra, Rhagodia eremaea*
Hummock grasses	
Grasses	*Enteropogon ramosus*
Herbs/creepers	
Parasites	*Amyema maidenii*
Species near plot	

Site	LW56
Coordinates	51 J 234902 7044799
Description	
Plot size	30 * 30m
Topography	drainage flat
Slope	nil
Soil	pale brown clay loam
Exposed rock type	calcrete pebbles (4%)
Litter cover (%)	nil
Condition	good - very good
Disturbance details	rabbits, cattle tracks, grasses grazed
Trees	
Shrubs >2m	*Eremophila oppositifolia* subsp *angustifolia*
Shrubs 1-2m	*Lycium australe*
Shrubs <1m	*Atriplex amnicola, Maireana amoena, Cratystylis spinescens Sclerolaena bicornis*
Hummock grasses	
Grasses	*Eragrostis* spp
Herbs/creepers	
Species near plot	

Site	LW57
Coordinates	51 J 234523 7044488
Description	
Plot size	30 * 30m
Topography	flat
Slope	nit
Soil	red loam clay
Exposed rock type	nil
Litter cover (%)	dead *Triodia* (2%)
Condition	excellent
Disturbance details	fire recovery
Trees	
Shrubs >2m	*Pittosporum phylliraeoides*
Shrubs 1-2m	*Acacia jennerae, Alyogyne pinoniana, Eremophila glabra* subsp *glabra* *Dodonaea viscosa* subsp *angustissima*
Shrubs <1m	*Ptilotus obovatus* var *obovatus, Olearia stuartii* *Grevillea sarissa* subsp *succincta*
Hummock grasses	*Triodia melvillei*
Grasses	*Enteropogon ramosus*
Herbs/creepers	
Species near plot	

Site	LW58
Coordinates	51 J 234521 7045088
Description	
Plot size	30 * 30m
Topography	plain
Slope	flat
Soil	pale brown sandy loam
Exposed rock type	calcrete pebbles (20%)
Litter cover (%)	
Condition	very good
Disturbance details	rabbit burrows, grazing of grasses
Trees	
Shrubs >2m	*Eremophila glabra* subsp *glabra, Acacia ?xanthocarpa*
Shrubs 1-2m	*Eremophila oppositifolia* subsp *angustifolia, Acacia tetragonophylla*
Shrubs <1m	*Scaevola spinescens, Maireana amoena, Sclerolaena bicornis Salsola tragus, Maireana pyramidata*
Hummock grasses	
Grasses	*Eragrostis* spp*, Eragrostis eriopoda, Enneapogon caerulescens*
Herbs/creepers	
Species near plot	

Site	LW59
Coordinates	51 J 237482 7045170
Description	
Plot size	30 * 30m
Topography	clay pan
Slope	flat
Soil	orange clay
Exposed rock type	nil
Litter cover (%)	dead grass, *Acacia* (12%)
Condition	very good
Disturbance details	signs of heavy grazing, cattle tracks
Trees	
Shrubs >2m	*Acacia aneura* var *aneura, Acacia aneura* var *intermedia*
Shrubs 1-2m	*Grevillea sarissa* subsp *succincta, Acacia tetragonophylla*
Shrubs <1m	*Halosarcia auriculata, Scaevola spinescens, Maireana villosa* *Cratystylis spinescens, Frankenia* sp
Hummock grasses	
Grasses	*Eragrostis* spp*, Enteropogon ramosus*
Herbs/creepers	
Species near plot	

Site	LW60
Coordinates	51 J 234672 7044153
Description	
Plot size	30 * 30m
Topography	plain
Slope	flat
Soil	red brown sand
Exposed rock type	nil
Litter cover (%)	dead wood (20%)
Condition	very good - excellent
Disturbance details	historic fire
Trees	*Acacia ayersiana* var *latifolia, Eucalyptus transcontinentalis* subsp *transcontinentalis*
Shrubs >2m	*Acacia jennerae, Grevillea sarissa* subsp *succincta*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Dodonaea viscosa* subsp *angustissima*
Shrubs <1m	*Solanum lasiophyllum, Maireana thesioides*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	LW61
Coordinates	51 J 237591 7045562
Description	
Plot size	30 * 30m
Topography	plain
Slope	flat
Soil	red brown sandy loam
Exposed rock type	nil
Litter cover (%)	dead mulga (5%)
Condition	very good
Disturbance details	burnt area, dead mulgas across fire scar
Trees	*Acacia ayersiana* var *latifolia, Acacia aneura* var *fuliginea*
Shrubs >2m	*Santalum spicatum*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Grevillea sarissa* subsp *succincta* *Acacia tetragonophylla*
Shrubs <1m	*Pittosporum phylliraeoides, Dicrastylis exsuccosa* var *tomentosa*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	

Site	LW62
Coordinates	51 J 237806 7045645
Description	
Plot size	30 * 30m
Topography	plain
Slope	flat
Soil	red brown sandy loam
Exposed rock type	nil
Litter cover (%)	mulga leaf litter (50%)
Condition	excellent
Disturbance details	
Trees	*Acacia ayersiana* var *latifolia*
Shrubs >2m	*Acacia aneura* var *aneura, Psydrax suaveolens*
Shrubs 1-2m	*Eremophila glabra* subsp *glabra, Grevillea sarissa* subsp *succincta*
Shrubs <1m	*Scaevola spinescens*
Hummock grasses	*Triodia melvillei, Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	
Species near plot	*Eremophila forestii* subsp *forestii, Eriachne helmsii* *Acacia tetragonophylla*

Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Lake Way, Centipede and West Creek borefield.

Report prepared for

July 2011

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1.0 SUMMARY

Toro Energy Ltd (Toro) is proposing to develop uranium resources within the Wiluna Uranium Project. The project comprises two prospective mining areas; Centipede and Lake Way. The two proposed mining areas are located south and southeast of the town of Wiluna in Western Australia. To develop the resources, Toro need to submit a mining application, within which a summary of environmental impacts is provided. One area for which potential impacts require an assessment relate to flora and vegetation. Toro contracted Niche Environmental Services (Niche) to undertake studies over the proposed Centipede and Lake Way mining areas. This report documents the findings of survey work completed over the project area by Niche in April – June and September – October 2010.

The surveys were completed over the following areas:

- Centipede survey area – comprising an area of approximately 874 ha within M53/0224, 35 km south of the town of Wiluna;
- Lake Way project area – comprising an area of approximately 2 324 ha within M53/1090, 10 km southeast of the town of Wiluna; and
- Regional – completed adjacent to the project areas, around Lake Way and other salt lake systems in the region.

Prior to commencing the field surveys, a desktop review was undertaken. The desktop review included:

- A search of the *Protected Matters database* for matters listed under the provisions of the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999;*
- A search of the Western Australian Department of Environment and Conservation (DEC) Threatened (Declared Rare) Flora database, the Western Australian Herbarium (WAHERB) database and the Declared Rare and Priority Flora List for rare and priority flora collected from the survey area and surrounds or potentially occurring within the survey area;
- A search of the DEC Threatened Ecological Communities (TEC) database for listings of Threatened Ecological Communities or Priority Ecological Communities (PEC) recorded at or in the surrounds of the survey area; and
- A review of publicly available reports and publications containing flora, vegetation and ecological information relevant to the survey area.

The key findings from the desktop review were:

- No flora and vegetation matters were noted in the *Protected Matters database* search that related to the project area;
- There were no Declared Rare Flora (DRF – now listed as Threatened Flora) listed for the project area and surrounds A total of 21 priority flora were listed in the DEC database, of which six were priority 1 taxa, 13 were priority 2 taxa and the remaining two were priority 3

taxa. In addition to the species listed in the database search, there were two species listed by the DEC after the review of the scoping document; and

- No Threatened Ecological Communities (TECs) as defined by the DEC were identified as occurring within the project area or surrounds. A total of 30 Priority Ecological Communities (PECs) were listed in the database, of which two were flora communities, being:
    - Wiluna West vegetation complexes (banded ironstone formation (BIF)) (Priority 1).
    - Montague Range vegetation complexes (BIF) (Priority 1).

  Neither of these PECS were within the survey areas.

The Centipede survey area covered approximately 874 ha, of which approximately 533 ha was vegetation and 341 ha was un-vegetated salt lake. Of the 533 ha of native vegetation, approximately 304 ha was Low Heath D of *Tecticornia* species. It is proposed to clear approximately 277.5 ha, representing 91.2 % of this unit in the survey area.

The Lake Way survey area covered approximately 2 324 ha on the northern sections of the lake system, of which approximately 1 984 ha was vegetated and 300 ha was un-vegetated salt lake. Within the Lake Way survey area, there were two units that were dominated by *Tecticornia* species. There was a Low Heath D of *Tecticornia* species on the edge of the playa. This unit covered 396 ha of the survey area, of which 216.2 ha, representing 54.6 % of the extent of this unit within the survey area, will be removed. In addition to this, there was a Low Heath D of *Tecticornia* species on sections of claypan. This unit covered 214 ha of the survey area, of which 117.02 ha, representing 54.7 % of the extent of this unit within the survey area, will be removed.

To determine whether vegetation was considered to have conservation significance, an assessment was made against the following factors:

- Presence of flora of conservation significance;
- Presence of new flora records;
- Vegetation unit potentially restricted in distribution;
- Vegetation containing a unique assemblage of species; and
- Identified by a recognised authority

The *Tecticornia* vegetation units are considered to be the most important, largely due to the potential extent of impact to these units. Other vegetation units that were identified as having conservation significance were not likely to be significantly impacted by the proposed development or had good regional representation.

During the completion of the surveys documented in this report, it was noted that there were threatening processes that were potentially having an impact on the condition of vegetation and the diversity of flora in the project area and surrounds. The key threatening processes noted were:

- Overgrazing by cattle;

- Grazing by camels;
- Grazing by rabbits;
- Track proliferation;
- Fire; and
- Drought.

An assessment as to the presence of groundwater dependent vegetation was completed. The presence of groundwater dependent vegetation was inferred in all survey areas. These units were:

- Centipede survey area – playa Low Heath D of *Tecticornia* species. This unit will be directly impacted by clearing.
- Lake Way survey area – playa Low Heath D of *Tecticornia* species and the claypan Low Heath D of *Tecticornia* species. These units will be directly impacted by clearing.

During the autumn and spring 2010 surveys within the Centipede, Lake Way and regional surveys, a total of 231 *Tecticornia* specimens were collected. Of the 231 specimens collected, there were 168 that were identified. From the 168 specimens, a total of 21 species were identified. Of the 21 species identified, 16 were identified to species, one to aggregate, three to affinity and one potential novel species. The potential novel species was not recorded in the Lake Way or Centipede project area.

Targeted searches have been completed within the survey areas and during regional surveys for *Tecticornia* sp. Lake Way (P. Armstrong 05/961) (P1). This species was only recorded in areas from which collections have been previously made, which was approximately 4.5 km south of the Centipede survey area.

The environmental weed *Acetosa vesicaria* (ruby dock) was recorded in the Centipede project area and in other locations not within, but very close to Toro tenements.

The survey work as detailed in this report was conducted in accordance with the guidelines of the EPA. The work in general is considered to meet the underlying requirements for a Level 2 survey, in relation to timing and intensity of surveys. Additional survey work may be required to facilitate completion of taxonomic work of *Tecticornia* specimens.

2.0 INTRODUCTION

2.1 Project Background

Toro Energy Ltd (Toro) is proposing to develop uranium resources within the Wiluna Uranium Project. The project comprises two prospective mining areas; Centipede and Lake Way. The two proposed mining areas are located south and southeast of the town of Wiluna in Western Australia. To develop the resources, Toro need to submit a mining application, within which a summary of environmental impacts is provided. One area for which potential impacts require an assessment relate to flora and vegetation. Toro contracted Niche Environmental Services (Niche) to undertake studies over the proposed Centipede and Lake Way mining areas. This report documents the findings of survey work completed over the project area by Niche in April – June and September – October 2010.

2.2 Scope and Objectives of the Study

The level of assessment for the Toro Wiluna Uranium Project has been set by the EPA at Environmental Review and Management Programme (ERMP). An ERMP is the highest level of assessment set by the EPA. Based on this, a Level 2 survey as defined by the EPA (2004) was considered an appropriate level of survey. A Level 2 survey is the most comprehensive survey prescribed by the EPA, with the central requirement being a quadrat-based survey over proposed areas of disturbance.

A Level 2 survey is comprised of

- A desktop review to collect ecological data relevant to the area to be surveyed and surrounds, including:
    - Searches of relevant DEC databases;
    - A search of the EPBC Act Protected Matters database; and
    - Reviews of publicly-available ecological information.
- A site visit to
    - Conduct a reconnaissance survey with the objectives of:
        - Verifying the information collected in the desktop review;
        - Completing a census of the flora, with a focus on determining the presence of any flora of conservation significance;
        - Assessing the condition of the vegetation;
        - Developing a preliminary delineation and description of the vegetation; and
        - Identifying any potential impacts.
    - Complete a quadrat-based survey of the vegetation to assist with:
        - Enhancing knowledge of the flora and vegetation, with the specific aim of placing the vegetation in a local and regional context. This is achieved by collecting data in a manner consistent with known or recommended levels of sampling effort and quadrat sizes. A minimum of two quadrats per vegetation unit is recommended.

This report contains the following

- An overview of the survey sites, which serves to place the survey sites in a regional context;
- The findings of the desktop review;
- A detailed description of the methods used;
- A summary of the flora recorded, with reference to flora of conservation significance;
- The findings of the field survey, incorporating a description of the vegetation, an assessment of the condition using the scale devised by Keighery (1994), an assessment of the extent of the vegetation and conservation significance of the vegetation; and
- An assessment of the adequacy of the survey.

3.0 SURVEY AREAS

3.1 Study sites

3.1.1 Overview

This report documents the findings of flora and vegetation surveys completed during autumn and spring 2010 over three areas, being the proposed Centipede mining area (Centipede), the proposed Lake Way mining area (Lake Way) and the proposed West Creek borefield, as shown in **Figure 1**. In addition to this, relevant findings from regional surveys conducted in autumn and spring 2010 are included in this report.

3.1.2 Centipede survey area

The Centipede survey area was located within Mining Lease M53/224, approximately 35 km south of the Town of Wiluna. The Centipede survey area is located to the east of the Goldfields Highway on the Lake Way pastoral lease. The Centipede survey area was approximately 874 ha in area.

3.1.3 Lake Way survey area

The Lake Way survey area was located within Mining Lease M53/1090, approximately 10 km southeast of the Town of Wiluna. The Lake Way survey area was located entirely within the Millbillillie pastoral lease. The Lake Way survey area was approximately 2324 ha in area.

3.1.4 Regional surveys autumn 2010

The regional surveys conducted during autumn 2010 were focused on the areas surrounding the Lake Way system, with a specific focus on the vegetation within the areas immediately adjacent to the Lake Way and Centipede survey areas and areas on the south and east of the lake system. The regional surveys were conducted within an area bounded by the Goldfields Highway, Lake Way Road, Wonganoo Road and the Yarraloola to Kalgoorlie Gas Pipeline.

3.1.5 Regional surveys spring 2010

The regional surveys conducted during spring 2010 were primarily focused on salt lake systems in the region surrounding Lake Way. Quadrats were located in samphire vegetation units, with additional quadrats located on plains or dune vegetation adjacent to the lake systems. Quadrats were surveyed at the following lake systems:

- Lake Naberru – this lake system was located approximately 100 km north of the town of Wiluna;
- Lake Ward – this lake system was located approximately 60 km northeast of the town of Wiluna;
- Lake Miranda – this lake system was located approximately 100 km south of the town of Wiluna; and
- Unnamed lake systems – these lake systems were located approximately 100 and 150 km east of the town of Wiluna.

3.2 Environmental Setting

3.2.1 IBRA Bioregion

The Toro Wiluna Uranium Project is located within the Murchison biogeographic region (bioregion) of the Interim Biogeographic Regionalisation for Australia (or IBRA) (Thackway and Cresswell, 1995). The Murchison bioregion comprises the northern part of the Yilgarn Craton and is further defined into two subregions; the Eastern Murchison (MUR1), and the Western Murchison (MUR2). The project is within the Eastern Murchison (MUR1) subregion.

The Eastern Murchison subregion is approximately 7 847 996 ha in size and comprises the “Southern Cross” and “Eastern Goldfields” terranes of the Yilgarn Craton (Cowan, 2001). The subregion was described by Cowan (2001) as being characterised by internal drainage, red sandplains, salt lake systems that are associated with an occluded Paleodrainage system, plains of red-brown soils, and breakaways (Cowan, 2001). Vegetation is dominated by Mulga woodlands, frequently rich in ephemeral species, hummock grasslands, saltbush and samphire shrublands (Cowan, 2001).

3.2.2 Beard Vegetation

Beard (1990) describes the region in which the Toro Wiluna Uranium Project is located as being the Murchison Region within the Austin Botanical District. The region is described as being predominately mulga (*Acacia aneura*) woodland on plains which is reduced to scrub on the hills, with *Eucalyptus* spp and *Triodia basedowii* on sand plains (Beard, 1990). The region is arid, with annual rainfall of 200 mm, received in both summer and winter (Beard, 1990). The geology of the region is Archaean granite with infolded volcanics and greenstones which form the Yilgarn block (Beard, 1990).

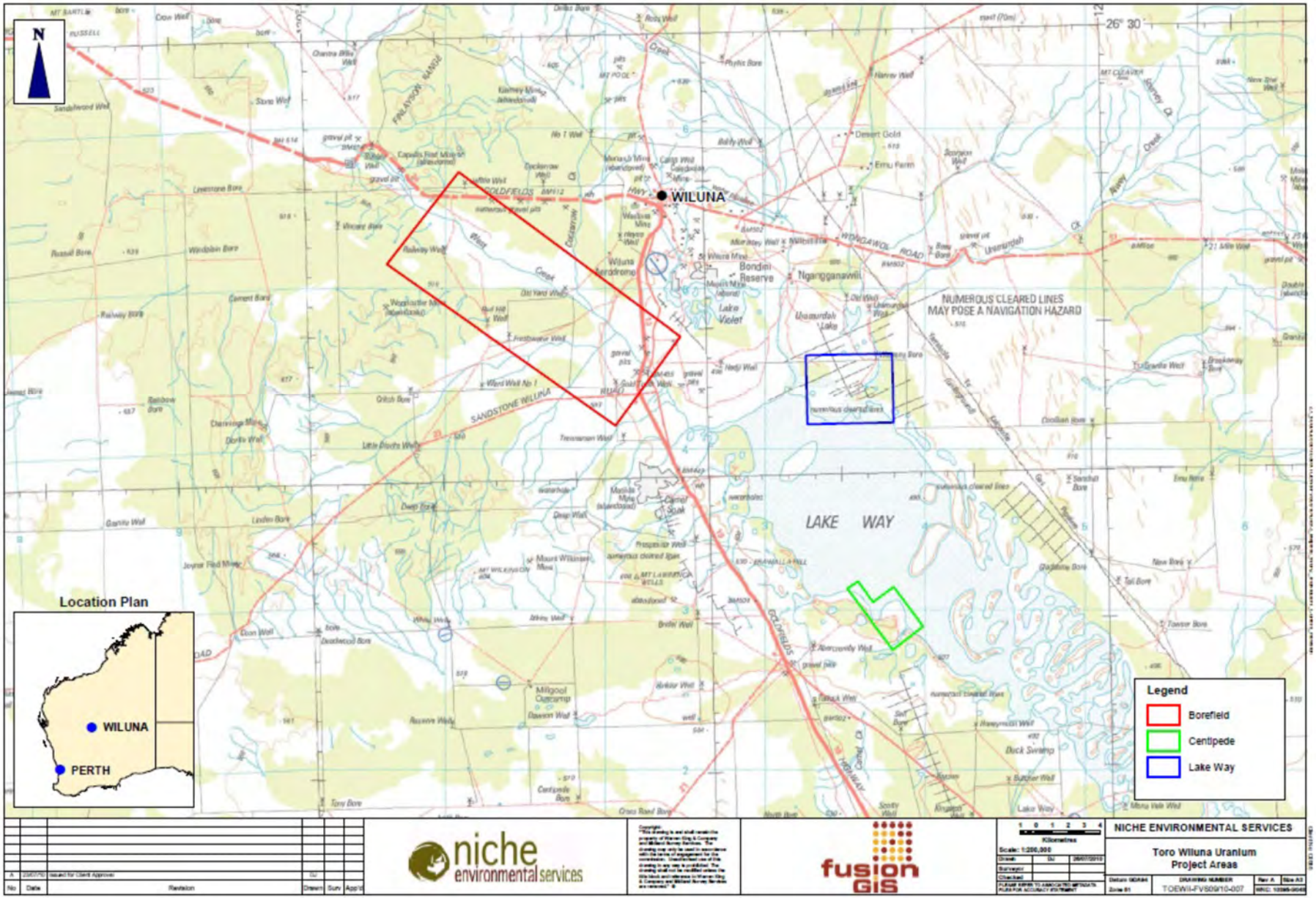

Figure 1 **Map showing the location of the Toro Energy Ltd Wiluna Uranium Project relative to the Town of Wiluna in Western Australia. The polygons outline the project areas surveyed by Niche Environmental Services in 2010 (image used with permission of Warren King and Co.).**

Beard (1990) identifies five important soils within the region, being:

- Shallow stony earthy loams on hills and ranges;
- Red earthy sands on upland sandplains, with red sands on occasional dunes;
- Earthy loams overlying red-brown hardpan, often with a surface stone layer, on undulating terrain;
- Shallow acid or neutral red earths in mosaics with the earthy loams on extensive flat and gently sloping plains; and
- Saline soils associated with salt lakes.

Beard (1990) identifies mulga as the dominant vegetation within the Murchison region. Mulga changes form depending on the climate and geology of the area, but the fundamental structure of mulga to 3 m over mid-shrubs to 2 m over an understorey of annuals and grasses that ranges in density depending on rainfall received (Beard, 1990). Variation from mulga is linked to changes in substrate and hydrology, with the following changes noted:

- Saline areas – samphire vegetation;
- Granite hills – *Acacia* species, including *A. aneura, A, grasbyi, A. ramulosa* and *A.quadrimarginea* with an understorey of *Senna* and *Eremophila;*
- Sand plains – *Acacia aneura* and *A. ramulosa* over spinifex in the eastern extent of the Murchison;
- Calcrete – *Acacia sclerosperma, A. aneura* and *Grevillea nematophylla*;
- Drainage lines and rivers – *Eucalyptus camaldulensis* and *Casuarina obesa* with *Acacia aneura.*

The relationship between vegetation and disturbances is addressed by Beard (1990), who noted that areas of mulga appear to regenerate in cycles, with successive droughts increasing mortality and excessive grazing leading to loss of regenerative capacity.

3.2.3 Climate

The Toro Wiluna Uranium Project is located in a region with a climate that is broadly characterised as hot dry summer, cold winter (Commonwealth of Australia, 2010). Rainfall in this region is noted as being highly variable (Commonwealth of Australia, 2010). Mean annual rainfall recorded at the station was 255.6 mm, with a median of 223.6 mm. The highest annual rainfall record at Wiluna was 712.1 mm, recorded in 1900, with the lowest recorded annual rainfall of 48.8 mm in 1910 (Commonwealth of Australia, 2010). Mean monthly temperature recorded at the Wiluna station ranges from a maximum of 37.9˚ C in January to a minimum of 19.4˚ C in July (Commonwealth of Australia, 2010).

Data recorded at the Wiluna Bureau of Meteorology recording station was reviewed prior to surveys to assist with defining survey times. In the 12 months prior to the autumn 2010 surveys, a total of 140.8 mm of rainfall was recorded (**Figure 2**). While the total rainfall figure for the 12 months preceding the surveys was below the average and the median for the location, it was noted that in

the four months prior to the autumn 2010 surveys, rainfall in one month was well below average, one month was 0.2 mm below average and two months were well above average. The two months with above average rainfall immediately preceded the autumn 2010 surveys. In the 12 months prior to the spring 2010 surveys, a total of 179.9 mm, of rain was recorded. It was noted that above average rainfall was recorded for the four months preceding the spring 2010 survey (**Figure 2**).

In the 12 months preceding the autumn 2010 surveys, the mean daily maximum temperature recorded at the Wiluna recording station was above the long term mean for all months (**Figure 3**). In the 12 months preceding the spring 2010 surveys, the mean daily maximum temperature was higher for the first eight months, but was at or below the long term mean for the four months preceding the surveys (**Figure 3**).

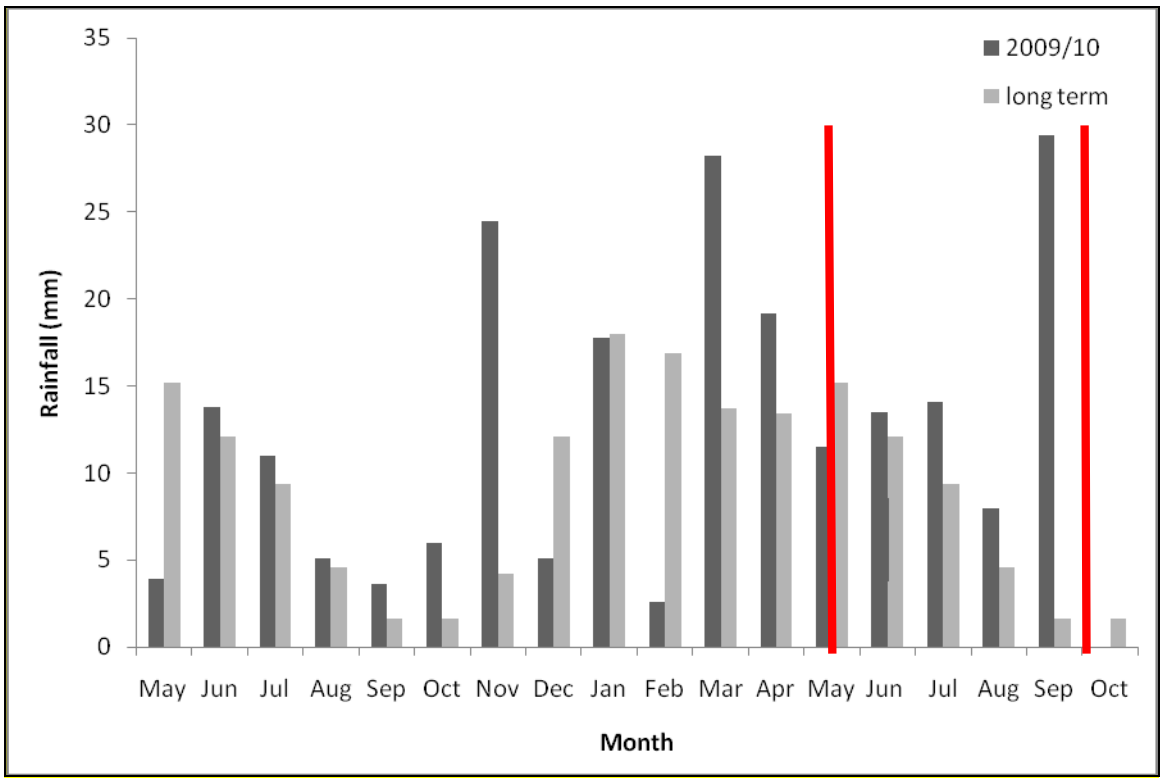

Figure 2 Graph displaying rainfall recorded at the Wiluna Bureau of Meteorology recording station from May 2009 until October 2010, which covered the 12 months preceding the 2010 surveys by Niche Environmental Services. The long-term median is presented for reference (Data sourced from Commonwealth of Australia, 2010).

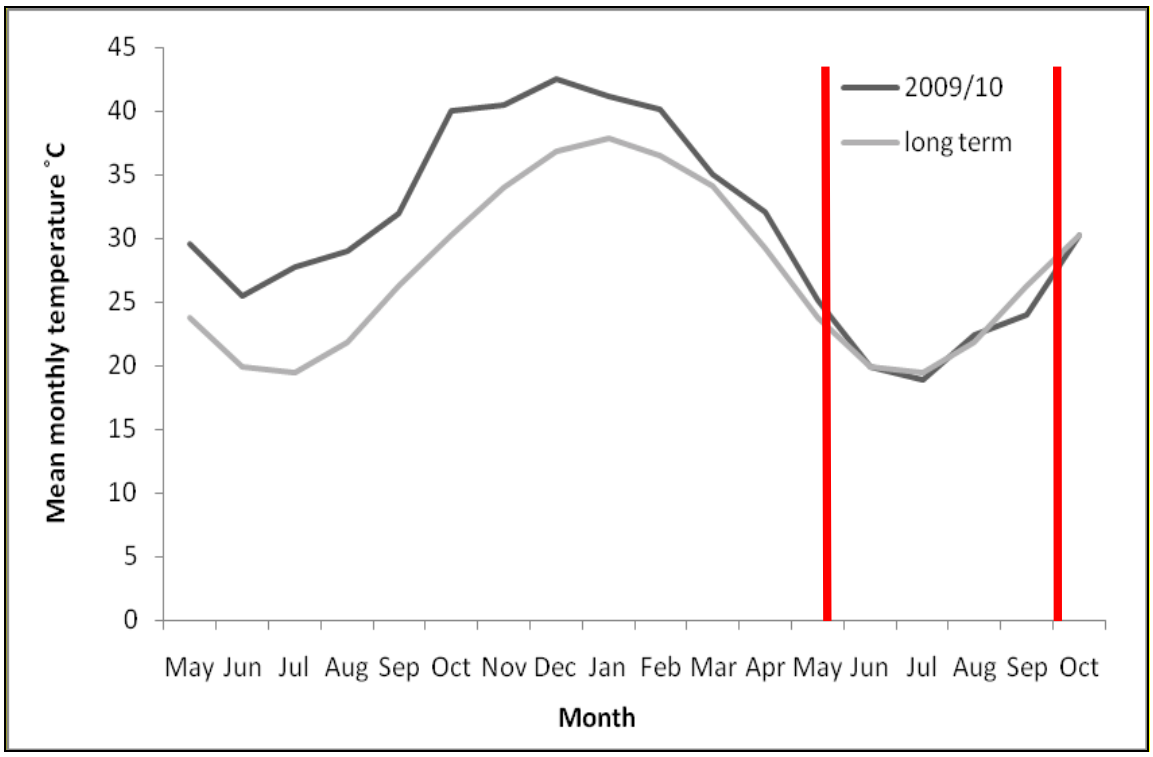

Figure 3 Graph displaying mean monthly daily maximum temperature recorded at the Wiluna Bureau of Meteorology recording station from May 2009 until October 2010, which covered the 12 months preceding the surveys by Niche Environmental Services. The long-term mean is presented for reference (Data sourced from Commonwealth of Australia, 2010).

4.0 METHODS – DESKTOP REVIEW

4.1 Overview

A desktop review was conducted prior to field surveys. The purpose of the desktop review was to collect information about the site and surrounds that would potentially assist with the design and implementation of the field survey. The desktop review consisted of:

- A search of the Federal Government *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database. The search was conducted to determine whether there were any flora and vegetation listings of relevance to the Toro project and to assess whether there were grounds for referral in relation to any of these matters;
- A search of the Western Australian Department of Environment and Conservation (DEC) Threatened (Declared Rare) Flora database, the Western Australian Herbarium (WAHERB) database and the Declared Rare and Priority Flora List for rare and priority flora collected from the survey area and surrounds or potentially occurring within the survey area;
- A search of the DEC Threatened Ecological Communities (TEC) database for listings of Threatened Ecological Communities or Priority Ecological Communities (PEC) recorded at or in the surrounds of the survey area; and
- A review of publicly available reports and publications containing flora, vegetation and ecological information relevant to the survey area.

4.2 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

The *Environment Protection and Biodiversity Conservation EPBC Act 1999* is a Federal Act drafted to facilitate a national level of protection for natural assets of conservation significance on Commonwealth, State and private lands. The key features of the legislation are the provision of a means to:

- protect biodiversity by identifying threatening processes and ensuring these are appropriately assessed and managed;
- protect critical habitat;
- ensure compliance and enforcement through auditing and legal processes;
- conduct assessments in addition to state assessments; and
- protect natural assets on Commonwealth lands.

To determine whether there were potential matters of national significance associated with the proposed project, a search of the Protected Matters database was undertaken. The Protected Matters database provides a summary of listings under the provisions of the Act. The proposed disturbances do not occur on Commonwealth lands and as such listings of relevance only to Commonwealth lands were not considered. The search was conducted using a point search with a centre of -26˚ 46' 21.26", 120˚ 15' 28.26" with a buffer of 50 km.

4.3 Declared Rare and Priority Flora – DEC Database Search

All flora within Western Australia is protected under the provisions of the *Environmental Protection Act 1986.* Under the Act, permission to clear vegetation is required, with a few exemptions for specific reasons. While this level of protection is provided for all flora, additional protection is warranted for declared rare flora (DRF). The declaration of rarity is applied to flora for which adequate searches have been made and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (DEC, 2010a). DRF are gazetted under subsection 2 of section 23F of the Western Australian *Wildlife Conservation Act 1950*. Once a species has been declared as rare, it is illegal to remove, take from or damage any DRF without Ministerial approval. Priority flora are species for which a level of conservation value is applied below declared rare (refer to **Appendix A** for definitions). There is no Ministerial approval required for disturbances affecting priority flora but these species are still protected under the *Environmental Protection Act 1986.* Impacts to priority flora are considered when assessing the conservation value of an area, especially in the context of clearing of native vegetation.

A search of the DEC *Threatened (Declared Rare) Flora* database and the *Western Australian Herbarium Specimen* database was completed prior to the field survey, based on a polygon with a northwest corner of -26 12 57.67, 119 49 16.90 and a southeast corner of -27 1 15.38, 120 43 48.23. Two searches were conducted for the project, one requested in December 2009 (search

reference 26-1209) and one requested in May 2010 (search 20-0510). The results of the May 2010 search have been used in this report, as this represents the most recent dataset.

To ensure that listings of priority flora presented in the database search findings were accurate, listed species were cross-referenced with Western Herbarium information presented on Florabase (Western Australian Herbarium, 2010). Where noted, species that no longer have conservation codes were removed, changed conservation codes were noted and amended and changed species names were noted and amended. Results of the database search presented in this report reflect these changes.

After the public review of the Toro Scoping Document, questions regarding the distribution of two new records of priority taxa, *Atriplex* sp. Yeelirrie Station (L. Trotter & A. Douglas LCH 25025) and *Tecticornia* sp. Lake Way (P. Armstrong 05/961), were raised. To facilitate an assessment of the distribution and likelihood of occurrence within the Toro Project, additional searches were conducted for DEC records of these species (search reference 49-0510).

4.4 Threatened Ecological Communities – DEC Database Search

Within Western Australia, biological assemblages that are considered to be unique, restricted or both can be assigned a status as a Threatened Ecological Community (TEC) or a Priority Ecological Community (PEC). A TEC is gazetted in parliament and Ministerial approval must be sought for any disturbance. There are currently four categories of TEC recognised by the DEC: Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable. Definitions of these are presented in **Appendix B**.

An ecological community that might be considered to have the potential to be ranked as a threatened ecological communities, but that do not meet survey criteria, or are not adequately defined, can be placed on the Priority Ecological Community List (DEC, 2010). These communities are ranked under categories 1, 2 and 3. The ranking of the categories reflect the order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities (DEC, 2010). The remaining categories are either near threatened, recently removed from the threatened list or are conservation dependent are placed in categories 4 or 5 (DEC, 2010). Definitions of the rankings are provided in (**Appendix B**).

A search of the DEC TEC database was requested by Niche Environmental Services based on a polygon with a northwest corner of -26 12 57.67, 119 49 16.90 and a southeast corner of -27 1 15.38, 120 43 48.23.

5.0 METHODS – FIELD SURVEY

5.1 Timing of surveys

The autumn surveys were conducted between mid – May and mid – June 2010. The spring surveys were conducted between late September and late October 2010.

5.2 Survey Locations

5.2.1 Centipede survey area

A total of 44 quadrats were established and surveyed within the Centipede survey area during 2010. Of the 44 quadrats, a total of 12 were located in vegetation that would be characterised as *Tecticornia* species vegetation. The distribution of the quadrats in the Centipede survey area is mapped in **Figure 4**. Quadrats located in *Tecticornia* species vegetation are: 1, 2, 4, 11, 13, 14, 15, 16, 18, 25, 47 and 51. All quadrats in the Centipede survey area were surveyed during autumn and spring 2010.

5.2.2 Lake Way survey area

A total of 54 quadrats were established and surveyed within the Lake way survey area during 2010. Of the 54 quadrats, a total of 11 were located in vegetation that would be characterised as *Tecticornia* species vegetation. The distribution of the quadrats within the Lake way survey area is mapped in **Figure 5**. Quadrats located in *Tecticornia* species vegetation are: 23, 25, 27, 29, 33, 35, 37, 39, 51, 70 and 70. All quadrats in the Lake way survey area were surveyed during autumn and spring 2011.

5.2.3 Regional surveys

A total of 74 quadrats were established and surveyed during regional surveys conducted in autumn 2010. The location of these quadrats is presented in **Figure 6**. A total of 26 quadrats were established and surveyed during regional surveys conducted during spring 2010. The location of these quadrats is presented in **Figure 7**.

During the autumn 2010 surveys, quadrats were located in the areas adjoining Lake Way, with a focus on the areas adjoining the Lake Way and Centipede survey areas. The quadrats were located to facilitate the collection of data to assess the extent, distribution and composition of vegetation around the lake system. In relation to *Tecticornia* species vegetation, quadrats were located in the area in which *Tecticornia* sp. Lake Way (P. Armstrong 05/961) (P1) was recorded, with the view to determining whether an underlying similarity existed between the vegetation within which this species was recorded and the *Tecticornia* species vegetation at Lake Way and Centipede. These quadrats are Reg 45 and reg 46 in **Figure 6**. In addition to these quadrats, there were an additional six quadrats within other areas of *Tecticornia* species vegetation. These were: 17, 26, 65, 66, 67 and 69. These are displayed in **Figure 6**.

The spring 2010 regional surveys were conducted over a broader range, with a focus on other salt lake systems and adjoining vegetation. The quadrats were located with the objective of extending the area over which surveys for *Tecticornia* spp. vegetation units were conducted, with the aim of better defining the relationship between the *Tecticornia* species vegetation units within the Centipede and Lake Way survey areas and other salt lake systems. Quadrats were located as follows:

- Lake Miranda – one quadrat was surveyed at Lake Miranda (Reg 2-22, inset 7 in **Figure 7**).
- Lake Ward – there were two quadrats surveyed at Lake Ward (Reg 2-14 and 2-15, inset 5 in **Figure 7**).
- Lake Nabberu – one quadrat was surveyed within the Lake Nabberu/Lake King/Lake Gregory system (Reg 2-17, inset 6 in **Figure 7**).
- Gunbarrel Highway – there were two quadrats surveyed along Gunbarrel Highway (Reg 2-11 and 2-12, inset 3 in **Figure 7**).
- Lake Way – there were three quadrats surveyed in the southern sections of Lake Way (Reg 2-23, 2-25 and 2-26, inset 8 in **Figure 7**).

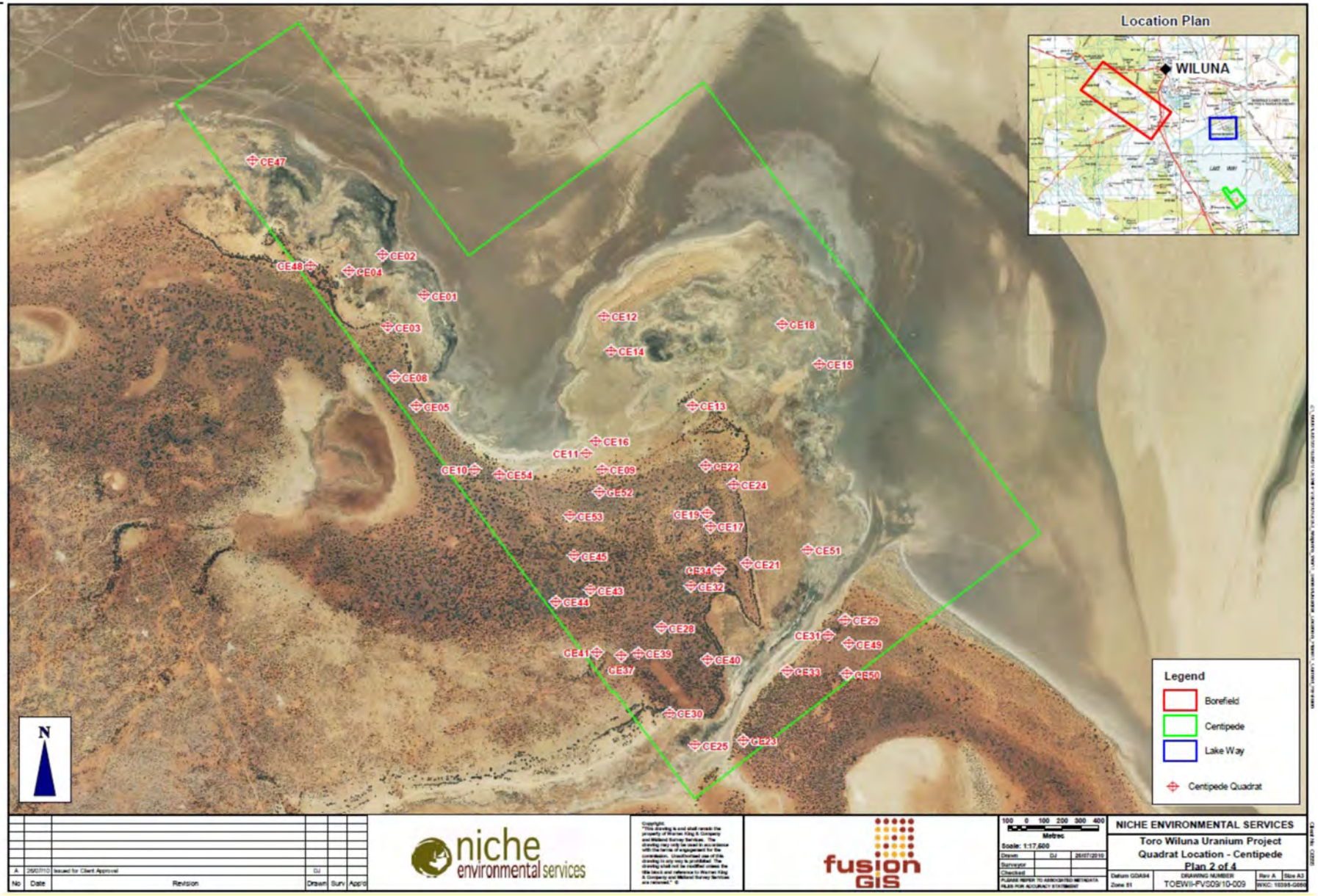

Figure 4 **Map of the Centipede survey area showing location of quadrats surveyed by Niche Environmental Services during autumn and spring 2010 (image used with permission of Warren King and Co.).**

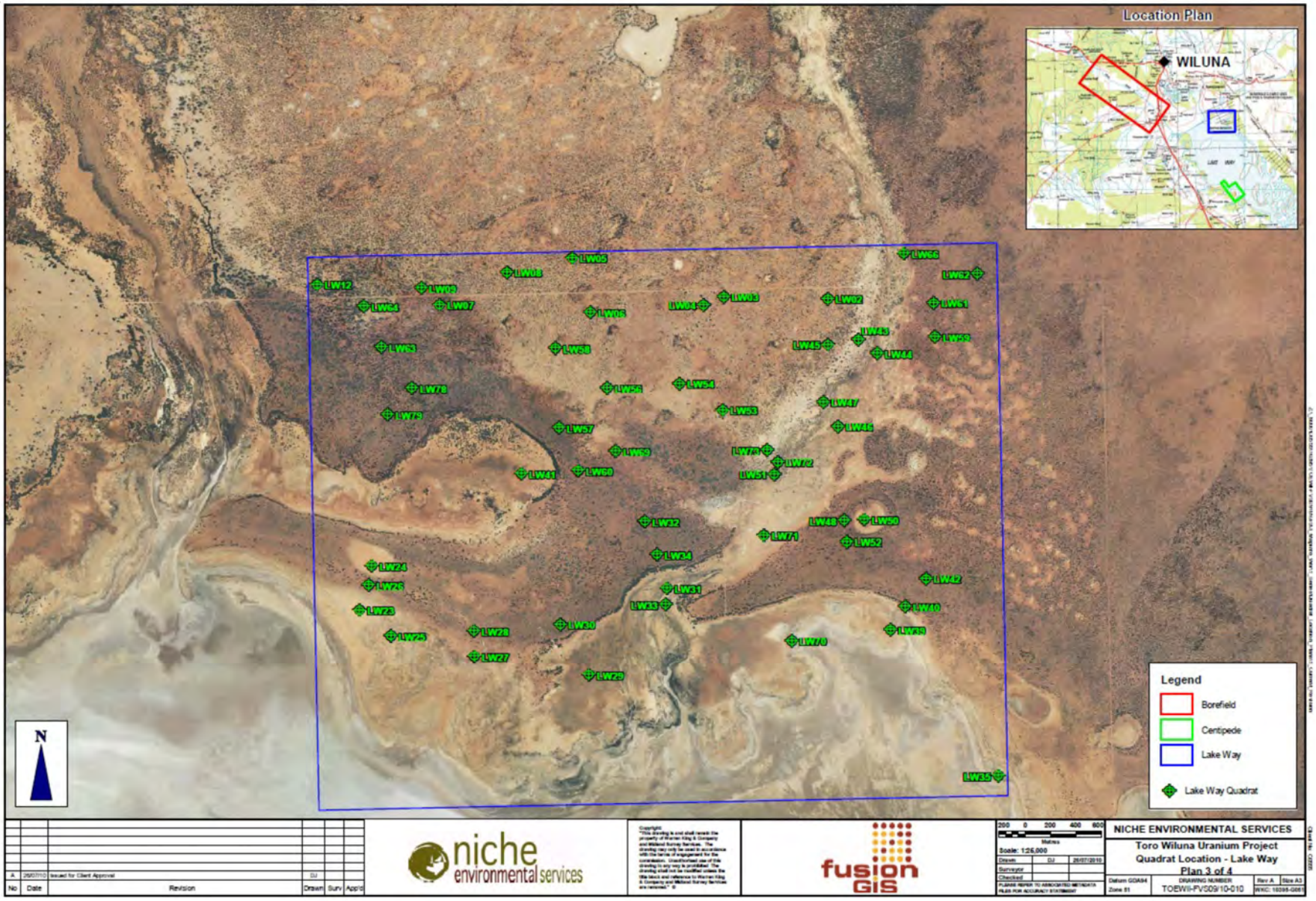

Figure 5 **Map of the Lake Way survey area showing location of quadrats surveyed by Niche Environmental Services in autumn and spring 2010 (image used with permission of Warren King and Co.).**

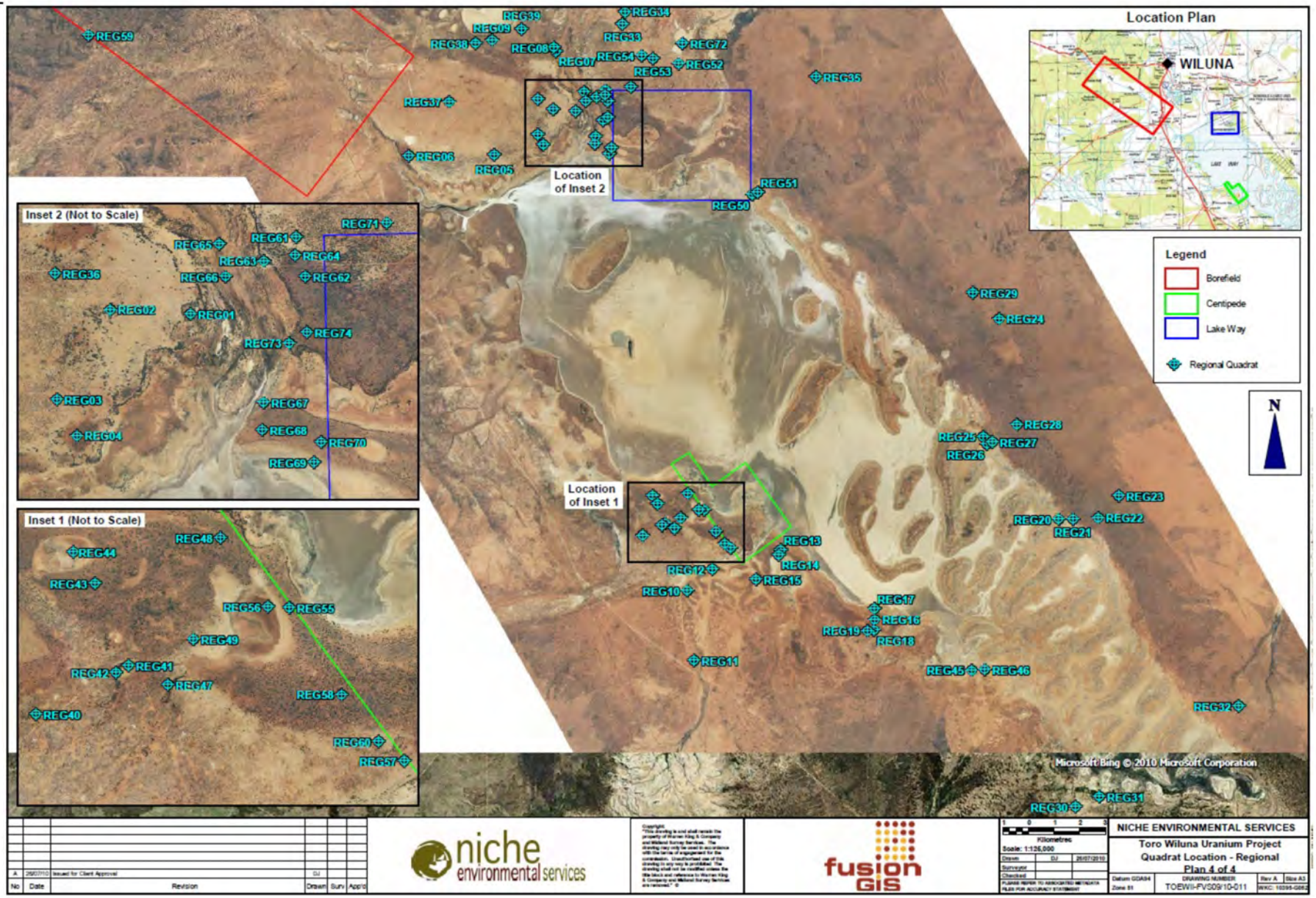

Figure 6 **Map of the location of regional quadrats established and surveyed during autumn 2010 by Niche Environmental Services (image used with permission of Warren King and Co.).**

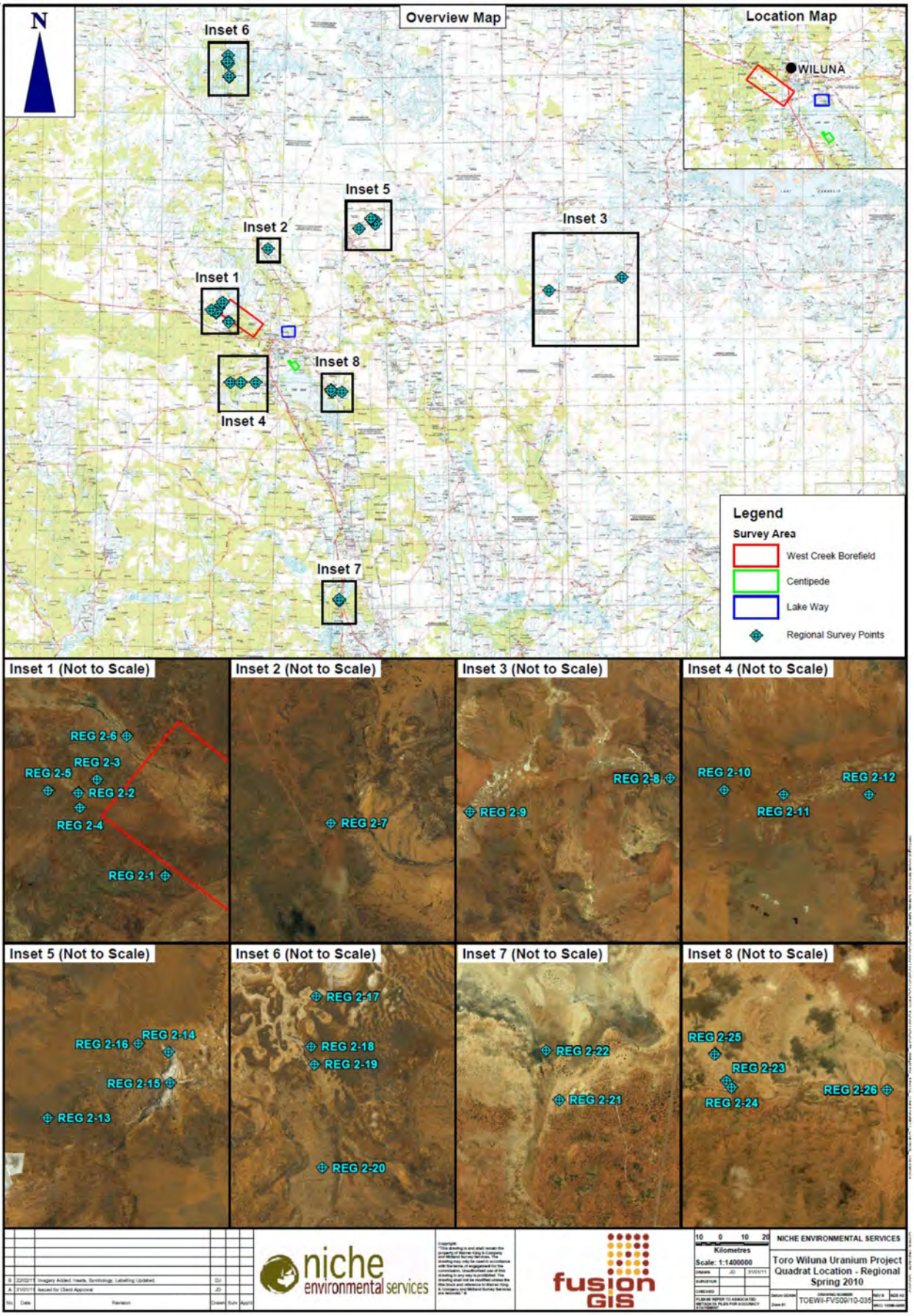

Figure 7 **Map of the location of regional quadrats established and surveyed during autumn 2010 by Niche Environmental Services (image used with permission of Warren King and Co.).**

5.3 Quadrat Survey Methods

At each quadrat location, the following was completed:

- A quadrat measuring 30 m × 30 m was pegged out using 1 170 mm Waratah Fence Droppers. The cardinal fence dropper was located in the northwest corner. The cardinal fence dropper and the fence dropper located diagonally across the quadrat were left in place. In instances where the vegetation unit could not be sampled using a 30 m × 30 m quadrat, a quadrat with a 900 m^2 area was used that better fit the vegetation unit.
- A photograph was taken of the quadrat. The photograph was always taken from the cardinal corner. Photographs were taken using either a Samsung ES15 digital camera or a Fujifilm A170 digital camera.
- The location of the survey area was recorded using a Garmin GPSmap 60CSx GPS, with the location recorded in WGS84, UTM.
- All flora present was recorded, with estimates of height and cover made to assist with describing the vegetation. Any species with less than 2 % cover was recorded as a +, all other cover values were recorded as ranges (eg.> 2-5, 5-10 etc.).
- The condition of the vegetation and any disturbances were noted.
- The geographical location of the site was recorded, with slope, topography and soil type recorded.
- The extent and nature of litter cover was recorded.

5.4 Traverse to develop census

Traverses were conducted within vegetation units in the Centipede, Lake Way survey areas and during the regional surveys in autumn and spring 2010. All specimens collected were assigned a field number and were pressed to facilitate identification in the herbarium. To ensure accuracy in the development of the census, specimens collected were stored according to vegetation unit, with duplicate specimens collected from different vegetation units.

5.5 Targeted searches

5.5.1 *Tecticornia* sp. Lake Way (P. Armstrong 05/961)

The Priority taxon *Tecticornia* sp. Lake Way (P. Armstrong 05/961) (P1) has been recorded in an area south of the Centipede and Lake Way survey areas (DEC, 2010) (refer Section 7.2). During autumn 2010, searches for this species were conducted in areas from which previous collections had been made. The species was noted as occurring within the salt lake system of Lake Way, in an area with low gypseous ridges to the east and low sand dunes to the west. The species was generally located along the edge of *Tecticornia* vegetation, effectively demarcating the zone between vegetated and non-vegetated areas.

A preliminary search for this species was conducted in the Centipede and Lake Way survey areas during autumn 2010. No records of this species were made during these searches, but the

searches were random in nature and not focused just on areas consistent with habitat for this species. In consideration of this limitation, additional targeted searches were conducted for this species within the Centipede and Lake Way survey areas during spring 2010. The targeted searches were conducted in areas considered to be potential habitat for the species. In addition to this, searches for this species were made in other salt lake systems surveyed during the regional surveys.

In the instance that the species was recorded, an estimate of population size was to be made based on counts within a defined area, to be defined by the length of the search area and a width of 10 m. The width of 10 m was considered to be consistent with the distribution in the areas from which the species was known to be found. The use of this method would provide for an estimate of population densities.

5.6 Project personnel

The following people were involved in the completion of surveys:

- Mr. Brett Neasham B.Sc. (Biol) Hons. (Env. Man.) – Project manager, Senior botanist, autumn and spring 2010 surveys
- Ms Sarah Dalgleish B.Sc. Hons. (Env. Man) – Botanist, autumn 2010 surveys
- Ms Serena Wright Assoc. Deg. Agribusiness – Environmental technician, autumn 2010 surveys
- Mr. Russell Barrett (B.Sc.) – Contract botanist, spring 2010 surveys

5.7 Survey limitations

Niche Environmental Services planned and implemented the surveys detailed in this report in accordance with EPA guidelines and requirements (EPA 2000, 2004). Within the survey guidelines a number of potential limitations to the completeness of surveys are presented. Niche Environmental Services have reviewed these guidelines and provide a response to these as considered relevant to this survey below.

- Competency of botanists – this survey was led by a botanist from Niche Environmental Services, who has relevant experience in the design and implementation of flora and vegetation surveys for environmental impact assessments within Western Australia. The lead botanist was involved in the completion of surveys of Centipede and Lake Way areas during 2007. In addition to this, the lead botanist had a working knowledge of the flora of the region and used recourse to recognised experts as was considered appropriate. Other personnel used in the completion of the surveys were considered to have an appropriate level of competence to contribute to the surveys in their defined roles.
- Scope – the scopes for these surveys were clearly defined, being flora and vegetation surveys over well-defined areas, being the proposed Toro Wiluna Uranium Project Centipede and Lake Way project areas. In addition to the surveys over the project areas,

regional surveys and targeted searches were conducted to develop a better understanding of the ecological context of the project areas. The scopes were considered to be realistically achievable within the allocated timeframe and resources.

- Proportion of flora identified – During the surveys, 231 specimens were collected. Of the 231 specimens, there were 75 species identified and a further 52 sterile species. The species that have been identified were all common, with the exception of the collections of the priority 1 species, *Tecticornia* sp. Lake Way. Collections of this species were made from the known location of this species. The sterile specimens were not identified beyond genus, and as such, it is not possible to determine whether this represents a series of potentially unique specimens, or whether there are a number of common species and some unique ones, or a series of common species. Additional collections are required to address this information gap.
- Timing of surveys – the surveys were conducted in late autumn and spring 2010. The autumn 2010 surveys were intended to coincide with post-summer rainfall. It was noted that rainfall during the summer of 2009/10 was below average; however, there was a rainfall event at the end of March 2010, in which greater than 2 5mm of rain was recorded in two days. This was considered to be sufficient to promote germination of annual taxa. In consideration of this, the autumn 2010 surveys were conducted in April – June 2010.

  The spring 2010 surveys were conducted in late September – October. Above-average rainfall was recorded at the Wiluna Bureau of Meteorology recording station for the months of July – September 2010, including a significant rainfall event in September. The rainfall was considered to be sufficient to promote the germination and growth of annual species. The spring survey was also timed to coincide with flowering time of the majority of perennial species in the region.
- Access to land – there were no access related issues associated with the surveys over the Centipede and Lake Way survey areas. There were some access issues in relation to areas over which regional surveys were planned.
- Completeness and further work – the Centipede, Lake Way and West Creek borefield survey areas as detailed in this report have been surveyed to a standard that is considered to meet the underlying requirements of a Level 2 survey as defined by the EPA. Quadrats were established within these areas, in locations that were considered to be consistent with being representative of the vegetation in the survey areas. The surveys were completed in two different seasons, autumn and spring 2010, with one series of surveys, in spring 2010, completed after four months of above-average rainfall. The rainfall in this timeframe was sufficient to promote germination of annual taxa as well as promoting flowering in perennial species. Consistent with this, a high number of annual species and specimens with flowers or fruit were collected during the spring surveys. The information collected during the autumn and spring surveys was considered to be sufficient to complete assessments of the vegetation within the survey areas.

Targeted searches were completed during spring 2010 for species of conservation significance known from within the Centipede and Lake Way survey areas or with the potential to occur in these areas. The searches were considered to have been completed with a sufficient level of sampling effort to allow for an assessment of the distribution and abundance of these species with the survey areas and to complete an assessment of potential impacts to these species in relation to the proposed development.

Taxonomic work on *Tecticornia* specimens has been completed by Dr Kelly Shepherd, an expert in the taxonomy of *Tecticornia* employed by the Western Australian Herbarium. Approximately 40 specimens were collected during the autumn 2010 surveys and 190 specimens of were collected during the spring 2010 surveys, with specimens collected from within the Centipede and Lake Way survey areas and other salt lake systems during regional surveys. This collection of specimens is considered to reflect a high level of sampling intensity with the areas surveyed. The taxonomic work completed on the specimens was limited by sterility of specimens and, therefore, additional survey work may need to be undertaken.

- Disturbances – the Centipede and Lake Way survey areas have been affected by disturbances largely associated with grazing and, to a lesser extent, exploration and track proliferation. The survey areas were all located on pastoral leases, all of which are currently stocked. There was clear evidence of the effects of grazing upon the vegetation, notably in the herbaceous understorey and on low shrubs. Grazing of taller shrubs was limited to lower branches. Trees were not noted as being affected by grazing. There were also a number of shrubs that had branches broken off. It was not clear if this was due to the actions of cattle or camels.

  In addition to the impacts associated with grazing, there was evidence of damage to vegetation by camels. This was noted in the manner in which some taller shrubs had been grazed. A small group of camels was noted to the east of Lake Way during the regional surveys.

  There was evidence of impacts to vegetation due to track proliferation. In all areas surveyed there were a number of tracks, ranging from well-developed access tracks to poorly developed tracks that appeared to be infrequently used. Vegetation had been removed from almost all tracks, even the infrequently used ones. There was evidence of dust deposition on vegetation adjacent to some tracks. The impacts to vegetation due to track proliferation were typically limited to the tracks and edges of tracks, with no evidence of impacts away from the tracks.

6.0 METHODS – DATA ANALYSIS AND INTERPRETATION

6.1 Taxonomy

Taxonomic work on *Tecticornia* specimens was completed by Dr Kelly Shepherd from the Western Australian Herbarium. Nomenclature was based on species data provided by Dr Kelly Shepherd.

6.2 Vegetation Description and Mapping

The vegetation within the survey area was described using the scale of Muir (1977) (**Appendix C)**. The condition of vegetation was described using the scale of Keighery (1994) (**Appendix D**). Vegetation maps presented in the report have been developed based on the information collected during the survey and the interpretation of aerial photography. Not all mapped areas have been ground-truthed and as such, there may be a need to verify mapped units prior to disturbance. Vegetation within this report is grouped according to substrate first and dominant species second. The coding applied to the vegetation is consistent with this, with the first lower case letters denoting the substrate, the capital letters denoting the Muir vegetation type and the second series of upper and lower case letters referring to the dominant species.

6.3 Statistical Analysis

Prior to completing statistical analysis, all quadrat data was reviewed in Microsoft excel, where all annual species were removed. Remaining species were then treated on a presence/absence basis, with the number 1 (one) indicating presence and 0 (zero) indicating absence. The balance of the analysis was completed using Plymouth Routines in Multivariate Ecological Research (PRIMER, version 6, single user licence registered to Niche Environmental Services Pty Ltd, licence details available upon request).

Analysis in PRIMER was commenced with establishment of resemblance in data based on Bray-Curtis similarity. After establishing resemblance, data was analysed using Multi-Dimensional Scaling (MDS). An MDS analysis produces a 2D ordination, in which the relationship between sample sites and ecological sampling data are represented. The ordination displays a spatial representation of the relationship between sample sites. A stress value of less than 0.2 is considered to be indicative of the plot in the ordination being of a level of accuracy sufficient to allow inferences to be made.

7.0 RESULTS AND DISCUSSION – DESKTOP REVIEW

7.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

There was no flora or vegetation (ecological communities, conservation areas) listed for the database search area (refer 4.2). Based on this, there are not considered to be any reasons for referring the project based on impacts to flora and vegetation.

7.2 Declared Rare and Priority Flora – DEC Database Search

No Declared Rare Flora (DRF) were listed in the database search (DEC, 2010a; search reference 21-0510). A total of 21 priority flora were listed in the database search results (DEC, 2010a; DEFL

and WAHERB records, search reference 21-0510), of which six were priority 1 taxa, 13 were priority 2 taxa and the remaining two were priority 3 taxa (definitions of the priority codes are provided in **Appendix A**). A summary of these species and brief description of habitat is provided in **Table 1.** A map illustrating the distribution of the database records relative to the Toro Wiluna project is presented in **Figure 8.** There were some species listed in the database search for which a conservation code was no longer applied. Accordingly, these species have been removed from the summary data and no further consideration to these species is warranted.

In addition to the species listed in the database search, the following species have been noted by the DEC as occurring within the broader region in similar environments and as such, may have the potential to occur in the Wiluna project area. The species noted were:

- *Atriplex* sp. Yeelirrie station (L. Trotter & A. Douglas LCH 25025) (P1) – this species was recorded over the BHP-Billiton Yeelirrie project area, with the distribution typically on self-mulching clays over calcrete. This type of habitat is not known within the Toro project area. Reference to this species was made via public comments in relation to the environmental scoping document prepared for this project. To address these comments, this species was included in targeted searches.
- *Rhagodia* sp. Yeelirrie station (K.A. Shepherd et al. KS 1396) (P1) – this species is a new listing and was recorded on similar habitat to *Atriplex* sp. Yeelirrie station. This species was a new listing at the timing of the spring surveys in 2010 and was brought to the attention of Niche personnel during a discussion with Melanie Smith from the DEC Species and Communities branch. It was recommended to include searches for this species to ensure that it was not located in any areas over which disturbances were planned.

Data in relation to the distribution of these species was collected from samples lodged with the Western Australian Herbarium. A supplementary search of Naturemap was completed, during which it was noted that *Sida* sp Wiluna (P1) had the potential to be located in the project area.

There was one *Tecticornia* species listed in the DEC database search, *Tecticornia* sp. Lake Way (P. Armstrong, 05/961). There are five records of this species to the south of the Centipede survey area. All of the records are in close proximity to each other (refer inset 3, **Figure 8**).

Table 1 Summary of Declared Rare Flora and Priority Flora records from DEC database search 21-0510, with conservation code and a brief description of habitat.

Species	Cons code[2]	Habitat
Beyeria lapidicola Halford and R.J.F. Hend.	P1	NNE facing steeply inclined mid to upper escarpment of haematite and ban (*sic*)[1]
Baeckea sp. Sandstone (C.A. Gardner s.n. 26 Oct 1963)	P3	Orange sands. Flats[2]
Baeckea sp. Melita Station (H. Pringle 2738)	P4	Dark red rocky soil over ironstone[1]
Calytrix uncinata Craven	P3	White or red sand, sandy clay. Granite or sandstone breakaways, rocky rises[2]
Eremophila arguta Chinook	P1	Loam soils[1]
Eremophila congesta Chinook	P1	Lateritic outcrops in greenstone hills, stony quartzite slopes[2]
Eremophila flaccida subsp. *attenuata* Chinook	P3	Stony clay over quartzite. Hillslopes, ridges[2]
Eremophila pungens Chinook	P4	Sandy loam, clayey sand over laterite. Plains, ridges and breakaways[2]
Euryomrytus inflata Trudgen	P3	Deep red sand. Flat plains[2]
Hemigenia exilis S. Moore	P4	Laterite. Breakaways and slopes[2]
Homalocalyx echinulatus Craven	P3	Laterite. Breakaways, sandstone hills[2]
Maireana prosthecochaeta (F. Muell.) Paul G. Wilson	P3	Laterite. Hills, salty places[2]
Mirbelia stipitata Crisp and J.M. Taylor	P3	Red sandy loam[2]
Neurachne lanigera S.T. Blake	P1	Red sand, laterite. Rocky outcrops, plains[2]
Olearia mucronata Lander	P3	Schistose hills, along drainage channels[2]
Ptilotus luteolus (Benl & H. Eichler) R.W. Davis	P3	Basalt hill, stony hills, quartz flat at base of breakaway[1]
Ptilotus chrysocomus R.W. Davis	P1	Brown sandy clays. Bases of breakaway, rocky scree slopes[2]
Prostanthera ferricola B. J. Conn & K.A. Sheph.	P3	Shallow red-brown skeletal sandy loam on banded ironstone, laterite, basalt or quartz. Gently inclined mid to upper slopes of hills, rocky crests, outcrops[2]
Stackhousia clementii Domin	P3	Skeletal soils. Sandstone hills[2]
Tribulus adelacanthus R.M. Barker	P3	Midslopes of banded ironstone formations[1]
Tecticornia sp. Lake Way (P. Armstrong 05/961)	P1	Lake bed within salt lake system[3]
Xanthoparmelia nashii Elix and J. Johnst.	P3	Granite breakaway[1]

[1] - DEC (2010a); [2] – Western Australian Herbarium (2010); and [3] – Niche Environmental Services data

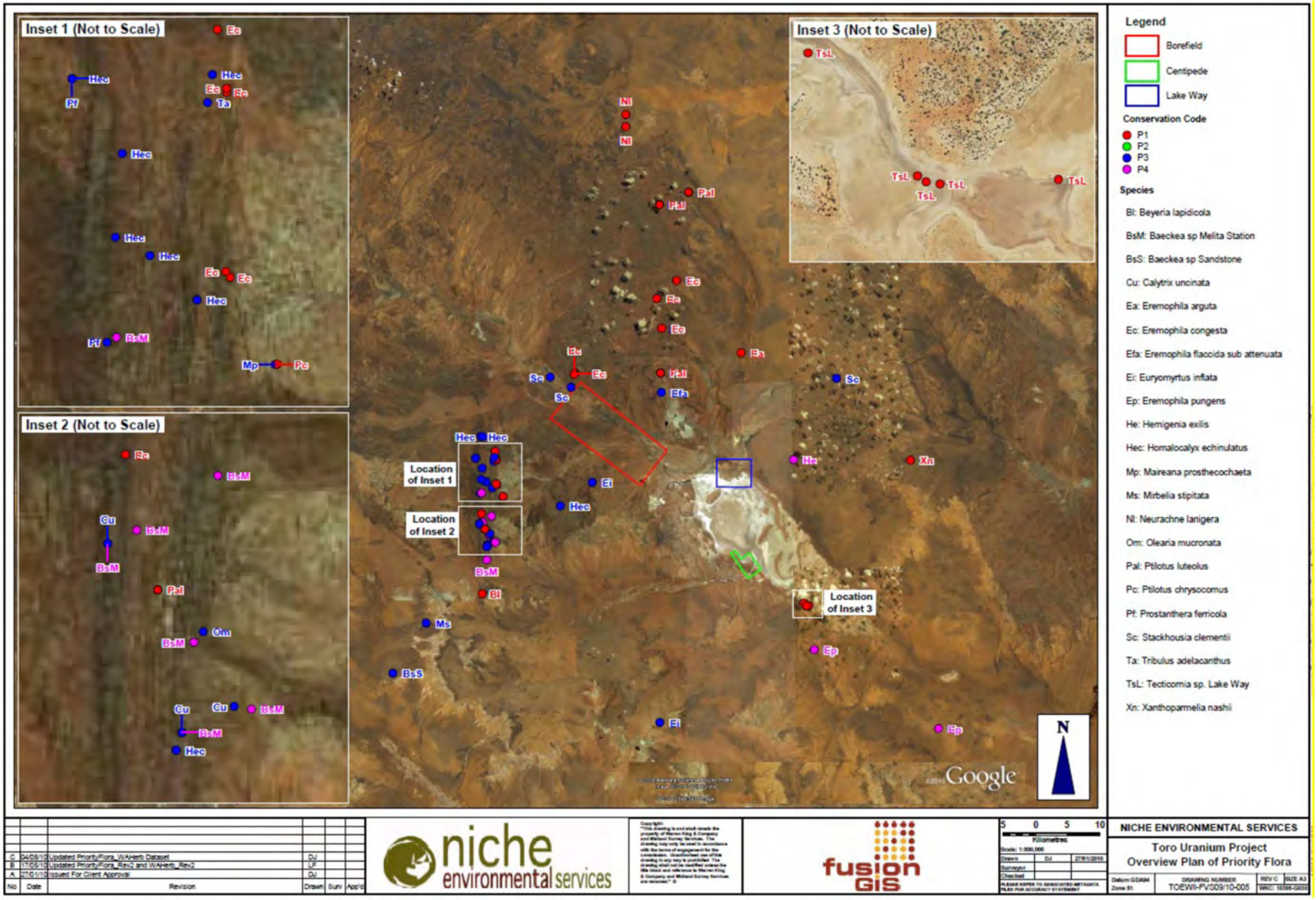

Figure 8 **Map of the Wiluna region with locations of priority flora recorded in DEC database search 21-0510. Polygons of the Toro Energy Wiluna Uranium Project survey areas provided for reference (map used with permission of Warren King and Co.).**

7.3 Threatened Ecological Communities – DEC database search

No Threatened Ecological Communities (TECs) as defined by the DEC were identified as occurring within the database search area (reference 17-0510; DEC 2010b). A total of 30 Priority Ecological Communities (PECs) were listed in the database, of which two were flora communities, being:

- Wiluna West vegetation complexes (banded ironstone formation (BIF)) – this is a Priority 1 ecological community located to the west of the proposed borefield (**Figure 9**). The PEC has a buffer of 17 500 m, which intercepts the northeast corner of the borefield.
- Montague Range vegetation complexes (BIF) – this is a Priority 1 ecological community located to the southwest of the Toro Wiluna uranium project **(Figure 9**). The buffer of this PEC is 25 000 m. This does not intercept any of the survey areas as detailed in this report.

Both of these PECs are located on BIF ridges. There are no BIF ridges within the Centipede or Lake Way project areas. There is a small BIF ridge within the proposed borefield. The BIF within the proposed borefield has a low relief and is essentially an occluded ridge. It is not considered that the low BIF ridge within the proposed borefield would be part of either of the PECs listed above or provide habitat consistent with either of the BIF ridges on which the PECs were located.

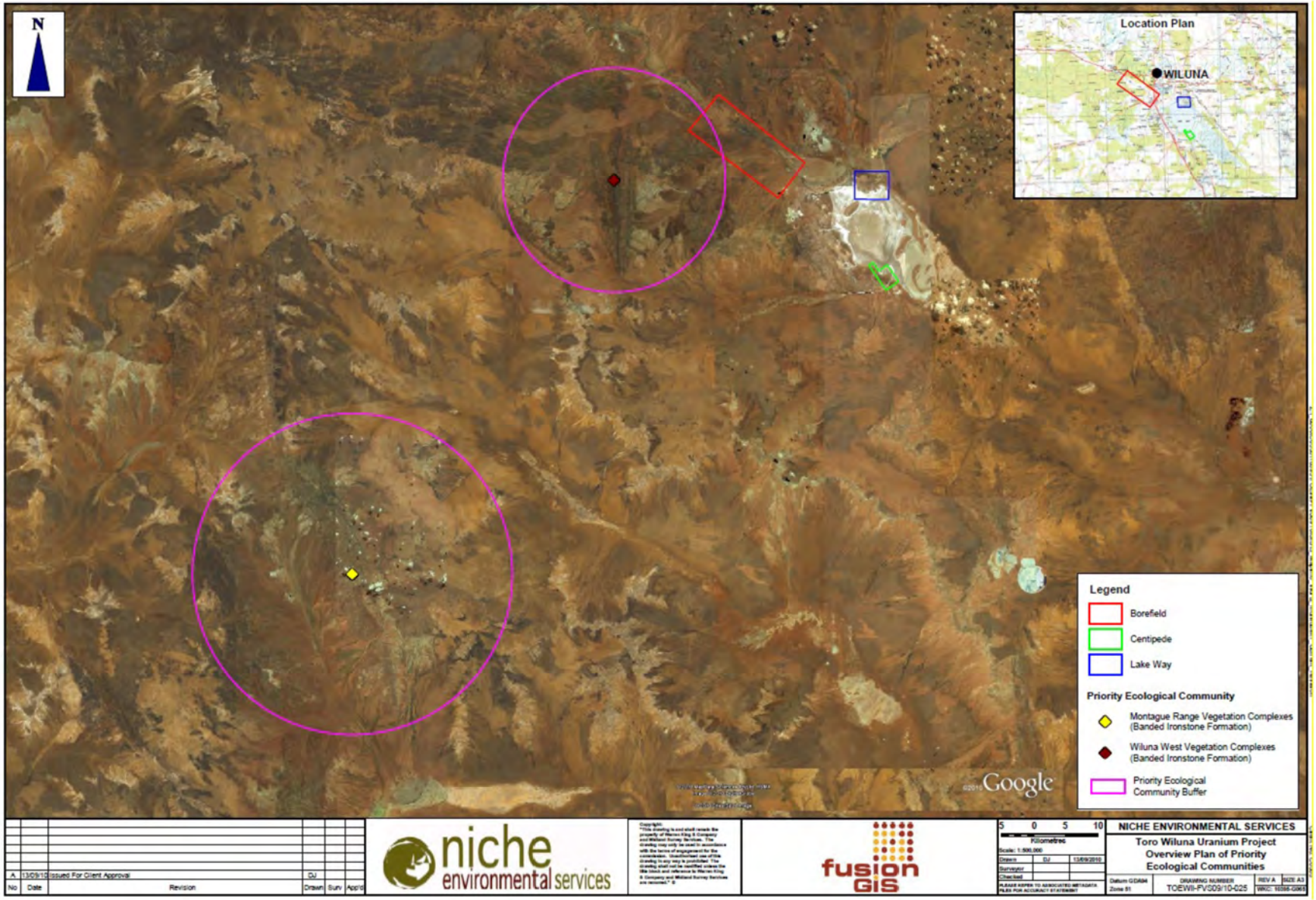

Figure 9 **Map of the Toro Energy Wiluna Uranium Project areas showing flora Priority Ecological Communities and buffers as listed in DEC database search 17-0510 (image used with permission of Warren King and Co.).**

7.4 Review of Existing Reports

7.4.1 Shepherd *et al.* (2007)

Shepherd *et al.* (2007) have completed an analysis and interpretation of the extent and distribution of vegetation types within Western Australia. The work is generally based on interpretations of aerial photography and uses the vegetation codes developed by Beard at the 1:250,000 scale. This information was used in the preparation of the report to assist with placing the Wiluna project into a broad floristic context. Data used in this report was provided by Mr. Damian Shepherd from the Department of Agriculture and Food, Western Australia (DAFWA). Mr. Shepherd provided data specific to the area within which the project area is located, based on a radius of 50 km from the centre of Wiluna town.

According to the data provided, there are a total of 17 Beard vegetation units within the project area and surrounds (**Table 2**). The dominant vegetation within the search area is characterised by the presence of mulga (*Acacia aneura*), with 12 of the vegetation units containing this species as either a dominant or co-dominant species. Samphire flats, coolibah woodlands, bowgada (*Acacia ramulosa* var. *linophylla*) or bare areas (claypans and salt lakes) form the balance.

The samphire vegetation covered approximately 4 000 ha, most of which would be concentrated around the edges of the Lake Way system. It should be noted that within the local government area (LGA) of the Shire of Wiluna, this vegetation covered over 800 000 ha.

The coolibah woodlands are a more restricted vegetation unit, with just over 7 000 ha in the Shire Wiluna, of which nearly 7 000 ha is within or close to the project area. The coolibah woodlands are described as being dominated by *Eucalpytus microtheca,* which is an incorrect definition; this species is restricted to the Kimberley and there are no records near Wiluna. This vegetation unit is considered to be the woodlands dominated by *Eucalyptus camaldulensis*. From a functional perspective, there is no difference between the two, with both units hosting phreatophytic species as the dominant canopy species.

The extent of clearing in the project area and surrounds is negligible, with 100 % of the inferred pre-European extent remaining (Shepherd *et al.,* 2007). While clearing is considered to be negligible, the extent of conservation of vegetation is low, as detailed in **Table 2**. The lack of conservation in the region is evident, with eight of the units identified in the Shepherd *et al.* (2007) report having no land in the DEC estate and only three units having more than 5 % in the DEC estate.

Table 2 Summary of vegetation types within a 50 km radius of the town of Wiluna, which incorporates all of the survey areas, with inferred extent from Shepherd *et al.* (2007).

System - Association code	Description	Environmental description	Area (ha)	Extent in reserves (%)*
11	Medium woodland; coolabah (*Eucalyptus microtheca*)	General	6 986	0
18	Low woodland; mulga (*Acacia aneura*)	General	621 623	3.75
19	Low woodland; mulga between sandridges	General	875	0
28	Open low woodland; mulga	General	4 527	0
29	Sparse low woodland; mulga, discontinuous in scattered groups	Wiluna	157 951	10
39	Shrublands; mulga scrub	Wiluna - Granite Hills	102 773	2.4
40	Shrublands; acacia scrub, various species	General	1 116	0.63
107	Hummock grasslands, shrub steppe; mulga and *Eucalyptus kingsmillii* over hard spinifex	Wiluna	494 618	8
125	Bare areas; salt lakes	General	25 167	1.3
188	Shrublands; mulga & *Acacia sclerosperma* scrub	General	3 634	0
202	Shrublands; mulga & *Acacia quadrimarginea* scrub	Wiluna - Granite Hills	31 400	0
204	Succulent steppe with open scrub; scattered mulga & *Acacia sclerosperma* over saltbush & bluebush	Wiluna	51 202	0
389	Succulent steppe with open low woodland; mulga over saltbush	Wiluna	7 884	.2
560	Mosaic: Shrublands; bowgada scrub / Succulent steppe; samphire	General	17 029	0
561	Succulent steppe with low woodland; mulga over saltbush	General	5 098	0
676	Succulent steppe; samphire	Wiluna	4 112	15.5
1 271	Bare areas; claypans	General	3 131	0
Total			**1 539 129**	

*this figure includes the entire LGA of Wiluna.

7.4.2 Mabbutt & CSIRO. (1963)

The project is located within an area over which broadscale surveys were completed by Mabbutt *et al.* in 1958 (Mabbutt & CSIRO, 1963). In this study, a number of land systems were identified. The land systems corresponded to geographic and floristic patterns observed during the surveys. To assist with placing the project area into the correct land systems, a digital dataset was acquired from the Department of Agriculture and Food, Western Australia (DAFWA). The digital dataset was used to determine the Land Systems and extent within the project areas.

A total of ten land systems were identified within the project area. A map illustrating the distribution of these across the project area is presented as **Figure 10**. A summary of the land systems, with a brief description of each and the total area within the project area is presented as **Table 3**. The Centipede survey area was located entirely within the Carnegie land system, while the Lake Way survey area was located within the Carnegie, Cunyu and Bullimore land systems. The West Creek borefield survey area was located over nine of the land systems, with the Carnegie system the only one not within the borefield.

Table 3 Summary of Land Systems on which the Toro Wiluna project is located. Area values derived from digital dataset, calculations prepared by FusionGIS and used with permission. Area values are presented for each project (codes used: Ce – Centipede; LW – Lake Way; and Bf – borefield).

Land System	Geological unit	Description (from Mabbutt *et al.* 1963)	Area (ha)
Bullimore	Sand plains and dunes	Sand plain with scattered dunes; deep red sandy soils; spinifex with mulga and mallee.	LW - 73 BF – 1 312
Carnegie	Salt lakes and dunes	Large salt lakes and surrounds. Bare floors with saline sediments. Alluvial plains; var.ious saline soils in lower parts, texture-contrast soils in higher parts; samphire in lower parts, halophytic shrublands in higher parts. Sand dunes; open mulga with halophytic and other palatable shrubs and perennial grasses.	Ce - 874 LW – 1 651
Cunyu	Calcreted valley fills	Valley fills with non-saline alluvium. Low calcrete platforms; shallow calcareous earths; open mulga and abundant annuals. Alluvial plains; red earths; minor texture contrast soils; dense mulga on margins; open woodland with sparse shrubs and patches of halophytic shrubland in central tracts.	LW - 593 BF – 3 795
Diamond		Very gently undulating terrain on weathered basalt and mudstone, relief up to 3 m. Broad rises; shallow gravelly soils; mulga with dense shrubs and perennial grasses. Shallow valleys and stripped lower slopes; red earths of var.iable depth to hard-pan; mulga groves with perennial grasses.	BF - 337
Dural		Strongly undulating terrain on weathered mudstone and basalt; relief up to 13 m. Stable crests; shallow gravelly and stony soils; open mulga with mallee, spinifex, and annual grasses. Lower slopes; mainly shallow red earths; mulga groves with sparse grasses.	BF - 412
Glengarry	Sandstone plateaux	Sandstone plateux, relief 15-65m. Uplands; shallow stony soils; mainly dense mulga and shrub, feathertop spinifex, and other perennial grasses. Drainage floors; red earths of var.iable depths; dense mulga with abundant herbage.	BF - 900
Trennaman	Mainly non-saline alluvial plains	Upper tributary plains, gradients above 1 in 500. Alluvial plains; red earths; mulga groves with sparse shrubs and short annual grasses. Wanderrie tracts; red sandy soils; open mulga with edible shrubs and palatable perennial grasses.	BF - 803
Violet	Breakaways and plains	Undulating terrain on weathered basalt and greenstone, relief up to 10 m. Stony rises; shallow soils; dense mulga and shrubs, feathertop spinifex, unpalatable grasses. Lower slopes and drainage floors; mulga groves with dense edible shrubs and grasses.	BF - 863
Yandil	Mainly non-saline alluvial plains	Lower tributary plains, gradients 1 in 500 to 1 in 1 000; shallow red earths; open mulga and curara with unpalatable shrubs and annual grasses.	BF - 210
Yanganoo	Mainly non-saline alluvial plains	Upper tributary plains, gradients above 1in 500; red earths, with sandy soils on margin; prominent mulga groves with edible shrubs and var.iable grasses, spinifex with dense mulga on margins.	BF – 3 674

*area information in this table in refers to areas surveyed, which are larger than areas over which disturbances are likely to occur

Figure 10 **Map illustrating the Mabbutt *et al.* (1963) land systems on which the Toro Energy Wiluna survey areas were located (image used with permission of Warren King and Co.; data sourced from DAFWA).**

7.4.3 Outback Ecology Services (2007)

First pass surveys were conducted over the Centipede and Lake Way project areas by Outback Ecology in 2007. During these surveys, a total of 46 quadrats were surveyed at Centipede and 62 quadrats were surveyed at Lake Way. A total of 132 taxa were recorded during the survey, which was noted as being low (Outback Ecology Services, 2007). Of particular note was the comparatively low diversity of annual and ephemeral flora. The low numbers in the census may be a reflection of the prevailing environmental conditions prior to the survey.

The vegetation over the project areas was described as fitting into six broad groups, being:

- Playa vegetation – recorded at Centipede and Lake Way;
- Fringing vegetation – recorded at Centipede and Lake Way;
- Dune vegetation – recorded at Centipede and Lake Way;
- Plains vegetation – recorded at Centipede and Lake Way;
- Calcrete vegetation – recorded at Lake Way; and
- Clay-pan vegetation – recorded at Lake Way.

Within these six broad groups, there were a total of 30 vegetation units. Nine of these were found at both sites, two were found at Centipede only and nine were found at Lake Way only. The fringing vegetation unit, *Melaleuca xerophila* Mid Density Low Forest (Me1) was noted as being an “at risk” vegetation unit. The status of “at risk” does not have any legislative imperative, but may indicate vegetation units that will be scrutinised should any impacts to the vegetation be considered. It was noted that impacts to this association should be avoided or minimised.

No EPBC-related issues were noted in relation to the flora and vegetation for the survey area during the 2007 database search. There were no Declared Rare Flora and 17 priority taxa noted in the DEC database search, none of which were observed during the survey. One Threatened Ecological Community (TEC), the Wiluna West vegetation complexes on Banded Ironstone Formation. This is no longer a TEC, but is still listed as a Priority 1 ecological community (refer Section 5.1.3 of this report).

The previous survey work was not considered to meet the basic assumptions of a Level 2 survey as defined by the EPA (2002; 2004), principally because a second survey was not completed over the area following the season during which the majority of rainfall is received.

8.0 RESULTS and DISCUSSION - VEGETATION

8.1 Centipede survey area

8.1.1 Site description

The Centipede survey area covered approximately 874 ha, of which approximately 533 ha was vegetation and 341 ha was un-vegetated salt lake. Of the 533 ha of native vegetation, approximately

473 ha will potentially be impacted by the proposed development of the Toro Energy Wiluna Project (**Figure 11**). The eastern boundary of the project area lays on the edge of the salt lake proper. The project area extends west over a dune system and terminates at the edge of a clay pan and a calcrete platform. Within the Centipede survey area, there were five clearly defined zones of vegetation, being:

- *Tecticornia* spp vegetation on the playa;
- Fringing vegetation, which was distributed as a belt along the interzone between the playa and the dune system;
- A foredune system, characterised by low shrubs over spinifex with a emergent canopy of *Callitris columellaris;*
- A rear dune (called dune) system comprised of *Acacia* species and mallee eucalypts over spinifex; and
- Calcrete platform, which was located in one section of the project area behind the reardune.

8.1.2 *Tecticornia* species vegetation description and condition assessment

There was one vegetation unit defined and delineated on the playa. The playa vegetation was the most widespread in the Centipede survey area, covering 304 ha. This vegetation unit was defined as a Low Heath D of *Tecticornia* species to 0.5 m with occasional pockets to 1 m (mapping unit sl1). The vegetation was generally uniform in height and density, with some changes in species composition noted across the surveyed area. The unit was located on the lake edge on heavy clays, light orange in colour with salt crusts. There were pockets of *Lawrencia helmsii* in some areas, but these were not extensive enough to be mapped as separate units. The vegetation within this unit was as assessed as being in good to very good condition. The vegetation had clearly been affected by exploration activity, with a number of tracks and drill lines located within the area. There was also some evidence of drought stress, but this was limited to a few, isolated areas. An image of this unit is presented as **Plate 1** in **Appendix E**. The extent of this unit within the disturbance footprint is presented in **Figure 11**. The extent of this unit within the survey area is presented in **Figure 18** in **Appendix E**. It is proposed that 277.5 ha of this unit, representing 91.2 % of the extent of the unit within the survey area.

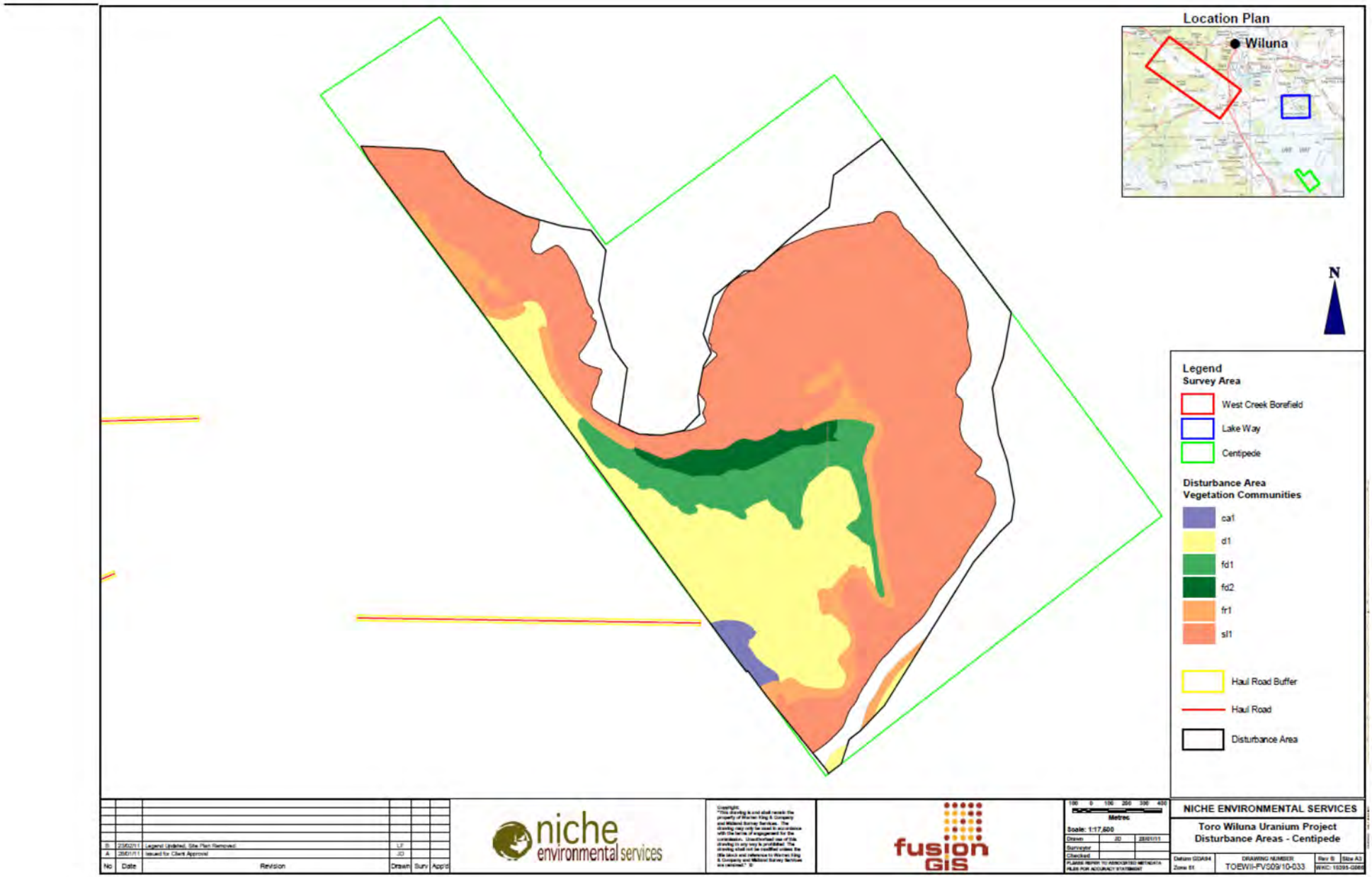

Figure 11 **Map illustrating the proposed disturbance footprint and associated vegetation units within the Centipede survey area as surveyed during 2010 by Niche Environmental Services (image used with permission of Warren King and Co.).**

8.2 Lake Way survey area

8.2.1 Site description

The Lake Way survey area covered approximately 2 324 ha on the northern sections of the lake system, of which approximately 1 984 ha was vegetated and 300 ha was un-vegetated salt lake. It is proposed that approximately 679 ha of the vegetation will be potentially be impacted by the proposed development of the Toro Energy Wiluna Project (**Figure 12**). The survey area commences on the salt lake, with the first vegetation recorded on the playa adjoining the lake proper. The playa vegetation extends for a short distance before being replaced by a dune system that is interspersed with sections of fringing *Melaleuca xerophila* closed forest and claypan vegetation and ends on the calcrete platform at the north of the tenement. Within the Lake Way survey area, there were five distinct zones, being:

- *Tecticornia* spp vegetation on the playa;
- Fringing vegetation, which was distributed as a belt along the interzone between the playa or claypans and the dune system;
- A system of anastomising claypans with halophytic vegetation;
- A low dune system comprised of *Acacia* species and mallee eucalypts over spinifex; and
- Calcrete platform dominated by *Acacia* species, with a small section of mallee vegetation.

8.2.2 Vegetation descriptions and condition assessment

There were two *Tecticornia* species vegetation units defined and delineated within the Lake Way survey area, with one unit recorded on the edge of the playa and one unit recorded on the claypan.

8.2.2.1 Playa vegetation

The playa vegetation unit was located in the southern section of the Lake Way survey area. The playa vegetation unit was defined as a Low Heath D of *Tecticornia* species to 0.5 m with occasional pockets to 1 m (mapping unit sl1). The vegetation was generally uniform in height and density, with some changes in species composition noted across the surveyed area. The unit was located on the lake edge on heavy clays, light orange in colour with salt crusts and on sections of self-mulching clays. There were occasional stands of *Lycium australe* and *Acacia victoriae* noted in sections. The vegetation within this unit was as assessed as being in good to very good condition. The vegetation had clearly been affected by exploration activity, with a number of tracks and drill lines located within the area. There was extensive of drought stress, which was particularly obvious in the vegetation located on the self-mulching clays. An image of this unit is presented as **Plate 2** in **Appendix F**. The distribution of this unit within the proposed disturbance footprint is shown in **Figure 12**. The full extent of this unit within the survey area is shown in **Figure 19** in **Appendix E**. This unit covers approximately 396 ha of the Lake Way survey area. It is proposed that approximately 216.2 ha of this unit, representing 54.6 5 of the extent in the survey area, will be removed.

8.2.2.4 Claypan vegetation

The claypan system within the Lake Way survey area was noted as being two, potentially distinct systems. One claypan system was recorded in the western side of the project area and was contiguous to the salt lake unit. The second claypan system was more extensive and formed north of the tenement near Lake Uramurdah. The second claypan was comprised of a series of anastomising pans, with sections of dune and calcrete vegetation interspersed along the length of the system. The claypan *Tecticornia* vegetation unit was defined as a Low Heath D of *Tecticornia* species to 0.5 m with occasional pockets to 1 m (mapping unit cp1). Patches with *Frankenia* species as dominants were noted, although these were generally not large enough to be mapped as separate units. There were occasional records of *Lycium australe, Acacia victoriae, Melaleuca xerophila* and *Cratystylis subspinescens* in this unit. This vegetation unit was recorded in both of the claypan systems referred to above. This vegetation unit was noted as being in good to very good condition. There were limited disturbance noted, with only a few tracks running though the unit and limited evidence of grazing. In some areas, there was clear evidence of drought stress on the vegetation; in particular this was noted on the western section of the claypan. An image of this unit is presented as **Plate 3** in **Appendix F**. The distribution of this unit within the Lake Way survey area is presented in **Figure 12**. The full extent of this unit within the survey area is presented in **Figure 19** in **Appendix E**. This unit covers approximately 214 ha of the survey area. It is proposed that approximately 117.02 ha, representing 54.7 % of the extent of this unit in the survey area, will be removed.

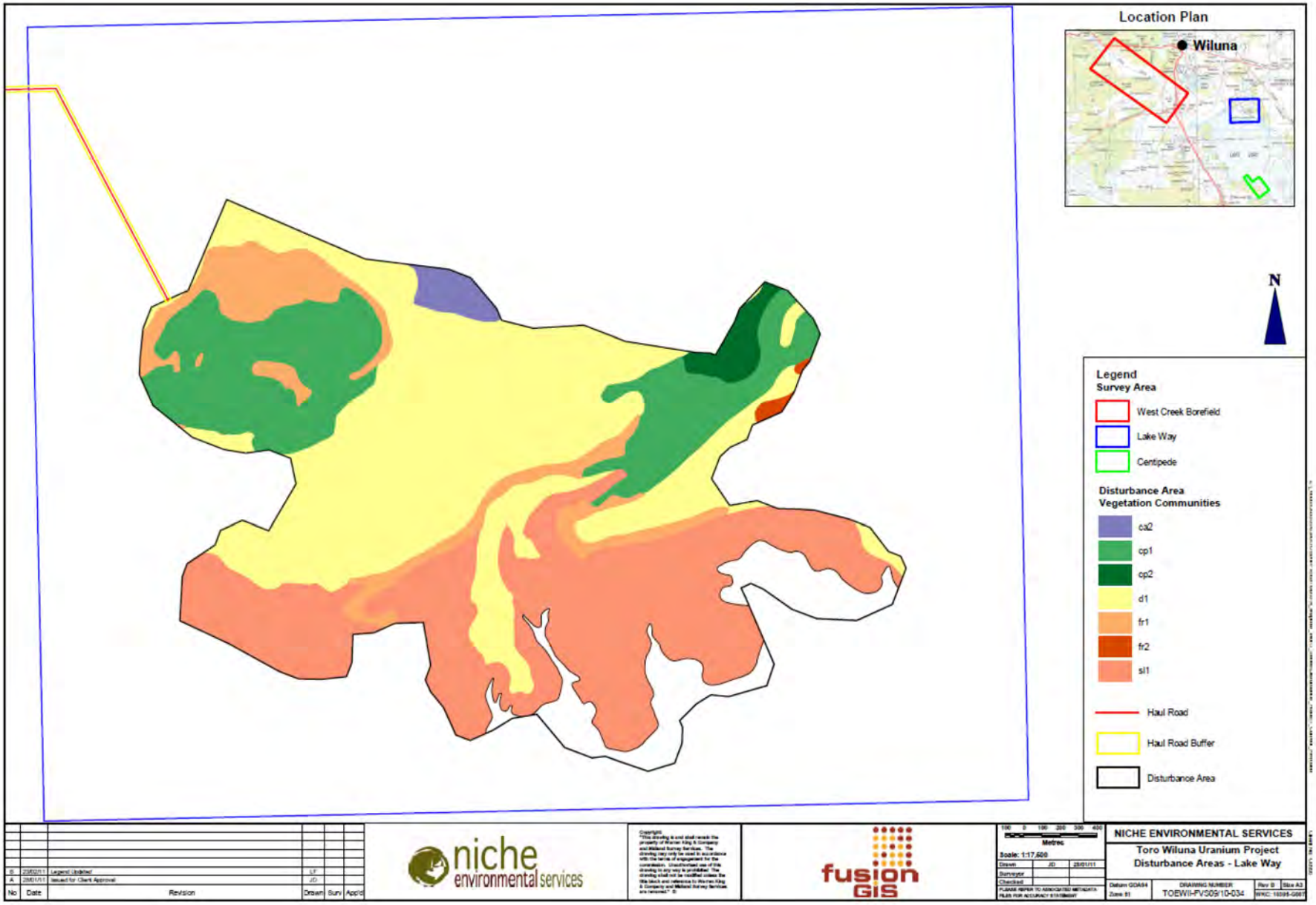

Figure 12 **Map illustrating the proposed disturbance footprint and associated vegetation units within the Lake Way survey area as surveyed during 2010 by Niche Environmental Services (image used with permission of Warren King and Co.).**

8.3 Statistical analysis

In the first pass analysis, all *Tecticornia* survey sites were included. The output, shown as **Figure 13**, has a distinct central grouping and a series of quadrats that appear to have limited levels of relationship with other quadrats. These are considered to be outliers, which in this instance is a reflection of a limited number of *Tecticornia* specimens in common between quadrats. Of the outliers, Reg 17, Reg 25, Reg 26, Reg 44, Reg 45 and Reg 46 are within the Lake Way system. Reg 45 and 46 were noted as being the areas in which the priority species, *Tecticornia* sp. Lake Way, was recorded. Reg 44 is located within a claypan to the west of the Centipede survey area. The other outliers are located in other lake systems. The outliers in the first ordination were removed prior to re-running the analysis.

The output from the second analysis is presented as **Figure 14**. In this output, there is a better sorting of quadrats into survey areas. The quadrats from the Lake Way and Centipede survey areas have sorted into two, comparatively distinct groupings. The proximity of the groupings to each other is indicative of there being a level of similarity between quadrats in the two areas. It is possible that with the removal of the outlying quadrats from this ordination, the Lake Way and Centipede survey quadrats would further separate.

In performing the statistical analysis, it is critical to consider the limitations of the data used in the analysis. The underlying datasets used in the analysis were derived from quadrat data collected during the surveys. As was identified in the limitations of the survey (section 5.7), there are gaps in the taxonomy of specimens collected during the surveys. Of the 231 specimens collected in the autumn and spring surveys, there were 168 specimens to which some identification was attached, representing approximately 73 % of all of the specimens. This leaves 63 specimens for which taxomony was not resolved. These 63 specimens may assist in clarifying the relationships between the quadrats. Having stated that, there is valid reason to assert that the quadrats that have clearly been identified as outliers are fundamentally different to other quadrats. This matter is considered in the following section.

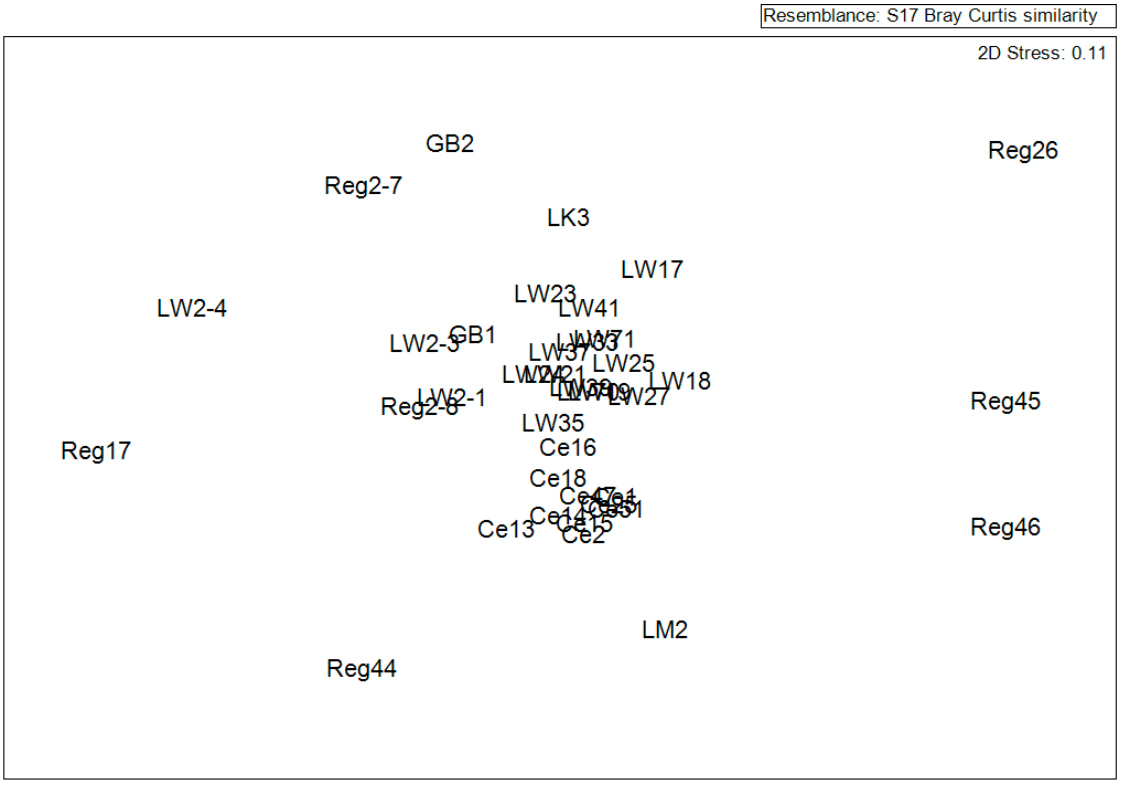

Figure 13 Multi-dimensional scaling (MDS) ordination output from PRIMER 6, displaying relationships between Centipede, Lake Way and regional survey quadrats. Output includes all quadrats surveyed.

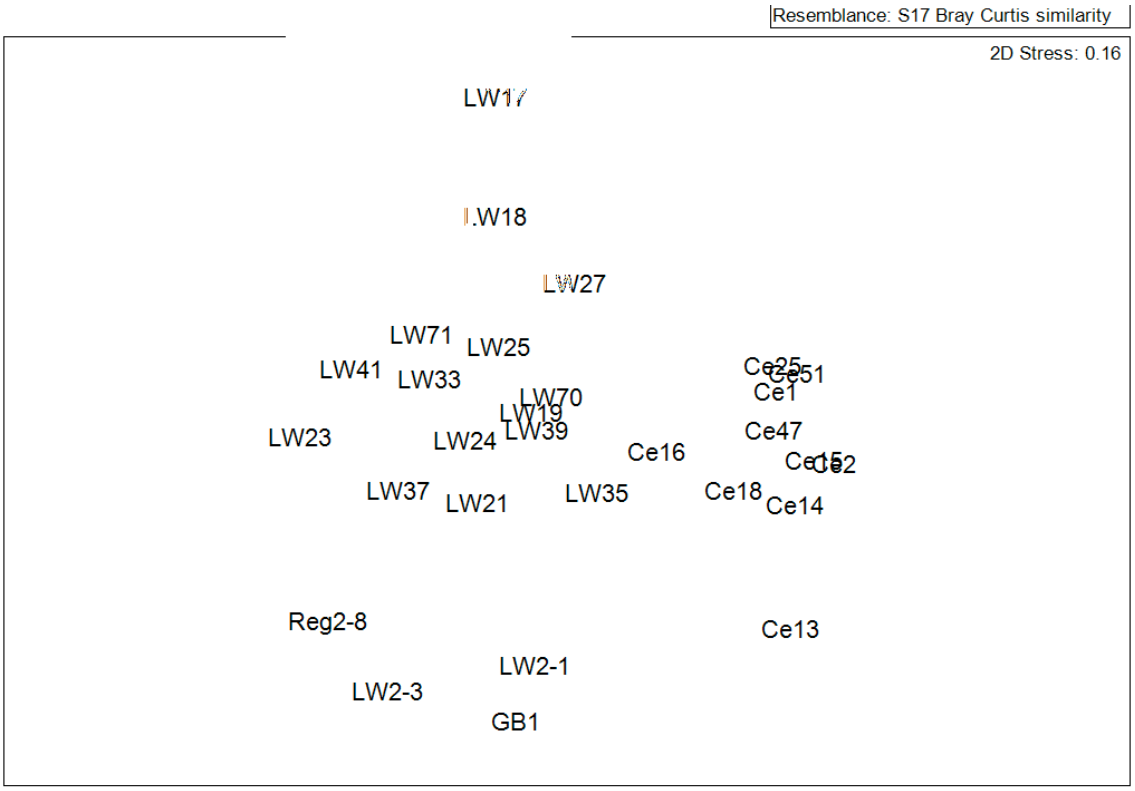

Figure 14 Multi-dimensional scaling (MDS) ordination output from PRIMER 6, displaying relationship between Centipede, lake way and regional survey quadrats, after removal of potential outliers identified in output shown in Figure 13.

8.4 Regional context

8.4.1 Summary of findings

The regional survey work for *Tecticornia* species vegetation was completed within the Lake way system and in a number of lake systems in the surrounding region. Each of these is addressed separately in this section.

- Lake Miranda – Lake Miranda is a lake system located approximately 100 km to the south of Lake way. Lake Miranda is dissected by the Goldfields Highway, which has potentially impacted on the hydrology and functional ecology of species that are recorded on, and adjacent to, the lake. While there may have been some effect as a consequence of the disturbance from the highway, and other disturbances, there are some landscape factors that point to an underlying difference between Lake Miranda and the northern sections of Lake Way.

  The dominant landform feature adjoining lake Miranda is a series of kopi ridges. There is one small section of calcrete on the southwestern edge of the lake, but the majority of the landforms surrounding the lake are kopi ridges. Kopi ridges are formed by the accretion of gypeous material. Ridges of this nature are noted as not occurring within either the Centipede or lake Way project areas. There is the potential that lake systems with kopi ridges have an underlying difference, geologically, to lake systems that don't. The potential that this has impacted on the hydrology and profile of available nutrients is beyond the scope of this work, but there was a distinct difference in the structural characterstics of the *Tecticornia* species vegetation between this site and the project survey areas, and a difference in the species present. Based on this analysis, the *Tecticornia* species vegetation at lake Miranda is not considered to be a functional or taxonomic analogue to the Centipede or Lake Way survey areas.
- Lake Ward – Lake Ward is located approximately 60 km to the northeast of the Lake way survey area, on the Jundee pastoral lease. Lake Ward is a comparatively small lake system, although there were some landform similarities between this site and the project survey areas. The landscape surrounding Lake Ward is comprised of low dune systems with *Euclapytus* and *Acacia* species as the key structural species over an understory of spinifex. In addition to this, there are sections in which there are stands of *Melalecua xerophila*, although at a much more limited degree than at either of the Lake Way or Centipede survey areas. From a floristic perspective, the two quadrats surveyed in Lake Ward were not considered to be analogous to the Lake Way or Centipede survey areas. This assertion was supported by the output from the MDS, in which the two quadrats from this lake sorted from the Lake Way and Centipede survey areas.
- Gunbarrel Highway – the two areas surveyed adjajcent to Gunnbarrel Highway were located approximately 100 km to the east of the Lake Way and Centipede survey areas. The lakes had been dissected by the highway, which may have impacted on the hydrology of the lake

system. The landcape in this area was characterised by the presence of low ridges of sandstone, interspersed with sections of calcrete and plains vegetation. The vegetation was surveyed as it was noted as having a structural similarity to the Lake Way and Centipede survey areas. While there was an amount of structural similarity, this was not reflected in floristic similarity, as can be seen in the MDS outputs (GB1 and GB2).

- Lake Naberru – Lake Naberru was located approximately 100 km to the north of the Lake Way survey area. Lake Naberru is part of a series of three lakes, comprised of Lake King, Lake George and Lake Naberru. From a landscape perspective, this lake system was considered to be analogous to the landscape surrounding the Lake Way and Centipede survey areas. There were dunes surrounding the lake, on which vegetation similar to the dunes near Lake Way and Centipede was recorded. In addition to this, there was an extensive band of *Melaleuca xerophila* closed forest, which was recorded in a similar landscape position as that found at Centipede and Lake Way. In addition to the landscape similarity, the lake was noted as having a surface hydrology that was broadly similar to that within the Lake Way and Centipede survey areas.

  While there was a high degree of landscape similarity, the quadrat surveyed at this site was not floristically similar to either of the project survey areas. It is considered that this may be artefact of sampling site and sampling effort, which was restricted to one section of the lake system. Lake Naberru is part of a chain of salt lakes that is approximately 120 km in length, with a span in parts of up to 10 km. There may be some value in further investigations in this lake system to determine whether analogous units to the Centipede and Lake Way are within other sections of the lake system.
- Lake Way – the southern sections of Lake Way were surveyed to determine degrees of similarity with the northern sections of the system. The quadrats in the southern section were not florisistically similar to the quadrats in either the Lake Way or the Centipede survey areas. In addition to the lack of floristic similarity, the landscape in the southern sections was generally different. While some sections of the landscape adjoining the lake system were noted as being similar to the north, the majority was different, with ridges of kopi the dominant landform.

8.4.2 Conservation Significance of Vegetation

To determine whether vegetation was considered to have conservation significance, an assessment was made against the following factors:

- Presence of flora of conservation significance;
- Presence of new flora records;
- Vegetation unit potentially restricted in distribution;
- Vegetation containing a unique assemblage of species; and/or
- Identified by a recognised authority as being a unit with conservation significance

Based on the above factors, there were a number of vegetation units within the survey areas that were identified as potentially having conservation significance. Initial assessments of conservation significance were completed after the autumn 2010 surveys. Where a vegetation unit was identified as potentially having conservation significance, additional survey work was undertaken by Niche in spring 2010, with a view to better quantifying the potential conservation significance and, where appropriate, the local or regional significance of the unit.

Dr Kelly Shepherd from the Western Australian Herbarium was consulted in relation to the conservation value attached to *Tecticornia* spp. vegetation (Niche mapping units: sl). Dr Shepherd noted that survey work on *Tecticornia* vegetation in the Wiluna region, and surrounds, was limited, in terms of intensity and scale. It was recommended that extensive survey work was required in the region to clarify the degree of relationship between samphire assemblages within and between lake systems. It was proposed by Dr. Shepherd that there may be an underlying difference in species assemblages within *Tecticornia* communities, within and between lake systems. This observation would appear to be consistent with findings from surveys completed by Niche, in which substrate was linked to differences in species within samphire vegetation units. In addition to the potential for species to vary between sites, the restriction in distribution due to habitat specificity limits the extent of these units. Based on these factors, samphire vegetation units potentially have a high level of conservation significance.

8.4.3 Threatening Processes

During the completion of the surveys documented in this report, it was noted that there were threatening processes that were potentially having an impact on the condition of vegetation and the diversity of flora in the project area and surrounds. While it is acknowledged that mining is a threatening process, the following summary relates to existing threatening processes beyond this. The key threatening processes noted were:

- Overgrazing by cattle – the impacts of cattle on the vegetation was noted across the two project areas and the borefield. Grazing impacts were noticed during the regional surveys, but this was concentrated on the western side of the lake system. The effects of grazing were evident on many species, but particularly on herbaceous understorey species. In some areas, the understorey had essentially been removed. Grass species such as *Eragrostis eriopoda* were noted as almost always being grazed to stubble. The grazing effects are being magnified by the prevailing climatic conditions, which are characterised by low rainfall. Removal of cattle would reduce grazing pressure, which may in turn improve the complexity and diversity in the understorey. With ongoing pressure from grazing, the recuperative capacity of the vegetation may well be lost. Beard (1990) notes grazing as being a disturbance factor that can reduce the recuperative capacity of mulga. Over time, the grazing pressure may result in the loss of not only understorey species, but also canopy species.
- Grazing by camels – grazing by camels was not noted as being widespread, but the impacts were significant where observed. Camels strip vegetation from mulga, resulting in individual

plants being left with no leaves. Damage by camels in itself may not be significant, but in combination with the grazing by cattle may result in a loss of recuperative capacity, particularly for mulga.

- Grazing by rabbits – as with the other grazing pressure, grazing by rabbits damages or destroys herbaceous species and recruits of perennial species. The combination of grazing pressures by cattle, camels and rabbits has the potential to significantly threaten the vegetation in the project areas and surrounds. Over time, the extent of grazing may lead to loss of suites of species and may lead to the complete loss of recuperative capacity in the vegetation, with the concomitant loss of seedbank recharge due to lack of individuals reaching reproductive maturity magnifying the problem.
- Track proliferation – there were a number of tracks observed within the survey areas. The proliferation of tracks can increase fragmentation of vegetation, provide opportunities for the introduction of alien taxa and may lead to increased levels of erosion, particularly in areas with limited amounts of understorey cover to assist with maintaining soil integrity.
- Fire – fire may not in isolation present as a threatening process, provided fire frequency and intensity is consistent with existing natural patterns. In instances where fire frequencies change, especially with an increase in frequency, this may result in structural changes to vegetation. The effects of changes to fire frequency and intensity may also magnify the effects associated with excessive grazing.
- Drought – during the surveys, it was noted that there was evidence of drought stress in some species and vegetation types. It was most notable in groundwater-dependent vegetation, which would be the most susceptible to drought. Baseline information in relation to the extent of drought-related stress should be collected as soon as is practicable.

8.5 Groundwater-dependent vegetation

8.5.1 Overview

A groundwater-dependent ecosystem (GDE) is an ecosystem that requires access to groundwater so that ecological structure and function can be maintained (Murray *et al.,* 2006). Within the broad definition of a GDE, there are three distinct groupings, being:

- Aquifer and cave ecosystems, which provide habitat for stygofauna;
- Ecosystems that are dependent on surface expressions of groundwater. These systems include rivers and streams, wetlands, mound-springs and floodplains; and
- Ecosystems that are dependent on subsurface groundwater. There is no surface expression of groundwater required in this class of GDE (Eamus *et al.,* 2006)

The aquifer and cave ecosystems are recognised as habitat for fauna (Eamus *et al.,* 2006; Humphrey *et al.,* 2006) and whilst they may form part of the groundwater system associated with vegetation, they are not considered further in this report. The remaining two systems are generally defined and discussed in relation to vegetation, but this is not indicative of an absence of fauna or other lifeforms (Eamus *et al.,* 2006). To determine which type of groundwater-dependent vegetation (GDV) was

present in the survey areas, the criteria listed in Eamus (2009) (**Table 4**) were applied against data collected during the surveys in 2010.

The dependency on groundwater of a species within a GDE can be defined as facultative and obligate (Eamus *et al.,* 2006). A GDE is considered to be obligate if, at the species level, the presence of a species is dependent upon continuous, seasonal or episodic access to groundwater (Eamus *et al.,* 2006). A GDE is considered to be facultative if a species uses groundwater when it is available, but does not demonstrate any loss of vegetative cover in the absence of groundwater (O'Grady *et al.,* 2006). Defining whether a system is facultative or obligate is considered to be relevant to understanding how changes in groundwater access will impact the vegetation. This assessment has not been undertaken for the groundwater-dependent vegetation (GDV) within the survey areas. This may need to be addressed to provide a better understanding of vegetation interactions with groundwater.

The vegetation and landscape within the survey areas was reviewed in the context of the criteria listed in **Table 4**. There was no evidence of surface flows, wetlands or swamps in the survey areas, but there is groundwater recorded in the West Creek borefield survey area and the Lake Way survey area (Aquaterra, 2010a; 2010b). The similarity in landscape between the Lake Way and Centipede survey areas would support an assertion that similar underlying hydrological properties would be found in both survey areas. In light of this, it is inferred that the groundwater-dependent vegetation within the Centipede and Lake Way survey areas is accessing subsurface water.

Table 4 Criteria for determining groundwater dependence in vegetation (adapted from Eamus, 2009).

Surface expression of groundwater	Subsurface expression of groundwater
Does a river flow all year, or a wetland or swamp remain wet all year despite prolonged periods of zero surface flows (that is, zero or very low rainfall)?	Are roots able to reach the water table? If roots can reach a source of fresh water it is generally true that this water will be absorbed by the roots and transpired by the canopy.
Within an estuary, does the salinity drop below that of seawater in the absence of surface water inputs (e.g. tributaries or stormwater)?	During extended dry periods, does a significant proportion of the vegetation remain green and physiologically active? The green region might be using groundwater to maintain its physiological activity.
Does the volume of flow in a stream or river increase downstream in the absence of inflow from a tributary?	Are large changes in LAI apparent at some locations but not others within a small geographical range? The area not showing a large change in LAI might be accessing groundwater while the area that does show large intra-annual changes in LAI is probably not.
Is groundwater discharged (e.g. a spring) to the surface for significant periods of time each year? If such a resource is present, some species present are likely to be adapted to be using it.	Is the vegetation associated with the surface discharge of groundwater different (in terms of species composition, phenological pattern, LAI or vegetation structure) from vegetation close by but which is not associated (i.e. not accessing) this groundwater?
Is the vegetation associated with the surface discharge of groundwater different (in terms of species composition, phenological pattern, LAI or vegetation structure) from vegetation nearby that is not associated with this groundwater?	For sites that are not receiving significant amounts of lateral surface and sub-surface flows, is the annual rate of water use by the vegetation significantly larger than the annual rainfall at the site?
Is the annual rate of water use by the vegetation significantly larger than annual rainfall at the site, and the site is not a run-on site?	Are plant water relations (especially pre-dawn and midday water potentials and transpiration rates) indicative of less water stress (potentials closer to zero; transpiration rate larger) than vegetation located nearby but upslope? The best time to measure this is during rainless periods.
Are plant water relations (especially pre-dawn and midday water potentials and transpiration rates) indicative of less water stress (potentials close to zero; transpiration rate larger) than vegetation located nearby but not accessing the groundwater discharged at the surface?	Are seasonal changes in groundwater depth larger than can be accounted for by the sum of lateral flows and percolation to depth (that is, a significant discharge path for groundwater)?
Is occasional (or habitual) groundwater release at the surface associated with key developmental stages of the vegetation (such as flowering, germination, seedling establishment)?	
Can small (typically less than 20 mm per day) fluctuations in the depth to groundwater be seen in the aquifer with a diurnal periodicity?	

Based on the assumption that the groundwater-dependent vegetation is using subsurface groundwater, the review of vegetation in the Centipede, Lake Way and West Creek survey areas was based on the criteria for subsurface groundwater-dependent vegetation in **Table 4.** The key criteria considered to be relevant to vegetation in the survey areas were:

- The groundwater or capillary fringe above the water table is likely to be within the rooting depth of any of the vegetation;
- A proportion of the vegetation remains green and is likely to be physiologically active during extended dry periods;
- The vegetation associated with the subsurface groundwater is different, in terms of species composition and phenology, to the surrounding vegetation; and
- The annual use of water by vegetation is considered to be significantly greater than the annual rainfall.

To complete a discussion of groundwater-dependent vegetation, particularly in the context of determining potential impacts associated with alterations of hydrological processes, an assessment of the environmental water requirements and the degree of dependence of vegetation on groundwater is considered beneficial. Understanding the environmental water requirements would assist in determining ranges over which impacts to vegetation due to changes can be tolerated. Understanding the degree of dependence on groundwater can assist with planning for rehabilitation and revegetation in a post-mining environment.

8.5.2 Centipede survey area

Within the Centipede survey area, the playa vegetation Low Heath D of *Tecticornia* species was defined as being potentially groundwater-dependant. The distribution of this unit is illustrated in **Figure 15**.

8.5.3 Lake way survey area

Within the Lake Way survey area, the playa vegetation Low Heath D of *Tecticornia* species and the claypan vegetation Low Heath D of *Tecticornia* species were identified as being potentially groundwater-dependant. The distribution of these within the Lake Way survey area is illustrated in **Figure 16**.

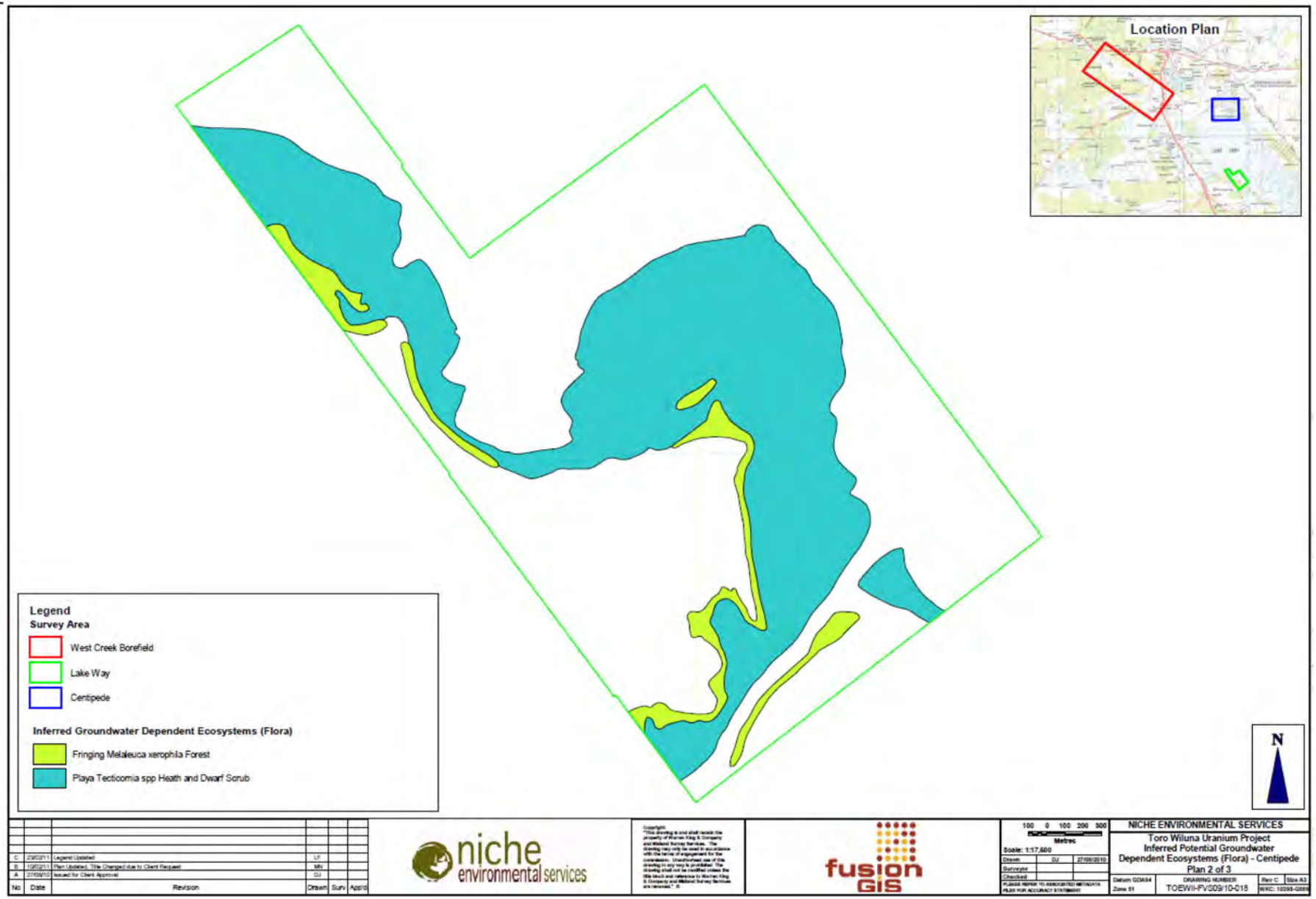

Figure 15 **Map illustrating the distribution of inferred groundwater dependent vegetation within the Centipede survey area (image use with permission of Warren King and Co.).**

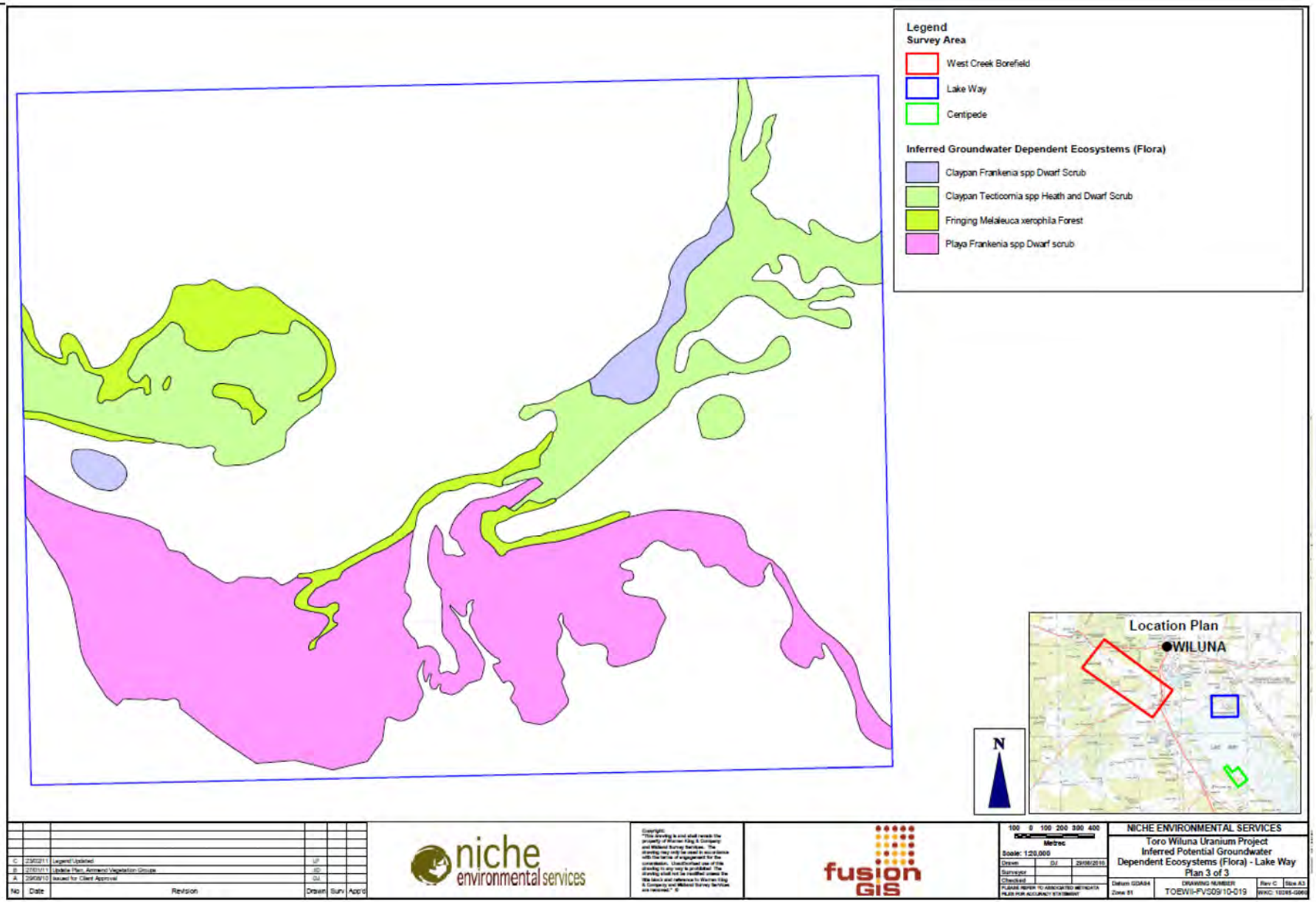

Figure 16 **Map illustrating the distribution of inferred groundwater dependent vegetation within the Lake Way survey area (image use with permission of Warren King and Co.).**

9.0 RESULTS and DISCUSSION - FLORA

9.1 Summary of Flora

During the autumn and spring 2010 surveys within the Centipede, Lake Way and regional surveys, a total of 231 *Tecticornia* specimens were collected. Of the 231 specimens collected, there were 168 that were identified. From the 168 specimens, a total of 21 species were identified. Of the 21 species identified, 16 were identified to species, one to aggregate, three to affinity and one potential novel species. The potential novel species was not recorded in the Lake Way or Centipede project area. The balance of *Tecticornia* specimens collected were not identified due to sterility. A summary of the flora is presented in **Appendix G**.

9.2 Targeted Search Results

9.2.1 *Tecticornia* sp. Lake Way (P.G. Armstrong 05/961)

Targeted searches for this species were conducted within the *Tecticornia* vegetation units within the Centipede and Lake Way survey areas (**Figures 18** and **19**), the southern section of Lake Way, Lake Miranda, Lake Ward, Lake Naberru and two unnamed sections of playa vegetation located adjacent to the Gunbarrel Highway, east of the town of Wiluna. There were no records of this species made in any of these areas. Based on the data collected during these surveys, it appears that *Tecticornia* sp. Lake Way (P.G. Armstrong 05/961) is restricted to currently known records. Based on the current defined areas of disturbance associated with the Toro Energy Wiluna Project, there are not predicted to be any impacts to this species.

9.3 Alien Taxon – *Acetosa vesicaria*

The weed species *Acetosa vesicaria* (ruby dock) was recorded in the Centipede survey area, in one section of the proposed West Creek borefield and in other locations not within Toro tenements. The locations of the records and a description of the nature of the infestation is presented in **Figure 17.** *Acetosa vesicaria* is a significant environmental weed, and whilst not a Weed of National Significance (WONS) or a declared plant pursuant to the *Agriculture and Related Resources Protection Act (1976),* the species has been identified by the DEC as a weed with a high level of potential for environmental impacts, based on invasive, distribution and impacts (DEC, 1999). The other weed species collected during the surveys were not considered to present a significant environmental risk.

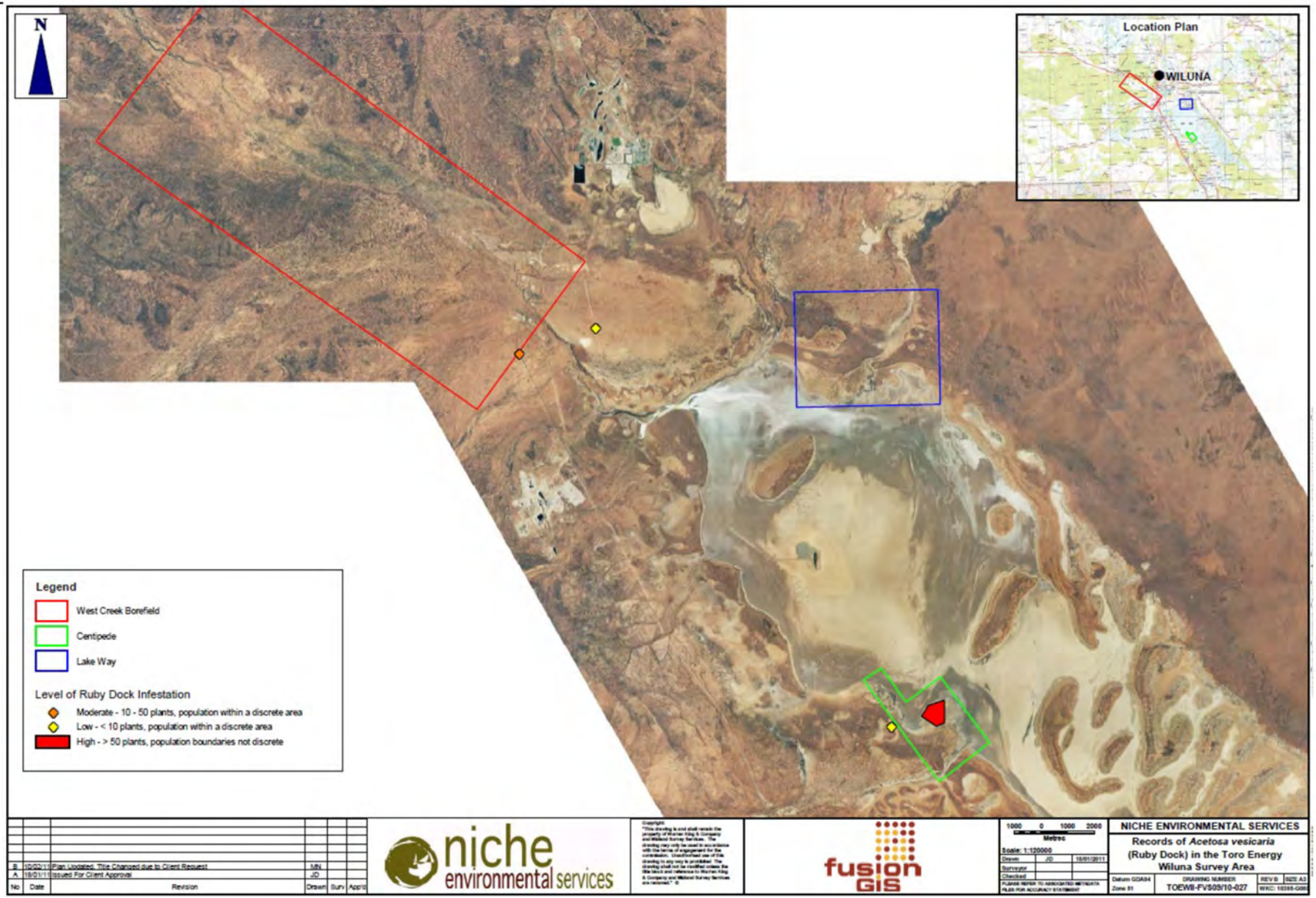

Figure 17 **Map illustrating locations at which the alien taxon *Acetosa vesicaria* was recorded during surveys conducted in spring 2010 (image used with permission of Warren King and Co.).**

10.0 CONCLUSION AND RECOMMENDATIONS

The surveys as detailed in this report were conducted to comply with the requirements of a Level 2 survey as detailed in *Guidance Statement No. 51* (EPA, 2004). The surveys were conducted over two seasons, with surveys timed to follow periods of rainfall and/or flowering times for species in the region. Sampling intensity was sufficient to allow for description and delineation of vegetation. Sampling intensity should have been sufficient to develop a census of the flora and to assess potential impacts to flora of conservation significance; however, there are still some issues in relation to resolution of taxonomy of *Tecticornia* specimens.

Description and delineation of *Tecticornia* vegetation units has been completed, with the playa vegetation at Centipede and Lake Way being structurally similar. The vegetation at both of these sites was a Low Heath D. In addition to the underlying structural similarities, there are other similarities in vegetation immediately adjajcent to the playa. While there may be structural similarities, the outputs from statistical analysis would seem to support the assertion that there is a difference in floristic composition between the two sites. It is noted that there are limitations required on the robustness of assertions based on the statistical outputs, as there are still some issues with unresolved taxonomy. The clarification of taxonomy may have one of three potential outcomes in relation to statistical analyses: that the current representation in the ordination is maintained; that the two project survey areas are plotted closer together; or, that the two project areas plot further apart.

Irrespective of the changes to statistical outputs of the two project areas, it appears that analogous units are not within other regional salt lakes. Regional surveys completed in autumn and spring 2010 were focused on lakes to the south, north, northeast and east of the two project areas, as well as the southern sections of Lake Way. The *Tecticornia* vegetation at the salt lakes surveyed in the regional surveys was not considered to be structurally or floristically analogous to the Centipede or Lake Way project areas. Lake Miranda, 100 km to the south of Lake Way, was noted as being surrounded by ridges of kopi, had vegetation that was shorter than that observed in either of the project survey areas, and was floristically dissimilar. Lake Ward, to the northeast, was located in a similar landscape as the two project survey areas, and had *Tecticornia* vegetation that was structurally similar, but was not floristically similar. The salt lakes to the east of the project area, adjacent to the Gunbarrel Highway, were noted as being in a landscape containing sandstone ridges, as well as plains and sections of calcrete. The salt lakes had been dissected by Gunbarrel Highway, which may have altered local hydrological processes. At any rate, the *Tecticornia* vegetation adjacent to Gunbarrel Highway bears limited floristic similarity to the two project survey areas. Lake Naberru, located approximately 100 km to the north of the project survey areas, was only surveyed in one location, which, based on statistical outputs, was not similar to either of the project areas. It was noted that Lake Naberru is within a series of salt lakes that span over 120 km in length and 10 km in width. Given that the landscape surrounding Lake Naberru was similar to that around Lake Way, there may be scope in expanding the survey intensity at within this lake system.

The southern sections of Lake Way were also surveyed as a component of the regional survey work. The findings of survey work in the southern sections of the lake were clear; the structural and floristic composition of the southern sections of the lake were different to the north. It was noted the landforms in the southern section of the lake are dominated by ridges of kopi, with a transitional zone in the central sections of the lake where kopi and sand dunes are located in close proximity. The two project areas lie adjacent to platforms of calcrete and dunes of sand. The causal factors driving the changes in structural and floristic composition were not investigated, but it is proposed that there may be effects due to changes in surface and subsurface hydrology as well as the influence of substrate.

The conservation value of the *Tecticornia* species vegetation units within the Centipede and Lake Way project areas is unresolved. Dr Kelly Shepherd, from the Western Australian Herbarium, has indicated that she believes that each salt lake system is comparatively unique, but that there is a lack of survey data to either support or refute this assertion. Based on this, the precautionary principle should reasonably be invoked, at least until data to indicate the conservation value of the vegetation is sufficiently robust. The regional survey work completed during autumn and spring 2010 would seem to indicate that the views of Dr Shepherd may have some merit. There is clearly a limited amount of similarity between *Tecticornia* vegetation units in the regional salt lake systems. It is proposed that the lack of similarity between the regional and project sites is not *sensu strictu* evidence of conservation value of any of the sites.

Conservation value of vegetation needs to be defined within a clear, measureable framework. A number of factors to be considered were presented in the report. These included unique habitat for fauna, the presence of novel species or species of conservation significance, condition better than that in similar habitats or a unique assemblage of species. There is currently no evidence that any of these factors is relevant to the Centipede or Lake Way project areas. To date there have been no records of novel species, or species with conservation significance within either of the project areas. The condition of the vegetation is not considered to be better than any of the other lake systems in the region, nor is it worse. Perhaps the most critical assessment pertains to the specific assemblage of species at the sites. While it may be claimed that the output from the statistical analysis would support the assertion that the project survey areas are different to the other lake systems, the specific species within the project areas are all noted as being common. It is considered to be valid to question the conservation value of a vegetation unit that is comprised of common species. That stated, the gaps in taxonomy need to be resolved to allow for a complete assessment of the values of the Centipede and Lake Way project areas.

The census of the flora was considered to be reasonably comprehensive. There were 231 specimens collected during the surveys, from which 168 species were identified. The 168 specimens were identified as being one of 21 species, of which only one was novel. The novel species was not recorded in either the Centipede or Lake Way project areas. The remaining specimens were not identified due to sterility of specimens. Of the 21 species, there were three to affinity and one to

aggregate level. It was noted that the majority of identified specimens were placed at the affinity level. The taxonomy was discussed with Dr Shepherd, who indicated that there was a lack of taxonomic resolution of *Tecticornia* within Western Australia. Dr Shepherd indicated that there were a number of species that contained a range of morphological variation consistent with there actually being a number of variants, subspecies or new species within the current groupings. This partly explained the application of affinity to a number of the specmens. Timeframes for resolution of taxonomic problems were discussed with Dr Shepherd, who indicated that there was a lack of resources available to complete this work.

Notwithstanding the lack of taxonomic resolution, there were still approximately 23 % of specimens collected for which additional sampling is required before taxonomy for the project areas can be completely resolved. Timings of additional surveys were discussed with Dr Shepherd, who indicated that seed storage syndromes and the timing of seed production needs to be considered. *Tecticornia* are broadly classed as either holding seeds or dropping seeds. For species that hold seeds, survey can be conducted at any time. For species that drop seeds, surveys need to be conducted at times when the species will still have seeds. While vegetative tissue can be used for resolution of taxonomy, the use of seeds is preferred, as these are more consistent in morphology and provide for a greater level of confidence in determining taxonomy. It is considered that the specimens for which taxonomy could not be resolved were more likely to have been those species that drop their seeds. Therefore, it is proposed that additional surveys are required, at different times of the year, to collect specimens of species that do not hold there seeds

While the surveys detailed in this report are considered to meet the underlying requirements of the EPA for a Level 2 survey, there is the potential that further studies are required to better understand the relationship between groundwater supplies in the project areas and groundwater-dependent vegetation. The presence of vegetation with a dependence on groundwater has been inferred based largely on species present and habitat. The inference does not provide any insight into the nature of the relationship between the species and groundwater, and as such, does not assist with determining how these species may be affected by abstraction during the life of the mine. It is recommended that additional studies be undertaken to better understand the relationship between the species and the groundwater supplies.

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Appendix A

Definitions of (Threatened) Declared Rare and Priority Flora

Definition of Declared Rare and Priority Flora Species (DEC, 2011)

Code	Category Description
T	*Threatened – (Declard Rare Flora – Extant)* Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act, 1950). Threatened Flora (Schedule 1) are further ranked by the DEC according to their level of threat using IUCN Red List Criteria: CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild EN: Endangered – considered to be facing a very high risk of extinction in the wild VU: Vulnerable – considered to be facing a high risk of extinction in the wild
X	*X: Presumed Extinct Flora (Declared Rare Flora — Extinct)* Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950)
Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.	
P1	*Priority One – Poorly-known Species* Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	*Priority Two – Poorly Known Species* Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	*Priority Three – Poorly Known Species* Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	*Priority Four – Rare, Near Threatened and other species in need of monitoring* a. Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	*Priority Five – Conservation-dependent species* Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix B

Definitions of Threatened and Priority Ecological Communities

Threatened Ecological Community Classifications and Descriptions (DEC, 2010)

Category	Category Description
Presumably totally destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be completely destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the forseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant AND EITHER of the following applies: A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or** B) All occurrences within the last 50 years have been destroyed.
Critically endangered (CR)	An ecological community will be listed as critically endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This is determined on the basis of the best available information, by it meeting ANY ONE OR MORE of the following criteria (A, D, or G): **A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90 % and either or both of the following apply (B or C):** B) Geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); C) Modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. **D) Current distribution is limited, and one or more of the following apply (E or F):** E) Geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); F) There may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. G) **The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).**
Endangered	An ecological community will be listed as endangered when it has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting ANY ONE OR MORE of the following (A, D or H): **A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70 % since European settlement and either or both of the following apply (B or C):** B) The estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); C) Modification throughout its range is continuing such that in the short term future (within approximately 20 years). **D) Current distribution is limited, and one or more of the following apply (E, F or G):** E) Geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); F) There are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; G) There may be many occurrences but the total area is small and/or isolated and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. **H) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).**
Vulnerable	An ecological community will be listed as vulnerable when it has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by meeting **any one or more** of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may be still widespread but is believed to move into a category of higher threat in the medium to long-term future because of existing or impending threatening processes.

Priority Ecological Community Classifications and Descriptions (DEC, 2010)

Category	Category Description
Priority One	Poorly-known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100 ha). Occurrences are believed to be under threat due to limited extent, or being on lands under which immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	Poorly-known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	Poorly-known ecological communities Communities that are known from several to many occurrences, a significance number or area of which are not under threat of habitat destruction or degradation; or Communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat; or, Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. Rare – Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. Near Threatened – Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	Conservation-Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix C

Classification of Vegetation Structural Formation and Height Classes

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE **70% - 100%**	**MID DENSE** **30% - 70%**	**SPARSE** **10% - 30%**	**VERY SPARSE** **2% - 10%**
Trees > 30m Trees 15 – 30m Trees 5 – 15m Trees < 5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
Mallee Tree Form Mallee Shrub Form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
Shrubs > 2m Shrubs 1.5 – 2m Shrubs 1 – 1.5m Shrubs 0.5 – 1m Shrubs 0 – 0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
Mat Plants Hummock Grass Bunch grass >0.5m Bunch grass < 0.5m Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-dense Hummock Grass Tall Grass Low Gras Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs
Sedges > 0.5m Sedges < 0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
Ferns Mosses, liverworts	Dense ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses

Appendix D
Vegetation Condition Scale

Code	Description
Pristine	Pristine or nearly so. No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Appendix E
Vegetation Maps

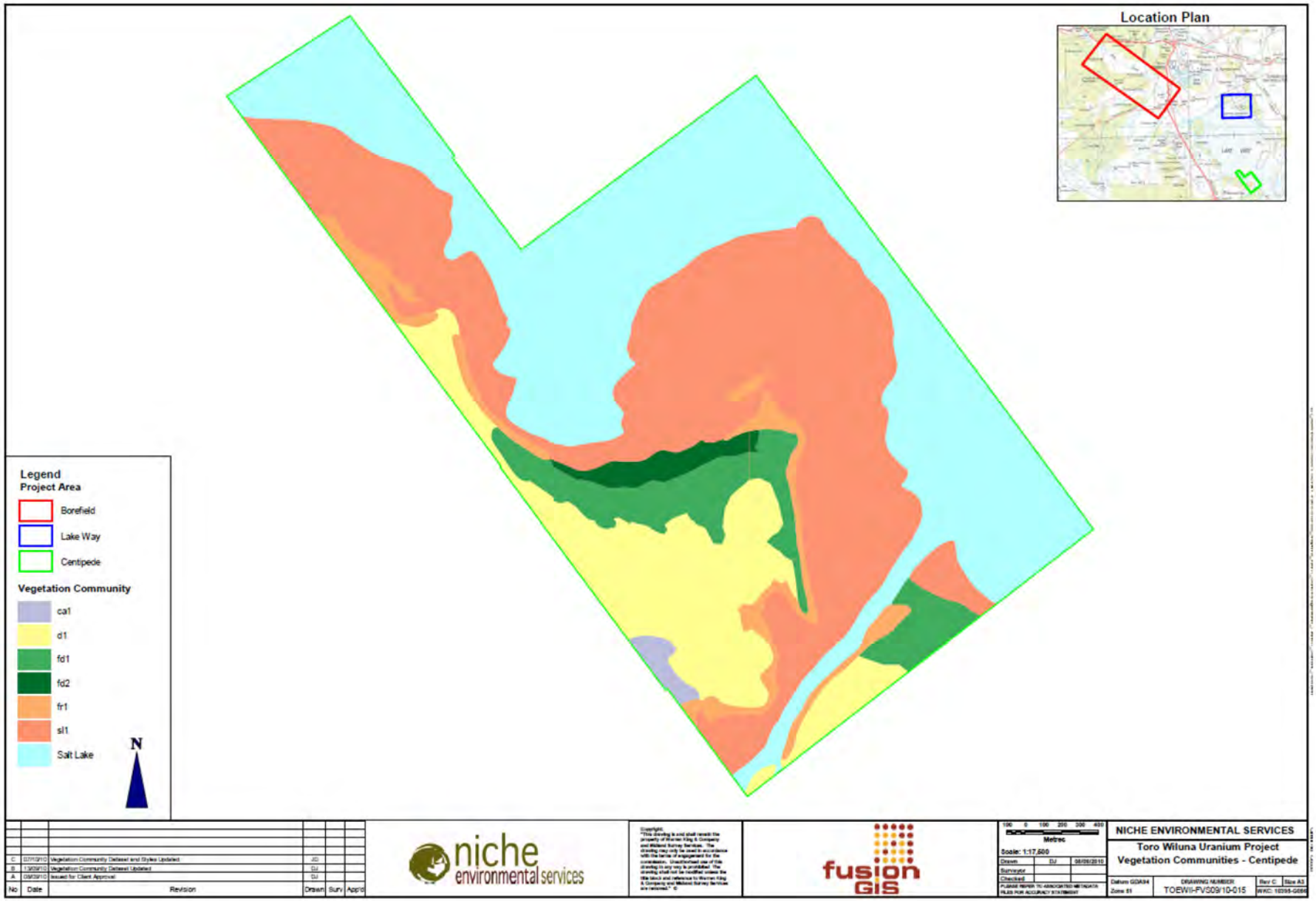


Figure 18 **Map of vegetation defined and delineated within the Centipede survey area, based on data collected in surveys conducted by Niche Environmental Services in 2010 (image used with permission of Warren King and Co.).**

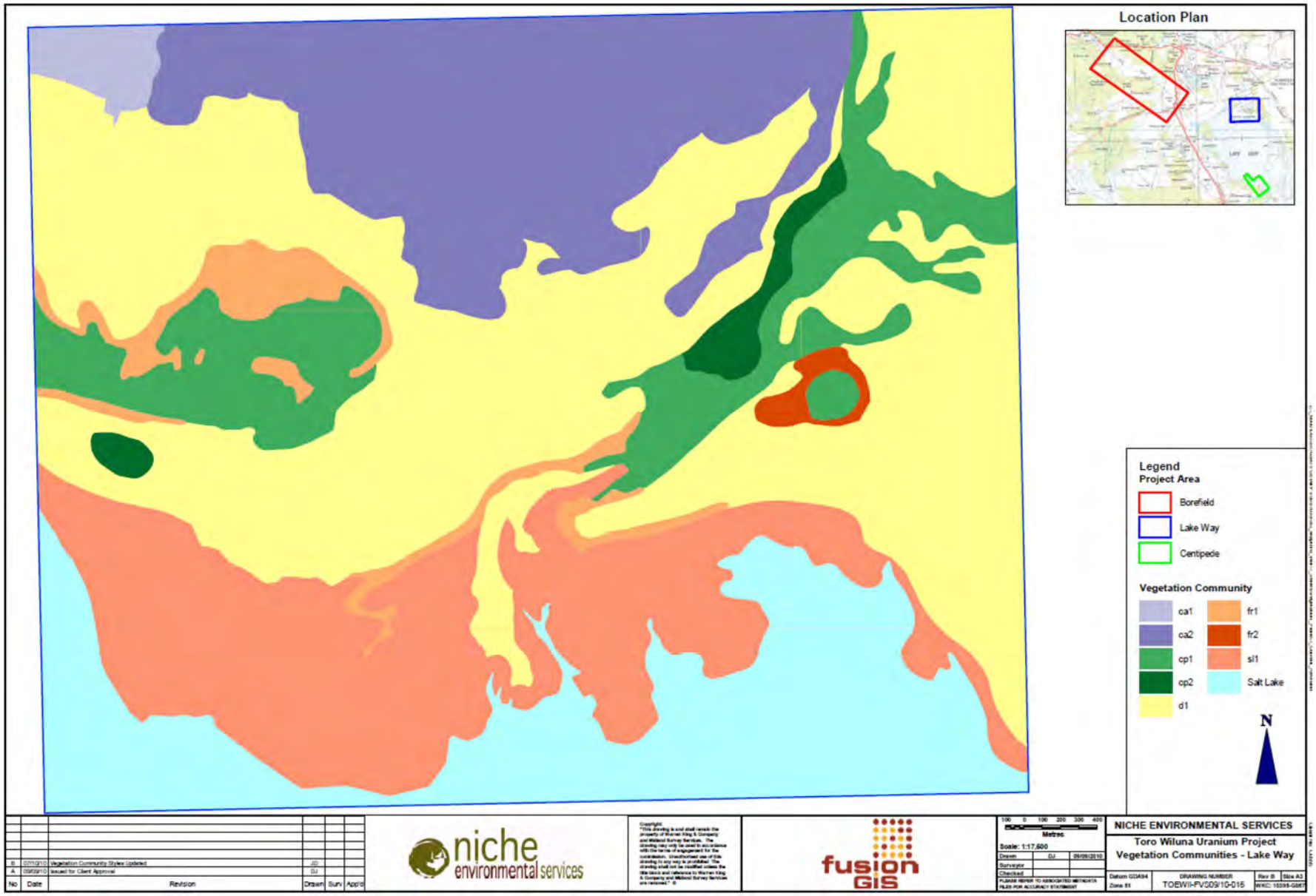


Figure 19 **Map of vegetation defined and delineated within the Lake Way survey area, based on data collected during surveys conducted by Niche Environmental Services in 2010 (image used with permission of Warren King and Co.).**

Appendix F
Vegetation Photographs

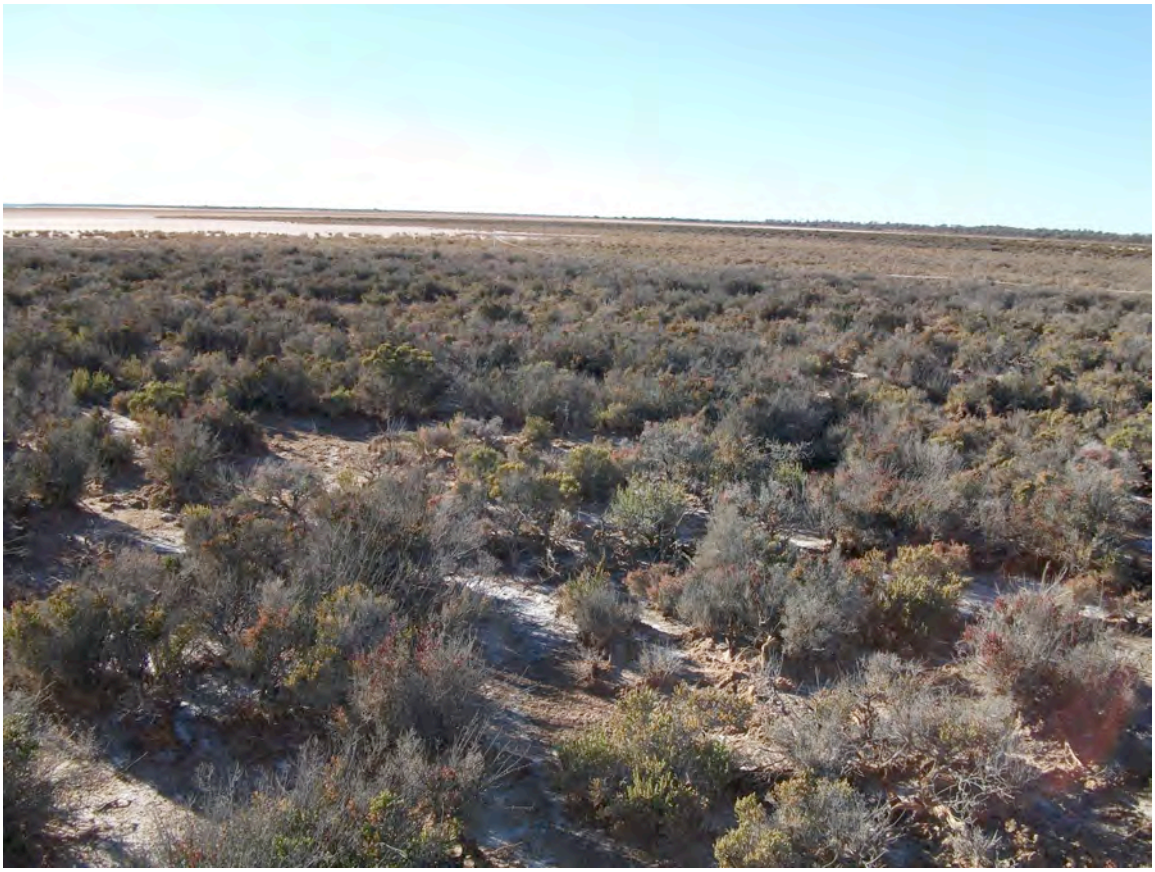


Plate 1 Image of sl1 (Centipede)

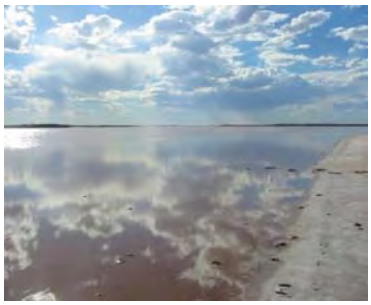
Plate 2 Image of sl1 (Lake Way)

Plate 3 Image of cp1 (Lake Way)

Appendix G

Species list

Species
Tecticornia calyptrata
Tecticornia cymbiformis
Tecticornia doleiformis
Tecticornia halocnemoides subsp*. catenulata*
Tecticornia indica subsp*. bidens*
Tecticornia indica subsp*. leiostachya*
Tecticornia laevigata
Tecticornia moniliformis
Tecticornia peltata
Tecticornia pruinosa
Tecticornia pterygosperma subsp*. denticulata*
Tecticornia sp. aff*. laevigata*
Tecticornia sp. aff*. pruinosa*
Tecticornia sp. aff*. undulata*
Tecticornia sp. Burnerbinmah (D. Edinger et al. 101)
Tecticornia sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)
Tecticornia sp*. halocnemoides* beaked seed aggregate
Tecticornia sp. Lake Way (P. Armstrong 05/961)
Tecticornia sp. nov.
Tecticornia tenuis
Tecticornia undulata



Mega Uranium Ltd

Lake Maitland: Baseline Vegetation and Flora Surveys – May and November 2007 and May 2009

FINAL REPORT

July 2009

Lake Maitland
A MEGA/JAURD/IMEA
Uranium Joint Venture

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Lake Maitland Baseline Vegetation and Flora Survey

Distribution:

Company	Copies	Contact Name
Mega Uranium Ltd	1	Mr David Button

Document Control for Job Number:

Author	Reviewer	Signature	Date of Issue
CK, KB	NIcola Burne	NB	12 June 2009
CK, KB	Julia Lawson	JL	30 July 2009
	David Jasper	DJ	30 July 2009

EXECUTIVE SUMMARY

Mega Uranium Ltd (Mega Uranium) is currently undertaking a Definitive Feasibility Study (DRF) for the development of the Lake Maitland uranium deposit in the Eastern Goldfields, Western Australia (WA). Mega Uranium currently holds four exploration leases (E53/947, E53/1060, E53/1099 and E53/1210) and eight prospecting leases (P53/1256, P53/1257, P53/1258, P53/1259, P53/1260, P53/1260, P53/1260, P53/1262 and P53/1263). There is a pending application for a mining lease (M53/1089) over the Lake Maitland Project area (Lake Maitland Project). The Lake Maitland Project mining lease will cover 7,327 hectares (ha), and is located near the northern portion of Lake Maitland, on the Barwidgee Pastoral Lease, approximately 95 kilometres (km) northeast of Leinster and 105 km southeast of Wiluna (**Figure 1**).

Mega Uranium commissioned Outback Ecology Services (Outback Ecology) to undertake baseline flora and vegetation surveys over the Lake Maitland Project (**Figure 2)**. Outback Ecology conducted flora and vegetation surveys during May 2007, November 2007 and May 2009. The flora and vegetation surveys were one component of a broader assessment undertaken concurrently by Outback Ecology. These included surveys for vertebrate fauna, short-range endemic invertebrate fauna, aquatic ecology, stygofauna and soils.

A total of 91 quadrats were assessed across the Lake Maitland Project. Vegetation was described using the Muir scale (Muir, 1977). Vegetation condition was assessed using the Keighery scale (Keighery, 1994). In addition, the potential mining footprint was searched for conservation significant species, in habitat likely to contain the conservation significant species identified from the database search.

A total of 244 taxa from 36 families and 78 genera were recorded across the Lake Maitland Project. The flora was dominated by the family Chenopodiaceae, with 48 taxa recorded. Other dominant families included Mimosaceae (28 taxa), Myoporaceae (27 taxa) and Poaceae (18 taxa).

No Declared Rare Flora (DRF) species have been positively identified as occurring in the Lake Maitland Project. One specimen collected during the November 2007 survey, which had insufficient characters to enable its positive identification, was initially identified as the DRF species *Eremophila rostrata.* A successive flora survey in May 2009 enabled this species to be identified as *Eremophila latrobei* subsp. *latrobei,* a non-conservation significant species, which flowers between winter and early summer.

One potential Priority 3 flora species, *Maireana prosthecochaeta,* was recorded at one location in the May 2009 survey; further survey work is required to positively identify the absence/presence of this species which flowers between July and August. Two weed species: *Portulaca oleracea* and *Tribulus terrestris,* were also recorded in the May 2009 survey, these two species are not listed as declared plants under the *Agriculture and Related Resources Protection Act, 1976*.

A total of 31 vegetation communities were described and mapped across the Lake Maitland Project. These were grouped into four vegetation associations: Salt Lake (playa) vegetation; Kopi Ridge vegetation; Calcrete vegetation and Plains vegetation. Three vegetation communities are described within the Salt Lake (playa) vegetation association; one within the Kopi Ridge vegetation; four within the Calcrete vegetation and 23 within the Plains vegetation.

The Plains vegetation association demonstrates a higher degree of variation with 23 different vegetation communities. However, it was also observed that the majority of the species recorded in the Plains were widespread throughout these communities. Five species recorded were noted to have restricted distributions: *Acacia aneura* var. cf. *major, A. brumalis, A. maxwellii, A. scleroclada* and *Sida kingii*. The regional and local distribution of these species within the Lake Maitland Project is discussed within the report.

A large percentage of the Lake Maitland Project hosts two mosaics and a successional vegetation unit (Fire Regeneration *Eucalyptus*), which is a consequence of sections of the Plains vegetation having been subjected to fire within the last five years. The distribution of six of the 23 Plains vegetation communities described was restricted to within the two Plains mosaic communities.

The Kopi Ridge Vegetation association was initially observed to be of limited extent within the Lake Maitland Project, a subsequent flora and vegetation survey undertaken in May 2009 established the presence of this association outside the Lake Maitland Project. No Priority Ecological Communities or Threatened Ecological Communities occur in the Lake Maitland Project. No vegetation communities deemed to be 'At Risk' by the Department of Environment and Conservation (DEC) occur in the Lake Maitland Project.

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Appendices

1.0 INTRODUCTION

1.1 Project Background and Location

Mega Uranium is currently undertaking a DFS for the development of the Lake Maitland uranium deposit in the Eastern Goldfields, WA. Mega Uranium currently holds four exploration leases (E53/947, E53/1060, E53/1099 and E53/1210) and eight prospecting leases (P53/1256, P53/1257, P53/1258, P53/1259, P53/1260, P53/1260, P53/1260, P53/1262 and P53/1263). Additionally, there is a pending application for a mining lease (M53/1089) over the Lake Maitland Project. The Lake Maitland Project is located near the northern portion of Lake Maitland, on the Barwidgee Pastoral lease, approximately 95 km northeast of Leinster and 105 km southeast of Wiluna (see **Figure 1**).

Mega Uranium commissioned Outback Ecology to undertake a baseline flora and vegetation survey over the Lake Maitland Project area (see **Figure 2**). Outback Ecology conducted flora and vegetation surveys during May 2007, November 2007 and May 2009. The flora and vegetation surveys were one component of a broader assessment undertaken concurrently by Outback Ecology. These included surveys for vertebrate fauna, short-range endemic invertebrate fauna, aquatic ecology, stygofauna and soils.

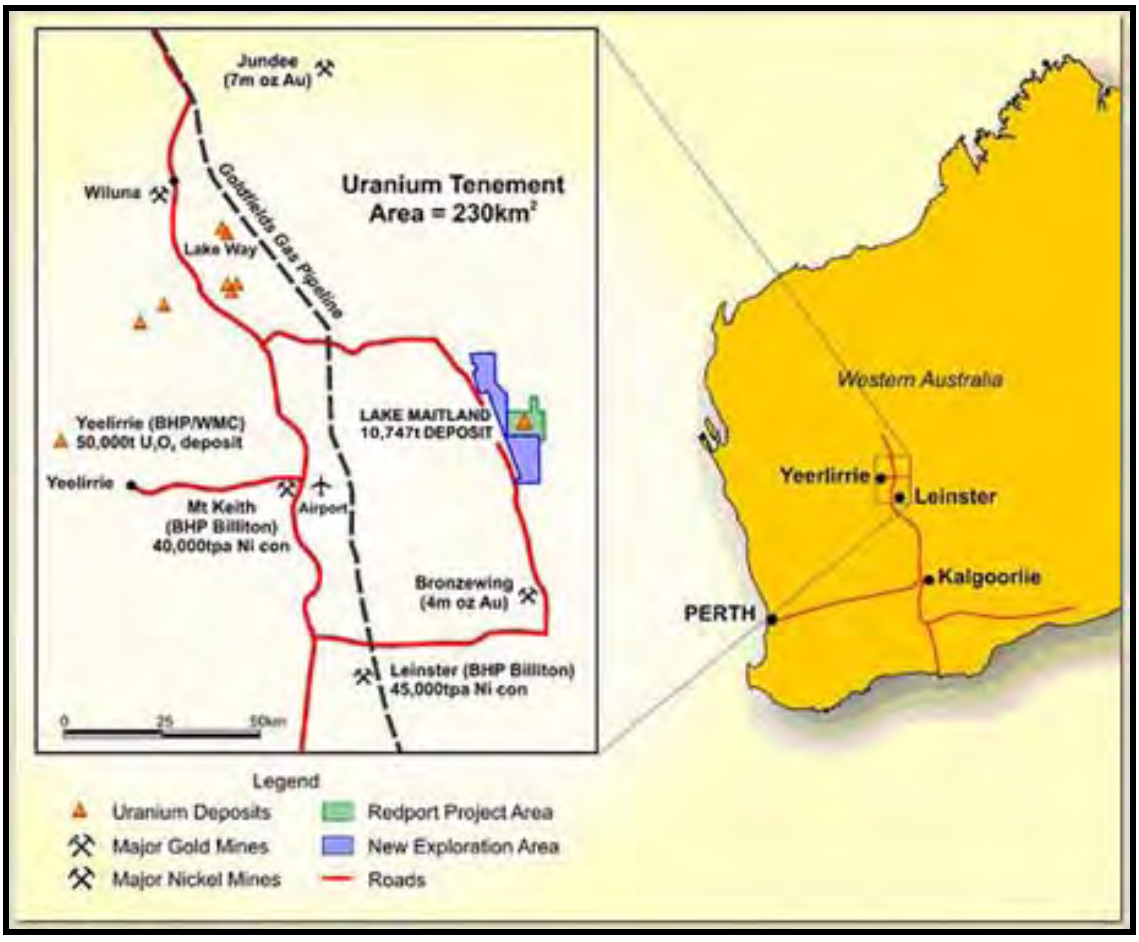

Figure 1 Location of the Lake Maitland Project Area (Mega Uranium, 2007)

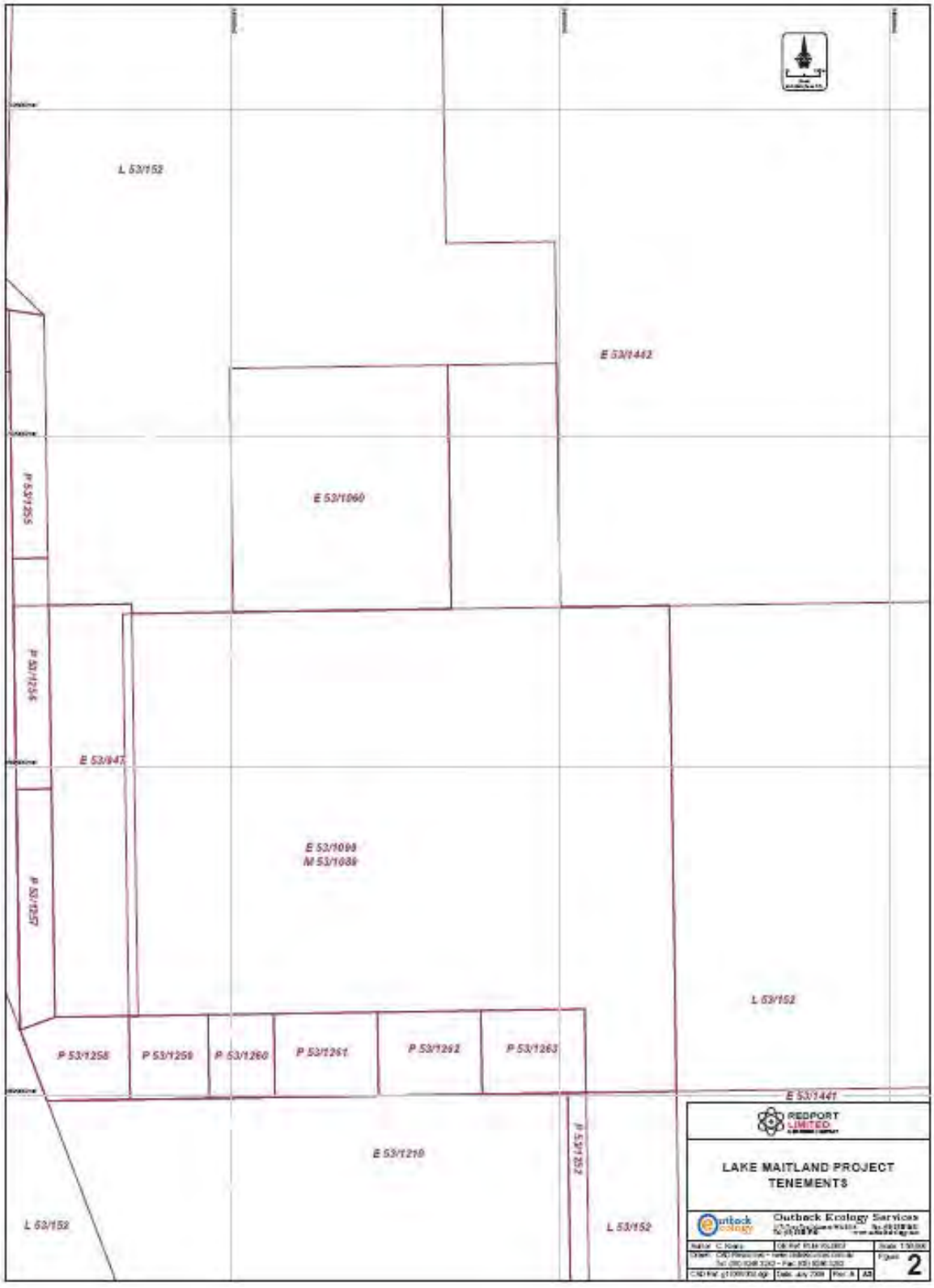

Figure 2 **Map of the Lake Maitland Project Area showing the tenements (blue) surveyed by Outback Ecology in 2007 and 2009**

1.2 Scope and Objectives of the Study

This report documents the results of a Level 2 flora and vegetation survey of the Lake Maitland Project conducted during May and November 2007 and May 2009.

The flora and vegetation surveys were conducted in accordance with the Western Australian Environmental Protection Authority's (EPA): Position Statement No. 3 '*Terrestrial Biological Surveys as an Element of Biodiversity Protection'* (EPA, 2002) and Guidance Statement No. 51 '*Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia'* (EPA, 2004).

The overall objectives of the flora and vegetation surveys were to:

i. Undertake a review of conservation significant flora species (Priority Flora and DRF), Priority Ecological Communities (PEC) and Threatened Ecological Communities (TEC) located, or likely to occur within the Lake Maitland Project.
ii. Develop an inventory of conservation significant flora (including data collated from detailed quadrat-based field surveys).
iii. Define, describe and map vegetation associations across the Lake Maitland Project.
iv. Provide an initial assessment of the regional and local conservation value of the flora and vegetation.
v. Provide quantitative data to establish a baseline against which future impacts and rehabilitation can be assessed. This formed the basis of the May 2009, re-monitoring survey.

The flora and vegetation assessment involved:

- Desktop review of:
  - flora and vegetation of conservation significance potentially present in the Lake Maitland Project
  - previous flora studies conducted in the Lake Maitland Project and surrounding areas.

- Flora and vegetation community surveys:
  - mapping of all vegetation communities within the Lake Maitland Project
  - census of all flora species found within the Lake Maitland Project
  - targeted search for conservation significant flora species and vegetation communities likely to occur within the Lake Maitland Project.

2.0 EXISTING ENVIRONMENT

2.1 Biogeographic Region

The Lake Maitland Project is located within the Murchison biogeographic region (bioregion) of the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995). The Murchison bioregion comprises the northern part of the Yilgarn Craton and includes two subregions: the Eastern Murchison (MUR1) and the Western Murchison (MUR2).

The Lake Maitland Project lies within the Eastern Murchison (MUR1) subregion, which is characterised by internal drainage, areas of red sandplains, salt lake systems associated with an occluded palaeodrainage system, broad plains of red-brown soils, and breakaway complexes (Cowan, 2001). The total area of the Eastern Murchison subregion is 7,847,996 ha, and comprises the "Southern Cross" and "Eastern Goldfields" terrains of the Yilgarn Craton (Cowan, 2001; National Land and Water Resources Audit (NLWRA), 2002).

2.2 Climate

The Murchison bioregion is characterised by an arid climate, with an average annual rainfall in the range of 200 millimetres (mm) (Beard, 1990; Gilligan, 1994). The area has a bimodal rainfall distribution, with both summer and winter rain (Beard, 1990; Gilligan, 1994). Rainfall within the region is unreliable, with zero rainfall potentially recordable in any month (Gilligan, 1994).

Summer weather in the bioregion is influenced by anticyclonic systems to the southeast, which result in a pattern of clear skies and easterly winds (Gilligan, 1994). The bioregion borders the southern end of the Intertropic Convergence Zone and as a consequence, thunderstorm activity and summer rainfall is generated (Gilligan, 1994). While summer rainfall is a feature of the bioregion, most years have a dry spell lasting four to six months, typically commencing around October (Gilligan, 1994).

Winter weather patterns are directly influenced by the anticyclonic system which results in the generation of westerly winds and rain-bearing frontal systems (Gilligan, 1994). Winter rains are usually heaviest around late May into August and subside during the months of September and October as the anticyclonic conditions stabilise (Gilligan, 1994).

The nearest Bureau of Meteorology (BOM) weather stations to the Lake Maitland Project are: Yeelirrie and Leinster. The Yeelirrie weather station is located approximately 98 km west of the Lake Maitland Project. Rainfall data has been collected at Yeelirrie since 1928, with temperature data collected since 1973; data has been collected at Leinster since 1985. Data from the Yeelirrie weather station was used to represent long-term regional climate patterns for the Lake Maitland

Project. Significant variation in rainfall is noted across the area, and as such, the data provided should be used as a guide only.

The monthly mean maximum temperature at Yeelirrie ranges from a high of 37.7 degrees centigrade (°C) during January to a low of 19.2°C in July (**Figure 3**). The highest temperature at Yeelirrie was 46°C, recorded in February 1991, whilst the lowest was -5.1°C, recorded in July 2000 (BOM, 2008).

The mean monthly rainfall at Yeelirrie ranges from a high of 32.1 mm in March to a low of 4.3 mm in September (see **Figure 3**). The mean annual rainfall for Yeelirrie is 239 mm (BOM, 2008). Zero rainfall has historically been recorded during each month of the year, whilst peak falls as high as 211 mm (April, 1992) have been recorded within a month (BOM, 2008). The annual rainfall recorded has ranged from a low of 43 mm in 1950 to a peak of 507 mm in 1975 (BOM, 2008).

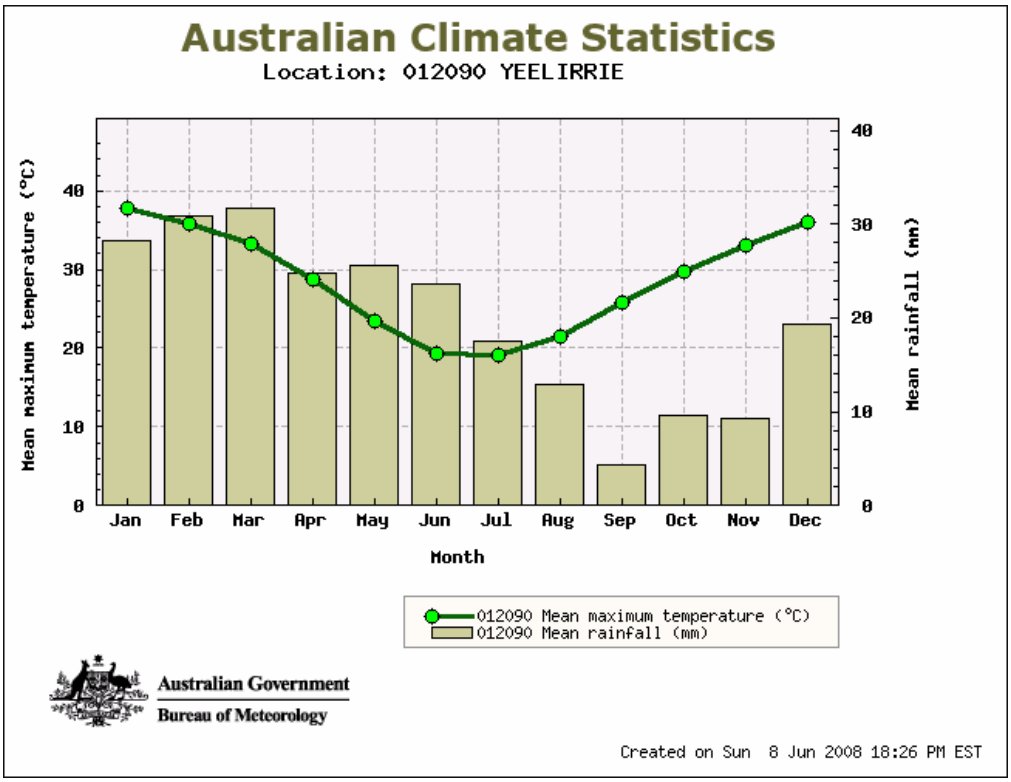

Figure 3 Mean maximum temperatures and mean rainfall for Yeelirrie station (BOM, 2008)

2.3 Flora and Vegetation

Vegetation of the East Murchison subregion is dominated by Mulga Woodlands that are frequently rich in ephemerals, hummock grasslands, saltbush shrublands and *Tecticornia* (formerly *Halosarcia*) shrublands (Cowan, 2001). Cowan described 26 vegetation types which have at least 85% of their total extent confined to the East Murchison subregion (Cowan, 2001), these are listed in **Appendix A.**

There are no TECs within the Eastern Murchison subregion; however, there are 12 threatened ecosystems, which have a number of degradation pressures, these include grazing pressure, feral animals and rising salinity. The threatened ecosystems and their degradation pressures, condition and status are listed in **Appendix B.**

2.4 Soils, Landforms and Land Systems

Soils of the Murchison bioregion consist of red loamy earths; red sandy earths; red shallow loams; red deep sands; red-brown hardpans; shallow loams with some red shallow sands and red shallow sandy duplexes (Tille, 2006). Landforms of the Murchison bioregion comprise hardpans, wash plains and sandplains, with some stony plains, hills, mesas and salt lakes on the granitic rocks and greenstone of the Yilgarn Craton (Tille, 2006).

The Lake Maitland Project is located over seven Land Systems: Ararak, Bullimore, Challenge, Darlot, Desdemona, Melaleuca and Mileura (**Table 1**), however, the Bullimore and Darlot Land Systems dominate the Lake Maitland Project area (Pringle *et al.*, 1994). The Darlot Land System is represented by the Lake Maitland playa and fringing saline alluvial plains, while the Bullimore Land Systems is represented by extensive spinifex sandplains to the east of the lake.

Table 1 Summary of Land Systems over the Project Area (Pringle *et al.,* 1994)

Land System	Description	Total size and % of north eastern Goldfields	Predominant location within the Project Area
Ararak	Broad plains with mantles of ironstone gravel supporting Mulga shrublands with wanderrie grasses	2,021 km² 2.0%	Scattered, with a minor occurrence in the extreme north of the Lake Maitland Project.
Bullimore	Extensive sandplains supporting spinifex hummock grasslands	24,013 km² 24%	Extensive representation over the Lake Maitland Project, particularly to the east of Lake Maitland.
Challenge	Gently undulating plains, occasional granite hills and low breakaways, with *Acacia* shrubland	554 km² 0.6%	Isolated occurrence in the extreme east of the Lake Maitland Project.
Darlot	Salt lakes and fringing saline alluvial plains, with extensive, regularly arranged, sandy banks and numerous claypans and swamps supporting halophytic shrublands and spinifex and wanderrie grasslands	1,344 km² 1.3%	Extensive representation across the Lake Maitland Project.
Desdemona	Extensive plains with deep sandy or loamy soils, supporting Mulga and wanderrie grasses	2,524 km² 2.5%	North-west corner of the Lake Maitland Project, abutting Bullimore Land System

Land System	Description	Total size and % of north eastern Goldfields	Predominant location within the Project Area
Melaleuca	Sandy-surfaced plains and calcareous plains, supporting spinifex or Mulga wanderrie shrublands	267 km² 0.3%	Scattered on edges of the Lake Maitland Project, often intersecting or abutting Darlot Land System
Mileura	Calcrete platforms and saline alluvial plains, supporting halophytic shrublands	550 km² 0.6%	Northern section of the Lake Maitland Project, intersecting or abutting Darlot Land System

2.5 Land Use

The dominant land use within the Eastern Murchison subregion is native pasture grazing (85.5%); this includes mining leases, which require land to be stocked under the *Pastoral Lands Act 1992*. Nickel and gold mining are the main types of mining within the subregion. Other dominant land uses are Unallocated Crown Land (UCL) and Crown Reserves (11.3%), and conservation (1.4%) (Cowan, 2001).

2.6 Conservation Areas in the Region

The Lake Maitland Project is located approximately 55 km east of the Wanjarri Nature Reserve. This reserve is a de-stocked pastoral lease covering 53,000 ha, which is now classified as an A Class Reserve that is managed for its conservation, scientific and anthropological values (Conservation and Land Management (CALM), 1996) (CALM is now recognised as the DEC).

3.0 SURVEY AND ASSESSMENT METHODS

3.1 Environmental Protection Authority Survey Guidelines

The methods adopted for the survey were designed and conducted in accordance with the EPA's Position Statement No. 3 '*Terrestrial Biological Surveys as an Element of Biodiversity Protection'* (EPA, 2002) and Guidance Statement No. 51 '*Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia'* (EPA, 2004).

The purpose of Position Statement No 3 (EPA, 2004) is to provide an overarching guide to the principles employed by the EPA when assessing the potential environmental impacts of an activity. Guideance Statement No 51 (EPA 2002) outlines the expected standards and protocols to enable consultants to meet EPA expectations for biological surveys. Within Position Statement No 51, two levels of biological survey are detailed, the requirements of the two survey levels are summarised below:

Level 1 Survey

- Desktop review – incorporating a literature review, database searches and review of maps of proposed area of disturbance
- Reconnaissance survey – a site visit by suitably qualified personnel to:
    - verify the desktop review
    - catalogue flora, with a focus on the potential sensitivity of flora to disturbance
    - undertake broad-scale vegetation community and condition mapping based on selected sites.

Level 2 Survey

- Desktop review
- Reconnaissance survey
- Comprehensive flora survey of the project area - key features of the survey are:
    - quadrat-based survey
    - application of statistical analyses to data
    - multi-seasonal surveys, with a minimum of one survey conducted in the season following the majority of rainfall for the region.

The EPA Guidance Statement No 51 (EPA, 2004) provides proponents with a guide to the instances within which the different levels of survey would be considered appropriate. The relative suitability of the two levels of surveys is a product of the location (bioregion) of the project and the proposed scale and nature of the impact. Where the scale and nature of impact is low, a Level 1 survey is considered adequate (EPA, 2002). Where the scale and nature of the impact is moderate to high, a Level 2 survey is required (EPA, 2002). In consideration of the scale and nature of the proposed activities within the Lake Maitland Project area, a Level 2 survey was deemed to be the appropriate level of survey.

In accordance with the Level 2 survey requirements, the initial survey of the Lake Maitland Project was conducted during May 2007, following the peak rainfall period; a subsequent survey was undertaken in November 2007, following a secondary rainfall period. A survey to ascertain the extent of the Kopi Ridge Vegetation association was undertaken in May 2009.

3.2 Desktop Review

A review of databases and publicly available information was conducted prior to the field survey, for flora species and vegetation communities of conservation significance known to, or likely to occur within the Lake Maitland Project area. A search of the databases was undertaken for an area of approximately 100 km^2 surrounding the Lake Maitland Project, using the following boundary co-ordinates:

- NW corner – S26° 15', E120° 00'
- SE corner – S28° 03', E122° 04'.

Databases and public information sources searched included the:

- Protected Matters database for flora of conservation significance and TECs listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (*EPBC Act*) (Department of Environment Water Heritage and Arts (DEWHA), 2008);
- Threatened (Declared Rare) Flora database, TEC database and the DRF and Priority Flora List sourced from the WA DEC (DEC, 2007);
- Western Australian Herbarium (WAH) database for rare and priority flora (WAH, 2008);

Previous studies which have been conducted in and around the Lake Maitland Project were reviewed; however, only a limited amount of information for the area is publicly available. The following reports were reviewed prior to the field survey:

- Cowan (2001), DEC Biodiversity audit report for the Murchison 1 Bioregion
- Pringle, H.J.R, Van Vreeswyk, A.M.E. and Gilligan, S.A. (1994), *An inventory and condition survey of the north-eastern Goldfields, Western Australia*.

***Environmental Protection and Biodiversity Conservation Act 1999* Protected Matters Database**

The *EPBC Act* is a Commonwealth Act with a focus on matters of National Environmental Significance (DEWHA, 2008). The *EPBC Act* serves to provide a means to manage threats to the natural environment by:

- providing for the protection of biodiversity conservation through the identification of threatening processes, protecting critical habitat, preparation of management plans and issuing conservation orders
- providing for compliance and enforcement through a range of actions, including court injunctions and environmental auditing
- providing for an additional level of approval for activities likely to impact on aspects of the natural environment protected under the *EPBC Act*.

A search of the *EPBC Act Protected Matters* database was also undertaken to determine whether potential habitat likely to support any TECs or protected flora listed under Schedule 2 of the *EPBC Act,* may occur within the Lake Maitland Project.

Approval from the Minister for the Environment, Water, Heritage and the Arts must be sought to undertake any action that is likely to have a significant impact on TECs and protected flora species listed under the *EPBC Act.* There are three categories of TECs under the *EPBC Act,* namely, 'Critically Endangered', 'Endangered' and 'Vulnerable'.

DEC Database – Conservation Significant Flora and Vegetation Communities

Rare flora is gazetted under subsection 2 of section 23F of the Western Australian *Wildlife Conservation Act 1950*. Species which may be rare, but about which insufficient data has been collected to determine abundance, may be placed on the priority flora list. The priority flora list does

not have the same legal status as the DRF schedule, however, priority flora are considered under the *Environmental Protection Act 1986,* as enforced by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, when determining the biodiversity value of an area (Department of Industry and Resources (DoIR), 2006). Definitions of declared rare and priority flora species (i.e., Priority 1 to Priority 4) are provided in **Appendix C**.

In Western Australia, the DEC recognizes four categories of TECs, as developed by English and Blyth (1997). These are 'Presumed Totally Destroyed', 'Critically Endangered', 'Endangered' and 'Vulnerable' (**Appendix D**).

Other ecological communities that are considered to possibly be under threat, but do not meet the survey criteria associated with TEC, are listed under the DEC's PEC List as Priorities 1, 2 and 3. Those ecological communities which are considered to be adequately known and are rare but not threatened, or that have been recently removed from the threatened list, are classified as Priority 4 and require regular monitoring. Conservation dependent ecological communities are classified as Priority 5 (Naturebase, 2007).

In addition to TECs and PECs, ecosystems are also described as being 'at risk' or 'threatened'. The status of 'at risk' is recognised by the DEC and the DEWHA. Whilst not conferring any form of legislative protection, the application of the 'at risk' status is a useful tool that highlights ecosystems that may be subject to threatening processes and, as such, could potentially become a TEC in the future. The potential presence of 'at risk' ecosystems within the Lake Maitland Project area was determined by reviewing listings in the DEC biodiversity audit report for the Murchison 1 Bioregion (Cowan, 2001). Cowan noted that the Calcrete Platform communities may potentially be deemed 'at risk' in other areas of the Goldfields (Cowan, 2001).

3.3 Flora and Vegetation Field Survey

The methods adopted for this survey were formulated as far as practicable in context with the EPA's Position Statement No. 2 '*Environmental Protection of Native Vegetation in Western Australia'* (EPA, 2000), Position Statement No. 3 '*Terrestrial Biological Surveys as an Element of Biodiversity Protection'* (EPA, 2002) and Guidance Statement No. 51 '*Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia'* (EPA, 2004).

The flora and vegetation assessment consisted of:

- a Level 2 quadrat-based survey
- targeted search for conservation significant species within the proposed mining footprint
- survey of regionally significant vegetation.

3.3.1 Timing of Surveys

The two peak flowering periods for the Murchison bioregion are: in spring following the heavier winter rains; and in autumn following the lighter and less reliable summer rain. Surveys conducted

during the peak flowering periods enables greater accuracy in taxonomic identification. Most species will flower in one of the two peak flowering periods, hence an initial survey was undertaken in May (autumn) 2007 and follow-up surveys were undertaken in November (spring) 2007 and in May (autumn) 2009.

May 2007 survey

The first May survey was undertaken between 7 and 13 May 2007. Rainfall in the month immediately preceding this survey (April) was above average (**Figure 4**) with 40.2 mm recorded; however, below average rainfall was recorded for February and March for Yeelirrie for the same year.

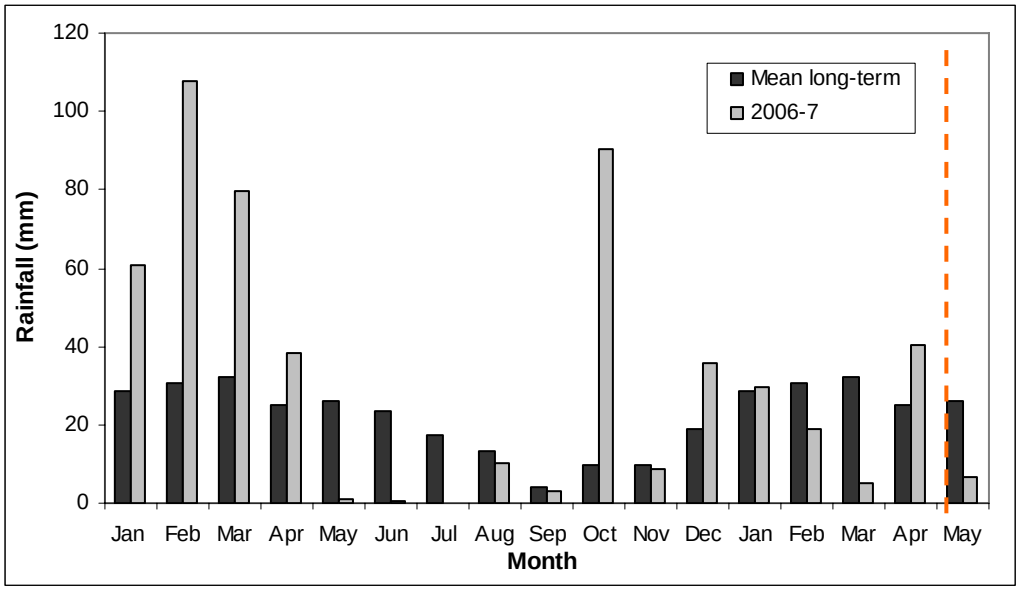

Figure 4 **Monthly rainfall received at Yeelirrie from January 2006 to May 2007 in comparison to the long-term mean monthly rainfall.**

The red line depicted in Figure 4 indicates the timing of the initial survey conducted in May 2007.

Survey personnel

Personnel involved in the May 2007 flora and vegetation survey were:

Mr Brett Neasham	BSc (Biol) Hons (Env Man)	Botanist/Environmental Scientist
Ms Belinda Jeanes	BSc Env Biol	Botanist/Environmental Scientist
Mr Jarrad Donald	BSc (Env Mgmt)	Environmental Scientist

Specimen identifications:

Ms Belinda Newman	BSc Env Sc	Botanist/Environmental Scientist
Mr Brett Neasham	BSc (Biol) Hons (Env Man)	Botanist/Environmental Scientist
Ms Belinda Jeanes	BSc (Env Biol)	Botanist/Environmental Scientist

Specialist identifications:

Mrs Bindy Datson (Actis Environmental Services (AES)), a botanist specialising in salt lake ecology.

November 2007 survey

A follow-up survey was undertaken between 1 and 3 November 2007. Rainfall in the three months immediately preceding this survey was below the long-term average for Yeelirrie (**Figure 5**) with just over 3 mm recorded.

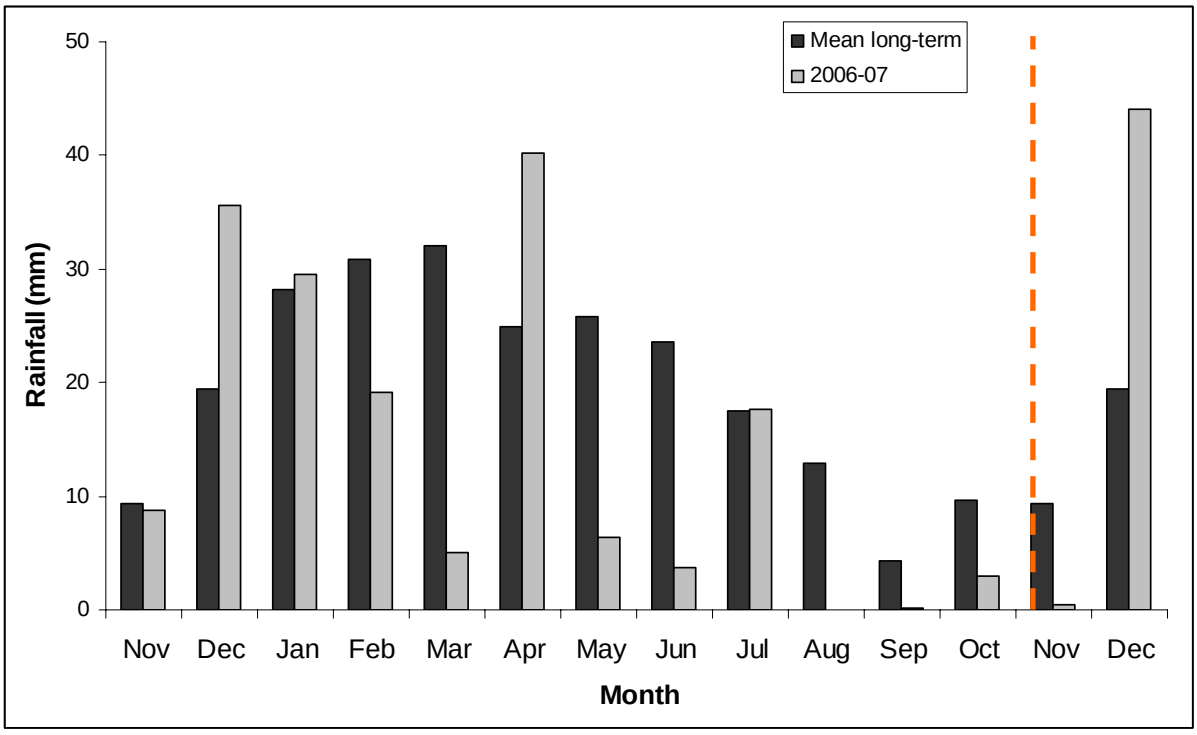

Figure 5 **Monthly rainfall received at Yeelirrie from November 2006 – December 2007 in comparison to the long-term mean monthly rainfall.**

The red line depicted in Figure 5 indicates the timing of the survey conducted in November 2007.

Survey personnel

Personnel involved in the November 2007 flora and vegetation survey were:

Mr Brett Neasham	BSc (Biol) Hons (Env Man)	Botanist/Environmental Scientist
Ms Belinda Jeanes	BSc (Env Biol)	Botanist/Environmental Scientist

Specimen identifications:

Mr Brett Neasham	BSc (Biol) Hons (Env Man)	Botanist/Environmental Scientist
Dr Aleida Williams	BSc (Hons) PhD	Botanist

Specialist identifications:

Mrs Bindy Datson (AES), a botanist specialising in salt lake ecology.

May 2009 survey

A second, follow-up survey was undertaken between 4 and 16 May 2009. Rainfall in the months preceding this survey (January to April 2009) were below the long-term average for Yeelirrie (**Figure 6**); however, the November and December 2008 rainfall was above the long-term rainfall average.

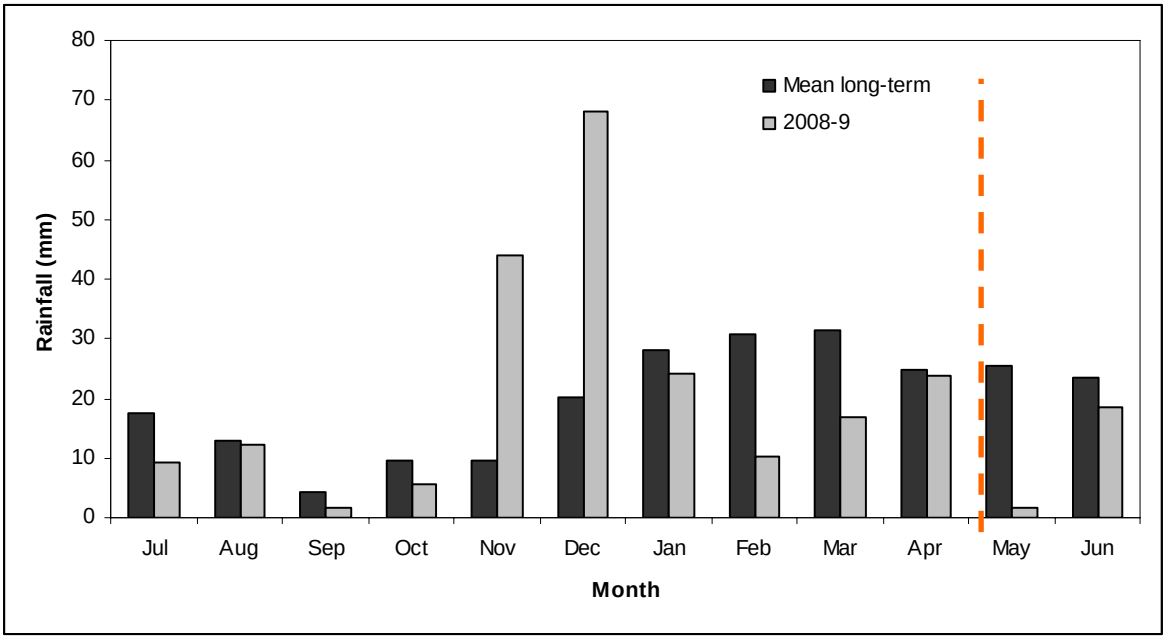

Figure 6 **Monthly rainfall received at Yeelirrie from July 2008 – June 2009 in comparison to the long-term mean monthly rainfall.**

The red line depicted in Figure 6 indicates the timing of the survey conducted in May 2009.

Survey personnel

Personnel involved in the May 2009 flora and vegetation survey were:

Mr Martin Henson	BEnvSc (Hons)	Botanist/Environmental Scientist
Ms Catherine Krens	BSc (Env Sc)	Botanist/Environmental Scientist
Ms Melissa Bolton	BSc (Env Biol)	Project Environmental Officer

Specimen identifications:

Ms Catherine Krens	BSc (Env Sc)	Botanist/Environmental Scientist
Mr Frank Obbens	BSc (Bot)	Botanist
Mr David Leach	BAppSc (Hons)	Environmental Scientist
Mr Chad Hughes	BSc (Env Sc) Hons (Bot)	Botanist/Environmental Scientist
Ms Lucinda Ransom	BEnvSc (Hons)	Environmental Scientist/Botantist

3.3.2 Level 2 Survey

A total of 91, permanent, 30 m x 30 m quadrats were established throughout the Lake Maitland Project during the 2007 and 2009 surveys. Fifty two quadrats (LM01 to LM52) were established in May 2007, 28 quadrats (LM53 to LM81, excluding LM74) were established in November 2007, and 11 quadrats (LM82 to LM92) were established in May 2009. The 31 vegetation communities mapped within the Lake Maitland Project, and the location of the flora survey quadrats are depicted in **Figure 7**.

The position of the quadrat locations were chosen to represent the various geographical, geomorphologic and floristic variations identified from aerial photographs and determined from on-ground observations within the E53/947, E53/1060, E53/1099 and E53/1210 tenements (**Figure 7**). Opportunistic sampling was also undertaken, with areas surrounding quadrats, and between plots for additional species. For each quadrat the following information was recorded:

- GPS Location (recorded in WGS84)
- a photograph of the vegetation
- vegetation condition, based on the Keighery scale (Keighery, 1994) (**Appendix E**)
- classification of vegetation structural formation and height classes (**Appendix F**)
- vegetation description (often deferred until after specimens were identified post-survey)
- species present with estimated height and percentage foliage cover
- topographic position
- slope and aspect
- soil type
- presence of outcropping and exposed rock type
- bare ground and litter percentages
- estimated time since fire
- disturbance level and description.

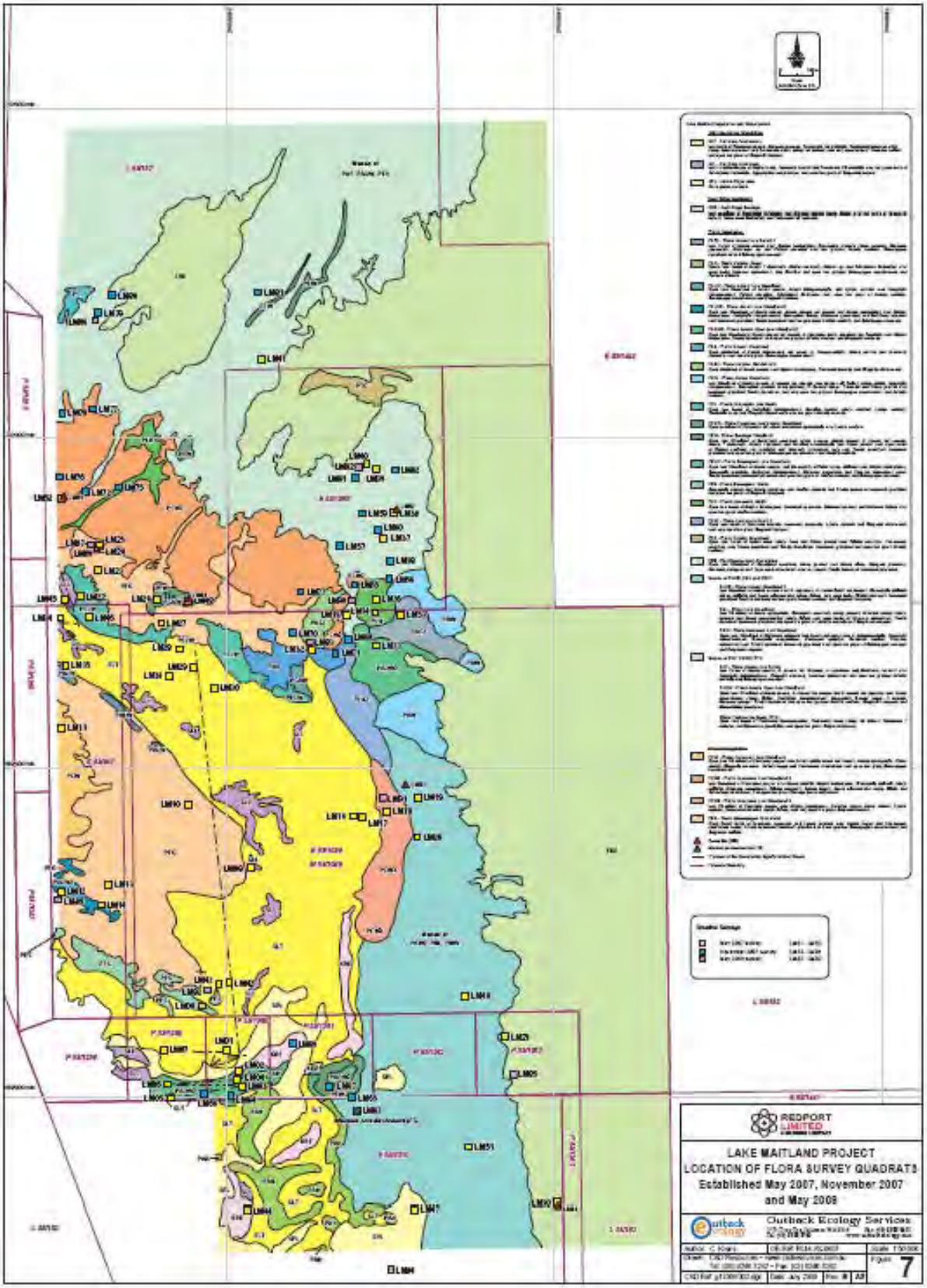

Figure 7 Location of each quadrat within the project area.

A sample of all the plant species within each quadrat was collected for later identification. Specimens collected were identified / verified with reference to taxonomic guides and WAH samples. Where specimens could not be identified by botanists from Outback Ecology, a specialist botanist was consulted. A complete list of species identified during the surveys is presented in **Appendix G**. Nomenclature follows Paczkowska and Chapman (2000) except for name changes, which were sourced from the WAH (WAH, 2008).

Vegetation condition was defined using the Keighery Scale (Keighery, 1994) (**Appendix E)**. Signs of disturbance were noted from within the quadrat and the surrounding area.

3.3.3 Targeted Conservation Significant Flora Search

Habitats that had the potential to contain species of conservation significance were searched. This involved walking transects of approximately 150 metres in length at 20 metre intervals (see **Figure 7**). Additional opportunistic searching was also carried out on transit to quadrats located within the proposed mining footprint.

Reference photographs and drawings were used to identify any potential conservation significant species. Where conservation significant species were found, a sample was collected, and their GPS location and approximate number of individual plants was recorded. Samples were lodged with the WAH for identification confirmation.

The following conservation significant flora (DRF and Priority flora) was specifically targeted within the proposed mine footprint in the May 2009 survey:

- *Acacia balsamea* (P4)
- *Apatophyllum macgillivrayi* (P1)
- *Baeckea* sp. Melita Station (P3)
- *Baeckea* sp. Sandstone (P1)
- *Calytrix erosipetala* (P3)
- *Calytrix uncinata* (P3)
- *Eremophila congesta* (P1)
- *Eremophila flaccida* subsp. *attenuata* (P1)
- *Eremophila gracillima* (P3)
- *Eremophila pungens* (P4)
- *Eremophila rostrata* (DRF)
- *Euryomyrtus inflate* (P1)
- *Grevillea inconspicua* (P4)
- *Gunniopsis propinqua* (P3)
- *Hemigenia exilis* (P4)
- *Micromyrtus chrysodema* (P1)
- *Mimulus repens* (P3)

- *Olearia mucronata* (P3)
- *Ptilotus astrolasius* var. *luteolus* (P1)
- *Stackhousia clementii* (P3)
- *Stenanthemum mediale* (P1)
- *Tecticornia cymbiformis* (P3)
- *Thryptomene* sp. Leinster (P1).

Eremophila rostrata (DRF) was specifically targeted in the May 2009 survey, as one specimen collected in the November 2007 survey was tentatively identified as this species. It was acknowledged at that time that the specimen could not be positively identified due to the absence of any fruiting bodies or flowers, and that a subsequent survey would be required to confirm the status and extent of this species.

3.3.4 Regionally Significant Vegetation Survey

The regional extent of the Kopi Ridge vegetation association was identified in the 2007 surveys as requiring further investigation. The association was considered to be locally restricted, as populations were recorded as occurring in pockets on rises, fringing salt lakes. Investigation of its extent outside the Lake Maitland Project was required to determine whether the proposed mining footprint would impact on the population.

Further confidence of the distribution of the Kopi Ridge communities was provided by extrapolation on aerial photography, these communities were ground-truthed to confirm their presence. Beyond the Lake Maitland Project boundary a quadrat was also established (LM84) to confirm the description of the Kopi Ridge community. It was determined that these communities occur in small pockets fringing the Lake Maitland playas up to 20 kilometres southeast from the Lake Maitland Project boundary. Their extent within the Lake Maitland Project is small compared to their distribution throughout the greater Lake Maitland area and is limited to the south-eastern boundary, outside of the proposed mining footprint.

Five Plains vegetation species recorded in the 2007 surveys were noted to have restricted distributions, with the potential to be considered locally significant, however, a number of collections at the time of those surveys had insufficient characters to provide positive identification. These sites were re-visited and specimens were recollected with flowering material.

Acacia aneura var. cf. *major* was recorded in quadrats LM90 (Plains Mosaic of PAF, PAF2, PALW, PALW2, PAOW, PAW2, PEW, PMW, PTH) and LM77 (Plains *Casuarina* Low Woodland 2 (PCW2)). Quadrat LM77 was located on the border of PCW2 and the Plains Mosaic communities. Limited information is known about this species, as very few specimens have been collected or locations recorded. Two populations have previously been recorded in the Gascoyne and Pilbara bioregions – one along a track and the second from the bank of a seasonal stream. These observations will

need to be verified to determine if a new population of *Acacia aneura* var. cf. *major* was recorded within the Lake Maitland Project.

Acacia brumalis was recorded in quadrats LM64 and LM66 – both these quadrats are found within the Plains *Acacia* Open Low Woodland 2 (PAOW2) community. The PAOW2 community is located in: E53/1099 and P53/1259; P53/1260 and P53/1261. This species is known to occur on plains, slopes, creeklines, flats, low-lying areas and laterite breakaways.

A potentially new population of *Acacia brumailis* was recorded within the Lake Maitland Project. Populations of *A. brumalis* have been recorded within the Southwest Botanical Province, extending across several IBRA bioregions; namely, The Swan Coastal Plain, the Geraldton Sandplains and Avon Wheatbelt. The nearest recorded location occurs on the eastern boundary of the Avon Wheatbelt. This potentially is the first recording of this species within the Eremaean Botanical Province.

Acacia maxwellii was recorded in quadrat LM66 (PAOW2). This species is known to occur on undulating plains, flats and along watercourses. A potentially new population of *Acacia maxwellii (*formerly *Acacia ramosissima)* was recorded within the Lake Maitland Project. Populations of *A. maxwellii* have been restricted to coastal areas of the Southwest Botanical Province, within the Mallee, Esperance Plains and Jarrah Forest IBRA bioregions. This potentially is the first recording of this species within the Eremaean Botanical Province.

Acacia scleroclada was recorded in quadrat LM50 (Fire Regeneration *Eucalyptus* (FRE)), to the southeast of the proposed mining footprint. Populations of *A. scleroclada* have been recorded on granite outcrops and hills across the Yalgoo bioregion and along the western boundary of the Murchison bioregion. This record represents a potential range extension of *A. scleroclada*

Sida kingii was also recorded in quadrat LM50 (FRE); this recording represents a potential range extension of *S. kingii*. Populations of *S. kingii* have been recorded across the north-east of the Murchison bioregion at the base of sand dunes, flats, and in low-lying areas.

The conservation significance of vegetation observed in the Lake Maitland Project area was assessed in the field based on the following factors:

i. The presence of a previously identified TEC or ‘at risk’ vegetation community
ii. The observation of a potentially unique and previously un-described vegetation association
iii. The extent (local significance) of any vegetation association, irrespective of whether it was perceived as a TEC, ‘at risk’ or novel assemblage
iv. The condition of any vegetation
v. The presence of any Priority Flora, new species or range extensions.

3.4 Statistical Analysis

A statistical investigation of the flora survey data was undertaken to identify patterns in the flora data. The statistical program Primer 6 was used to perform the analysis, and the analytic pathway is described below.

A hierarchical classification was used to determine floristic communities derived from the raw data (total flora), obtained from the May 2007, November 2007 and May 2009 surveys. The data was square-root transformed and converted to presence/absence species representation by scoring zero for foliage cover recorded as nil, and one for all other values. A dendrogram was produced, that showed similarity percentages between quadrats using the Bray-Curtis coefficient (Bray and Curtis, 1957). The dendrogram is based on dichotomous divisions, which generates branches based on levels of species comparability between quadrats.

A non-metric, multi-dimensional scale (MDS) was produced for the sites based on cover-adjusted, binary represented, and presence/absence data. The ordination produced a scatter plot, within which the relationship between quadrats was plotted against two valueless axes. The purpose of the ordination was to portray, in a spatial context, the underlying relationships between survey sites based on a specified number of permutations of the data. The permutations are intended to determine whether the species recorded at the survey sites are as a consequence of random chance or as a consequence of an underlying relationship. The stress value is an indication of the accuracy of the ordination as an expression of the relationship between survey sites. A stress value higher than 0.20, indicates that the ordination does not provide a good interpretation of the underlying relationship.

3.5 Vegetation Mapping

Vegetation mapping was based on interpretations of aerial photography, quadrat data, field observations and statistical analysis of quadrat data as described in Section 3.4.

The boundaries of vegetation communities were identified on aerial photography for plotting, at a scale of 1:25,000. Aerial photography was used to interpolate vegetation communities across the Lake Maitland Project. Vegetation communities were grouped into broad vegetation types, based on geomorphological and floristic similarities. Mapping of vegetation over the Lake Maitland Project was undertaken at a scale of 1:10,000. The vegetation mapping is provided in **Appendix N.**

4.0 RESULTS

4.1 Desktop Review

Environmental Protection and Biodiversity Conservation Act 1999 **Protected Matters Database Search**

The search of the *EPBC Act Protected Matters Database* for the defined search area around the Lake Maitland Project area (**Appendix H**) revealed:

- no known TEC
- no flora of conservation significance.

In addition to flora and vegetation of conservation significance, the database was also searched for areas of national and international importance, the results of the search were:

- no World Heritage areas
- no National Heritage areas
- no RAMSAR wetlands
- three places on the Register of the National Estate, one of which is Wanjarri, an A Class Reserve vested in the DEC and listed as a State Reserve (refer 2.3 for details).

The Indigenous Place, Yeelirrie, WA, Australia, and the Yeelirrie Station, Mythological site WA, Australia are the additional two places on the Register of the National Estate. These two places are located more than 50 km to the west of the Lake Maitland Project and will not be impacted by the development.

DEC Database Search – Conservation Significant Flora and vegetation communities

The search of the DEC databases and Priority Flora list and the WAH database for the defined search area around the Lake Maitland Project (**Appendix I**) area revealed:

- no DRF
- 25 Priority taxa
    - 12 P1 taxa
    - 2 P2 taxa
    - 6 P3 taxa
    - 5 P4 taxa
- one TEC – Depot Springs Stygofauna Community
- no PEC.

The Depot Springs Stygofauna TEC status is not based on the community's flora and vegetation ecological significance; therefore, it is not considered significant in the context of this flora and vegetation assessment. This TEC occurs outside the Lake Maitland Project area and is not one of the defined vegetation associations within the Lake Maitland Project.

Review of Existing Reports

DEC Biodiversity Audit Report

A review of the DEC Biodiversity Audit Report for the Murchison 1 Bioregion (Cowan, 2001) revealed 12 'at risk' or 'threatened' ecosystems (**Appendix B**).

Pringle et al, (2004), An inventory and condition survey of the north-eastern Goldfields, Western Australia.

A regional survey of land in the north-eastern Goldfields was undertaken between 1988 and 1990 by the Department of Agriculture (now Department of Agriculture and Food) and the Department of Land Administration (now Landgate). The purpose of that survey was to develop a comprehensive description of the biophysical resources and an assessment of the condition of the soils and vegetation of the north-eastern Goldfields (Pringle *et al.*, 1994).

The survey found that *Acacia aneura* (Mulga) was the dominant species within the survey area, occurring along greenstone ranges and gently undulating sandplains. Halophytic vegetation was also common throughout the survey area, occurring within salt lake systems and breakaways (Pringle *et al.,* 1994).

The survey identified 825 taxa representing 82 families and 290 genera, with the dominant families being Myrtaceae (88 taxa), Chenopodiaceae (71 taxa), Myoporaceae (56 taxa) and Mimosaceae (55 taxa). The survey identified four DRF and 24 Priority Flora; however, since the time of the survey, a number of taxa have had their conservation significance levels downgraded or have been removed from the Priority Flora list. The current status of the original flora list now includes one DRF and 21 Priority Flora species (**Table 2**).

Table 2 Current conservation significance of flora originally identified in Pringle *et al*., 1994

Species	Conservation Significance Identified in the Survey	Current Conservation Significance
Conospermum toddii	DRF	DRF
Grevillea inconspicua	DRF	P4
Prostanthera magnifica	DRF	Removed
Hemigenia exilis	DRF	P4
Apatophyllum macgillivrayi	P1	P1
Calytrix creswellii	P1	P1
Calytrix praecipua	P1	P3
Eremophila annosocaulis	P1	P1
Eremophila eversa	P1	P1
Eremophila mirabilis	P1	P2
Gnephosis arachnoidea	P1	Removed
Gnephosis intonsa	P1	P1
Hyalosperma stoveae	P1	P2
Newcastelia insignis	P1	P2
Persoonia leucopogon	P1	P1
Philotheca tubiflora	P1	P1

Species	Conservation Significance Identified in the Survey	Current Conservation Significance
Dampiera ramosa	P2	Removed
Eucalyptus jutsonii	P2	P2
Acacia eremophila var. *variabilis*	P3	P3
Eremophila pustulata	P3	Removed
Eucalyptus pimpiniana	P3	P3
Frankenia georgei	P3	P3
Granitites intangendus	P3	Removed
Mirbelia stipitata	P3	P3
Verticordia interioris	P3	Removed
Eucalyptus nigrifunda	P4	P4
Grevillea georgeana	P4	P3
Lepidobolus deserti	P4	P4

4.2 Level 2 Survey

4.2.1 Flora Composition

A total of 244 taxa (including subspecies and variants) from 36 families and 78 genera were recorded across the Lake Maitland Project during the three surveys. Species recorded within each quadrat are provided in the site species matrix (**Appendix J**) and a summary of the site observations is provided in **Appendix K**.

The flora of the Lake Maitland Project was dominated by the family Chenopodiaceae, with a total of 48 taxa recorded (**Table 3**). Other dominant families included Mimosaceae (28 taxa), Myoporaceae (27 taxa) and Poaceae (18 taxa).

Table 3 Summary of Families - Lake Maitland Project

Family	Total Taxa	Family	Total Taxa
Chenopodiaceae	48	Santalaceae	3
Mimosaceae	28	Sapindaceae	3
Myoporaceae	27	Asclepiadaceae	2
Poaceae	18	Casuarinaceae	2
Malvaceae	12	Chloanthaceae	2
Proteaceae	10	Lamiaceae	2
Myrtaceae	9	Aizoaceae	1
Solanaceae	9	Boraginaceae	1
Asteraceae	7	Convolvulaceae	1
Caesalpiniaceae	7	Gyrostemonaceae	1
Frankeniaceae	7	Malvaceae	1
Zygophyllaceae	6	Phormiaceae	1
Amaranthaceae	5	Plumbaginaceae	1
Papilionaceae	5	Polygonaceae	1
Goodeniaceae	4	Portulacaceae	1
Nyctaginaceae	4	Rubiaceae	1
Euphorbiaceae	3	Stackhousiaceae	1
Loranthaceae	3	Thymelaeaceae	1

The dominant genus across the Lake Maitland Project was *Acacia,* with 28 taxa recorded (**Table 4**). Other dominant genera were *Eremophila* (26 taxa), *Maireana* (17 taxa) and *Sclerolaena* (10 taxa).

Table 4 Summary of Genera - Lake Maitland Project

Genera	Total Taxa	Genera	Total Taxa
Acacia	*28*	*Bonamia*	*1*
Eremophila	*26*	*Chenopodiaceae*[1]	*1*
Maireana	*17*	*Codonocarpus*	*1*
Sclerolaena	*10*	*Cratystylis*	*1*
Atriplex	*8*	*Cynanchum*	*1*
Solanum	*8*	*Dianella*	*1*
Frankenia	*7*	*Enneapogon*	*1*
Grevillea	*7*	*Enteropogon*	*1*
Melaleuca	*6*	*Eremophea*	*1*
Senna	*6*	*Erymophyllum*	*1*
Sida	*6*	*Exocarpos*	*1*
Tecticornia	*6*	*Gnephosis*	*1*
Ptilotus	*5*	*Halgania*	*1*
Boerhavia	*4*	*Hemigenia*	*1*
Eragrostis	*4*	*Hibiscus*	*1*
Zygophyllum	*4*	*Jacksonia*	*1*

[1] Could not be identified to Genus level

Genera	Total Taxa	Genera	Total Taxa
Aristida	*3*	*Kennedia*	*1*
Dodonaea	*3*	*Leptosema*	*1*
Hakea	*3*	*Malvaceae*	*1*
Lawrencia	*3*	*Micromyrtus*	*1*
Rhagodia	*3*	*Monachather*	*1*
Triodia	*3*	*Muehlenbeckia*	*1*
Tribulus	*2*	*Muellerolimon*	*1*
Amyema	*2*	*Paspalidium*	*1*
Casuarina	*2*	*Petalostylis*	*1*
Dicrastylis	*2*	*Pimelea*	*1*
Enchylaena	*2*	*Poaceae*[1]	*1*
Eucalyptus	*2*	*Prostanthera*	*1*
Euphorbia	*2*	*Psydrax*	*1*
Goodenia	*2*	*Pterocaulon*	*1*
Lysiana	*2*	*Rhyncharrhena*	*1*
Olearia	*2*	*Rulingia*	*1*
Panicum	*2*	*Salsola*	*1*
Santalum	*2*	*Scaevola*	*1*
Portulaca	*1*	*Stackhousia*	*1*
Abutilon	*1*	*Swainsona*	*1*
Alyogyne	*1*	*Templetonia*	*1*
Angianthus	*1*	*Tragus*	*1*
Beyeria	*1*	*Trianthema*	*1*

[1] Could not be identified to Genus level

Species with widespread distributions across the Lake Maitland Project included *Enneapogon caerulescens* and *Tecticornia* species, which dominated vegetation on the playas, and *Triodia basedowii,* which was the dominant understory species on the plains.

A number of species identified in the Lake Maitland Project area have undergone taxonomic name changes since being identified, as outlined in Table 5.

Table 5 Species which have undergone taxonomic name changes since being identified (DEC, 2009)

Taxon Name Identified from Survey	Current Taxon Name	Reason for Taxonomic Name Change
Acacia ramosissima	*Acacia maxwellii*	*Acacia ramosissima* was found to be a taxonomic synonym of *Acacia maxwellii*
Enteropogon acicularis	*Enteropogon ramosus*	*Enteropogon acicularis* is a misapplied name that refers to *Enteropogon ramosus*
Eucalyptus striaticalyx	*Eucalyptus striaticalyx*	*Eucalyptus striaticalyx* subsp. *delicata* was

Taxon Name Identified from Survey	Current Taxon Name	Reason for Taxonomic Name Change
subsp. *delicata*		found to be a taxonomic synonym of *Eucalyptus striaticalyx*
Halosarcia halocnemoides subsp. *halocnemoides*	*Tecticornia halocnemoides* subsp. *halocnemoides*	*Halosarcia halocnemoides* subsp. *halocnemoides* is a nomenclatural synonym of *Tecticornia halocnemoides* subsp. *halocnemoides*
Halosarcia indica aff. *bidens*	*Tecticornia indica* subsp. *bidens*	*Halosarcia indica* aff. *bidens* is a nomenclatural synonym of *Tecticornia indica* subsp. *bidens*
Halosarcia aff. *undulata*	*Tecticornia undulata*	*Halosarcia* aff. *undulata* is a nomenclatural synonym of *Tecticornia undulata*
Muehlenbeckia cunninghamii	*Muehlenbeckia florulenta*	*Muehlenbeckia cunninghamii* was found to be a taxonomic synonym of *Muehlenbeckia florulenta*
Sida atrovirens	*Sida* sp. dark green fruits	*Sida atrovirens* was found to be a taxonomic synonym of *Sida* sp. dark green fruits

4.3 Conservation Significant Flora

- ***Maireana prosthecochaeta***

One specimen collected at quadrat LM63 during the May 2009 survey has been preliminarily identified as *Maireana prosthecochaeta,* a Priority 3 flora species. At that time, the specimen collected had no flowering material; therefore, a positive identification could not be given. Quadrat LM63 is located in the southern aspect of the Lake Maitland Project, within the Plains Mosaic community of PAW2, PELW, PES, PML and PMW (see **Figure 7**).

Maireana prosthecochaeta is described as an erect, open, glaborous, densely-leaved shrub, up to one metre high, with fleshy leaves and solitary flowers. This species has historically been recorded in the Eremean Botanical Province (Cue and Meekatharra); flowering period is July to August. It occurs in sandy loam, clays and salty soils and is found along hills and breakaways (DEC, 2009).

- ***Eremophila rostrata***

One specimen collected at quadrat LM72 during the November 2007 survey, which had insufficient characters to enable its positive identification, was initially identified as the DRF species *Eremophila rostrata.* A successive flora survey in May 2009 enabled this species to be identified as *Eremophila latrobei* subsp. *latrobei,* a non-conservation significant species, which flowers between winter and early summer.

Quadrat LM72 is located within the Calcrete vegetation community PCW2, in E53/213, in the northwestern aspect of the Lake Maitland Project. Quadrat LM72 is located on the border of PCW2 and the Plains Mosaic community of PAF, PAF2, PALW, PALW2, PAOW, PAW2, PEW, PMW and PTH.

4.4 Introduced Flora

A total of 27 weed species have been recorded in the wider region (Pringle *et al.*, 1994), of which five, namely: *Argemone ochroleuca* (Mexican poppy)*, Carthamus lanatus* (Saffron thistle)*, Datura stramonium* (Thornapple), *Emex australis* (Double gee) and *Xanthium spinosum* (Bathurst burr), are declared plants under the *Agriculture and Related Resources Protection Act, 1976*.

The May 2009 survey identified two weed species, *Portulaca oleracea* and *Tribulus terrestris,* within the Lake Maitland Project. Neither of these species is listed as declared plants under the *Agriculture and Related Resources Protection Act, 1976*.

4.5 Statistical Analysis

A dendrogram was produced from the statistical program Primer 6, derived from interpretation of cover-adjusted, binary, presence/absence data from the May and November 2007 and May 2009 surveys. The dendrogram shows a clear dichotomy, which effectively separates all of the Salt Lake and Kopi Ridge associated vegetation into one branch, with all other vegetation being located on the second branch (**Figure 8**).

Secondary branching on the salt lake branch of the dendogram is driven by location (Playa or Kopi Ridge) as well as dominant species, with further branching as the result of location within the landscape. A similar delineation occurs on the non-salt lake branch, with a stronger influence exerted by species presence (or absence) rather than position in the landscape.

The MDS produced from the data collected during the May and November 2007 and May 2009 survey of the Lake Maitland Project shows clear groupings of survey sites, with a stress value of 0.13 (**Figure 9**). The groupings on the ordination largely conform to the arrangement of sites in the dendrogram (see **Figure 8**), a reflection of the underlying similarity of many of the survey sites. The relationship between sites is driven by the widespread distribution of a number of species across sites and a comparatively low diversity of species per site.

During the first pass of the statistical program, one clear outlier was observed, quadrat LM64, this prevented any separation of the remaining quadrats. This quadrat was removed and the MDS and Cluster analyses were re-run.

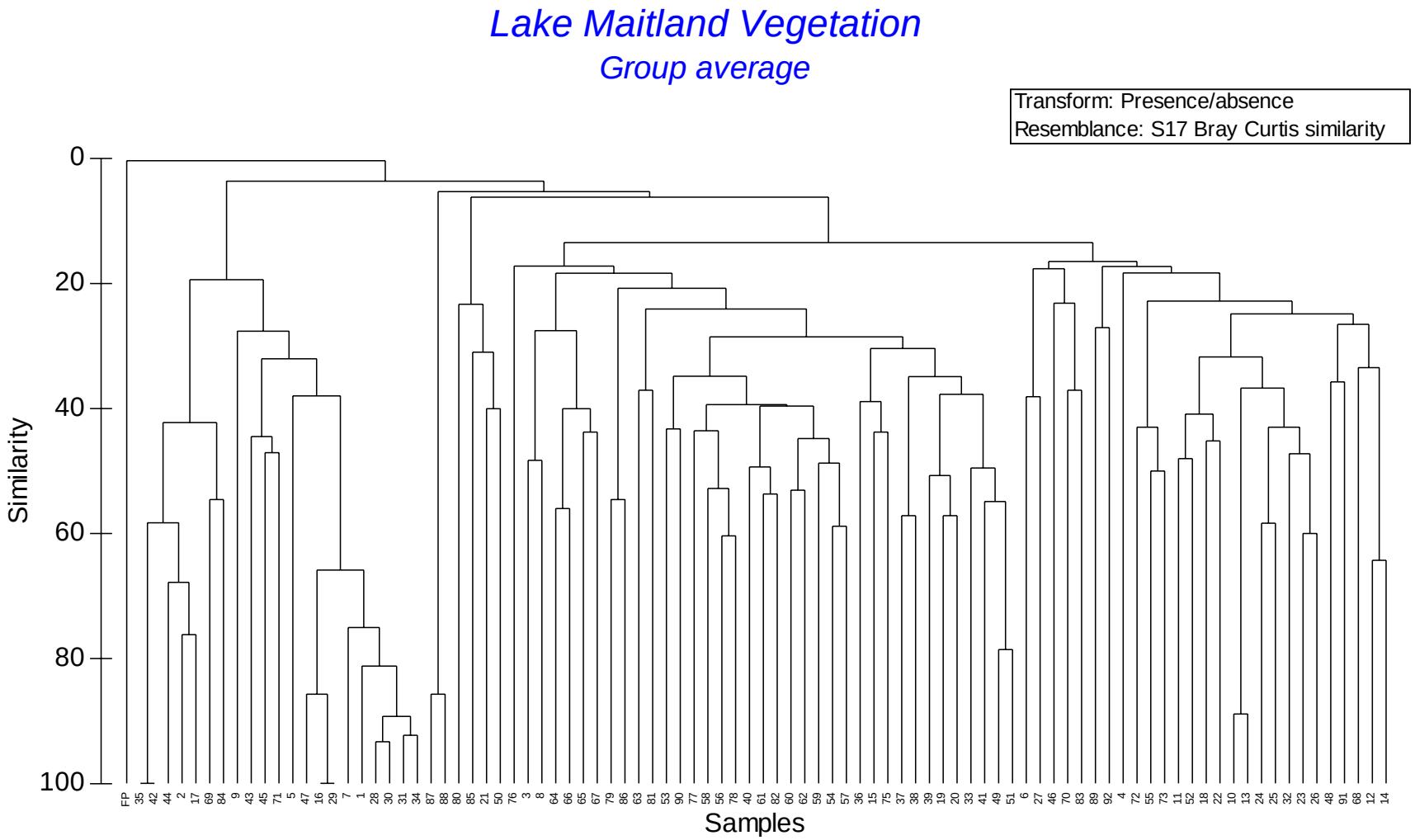

Figure 8 Dendrogram showing relationship between quadrats at the Lake Maitland Project area as surveyed in May and November 2007 and May 2009, based on cover and square-root transformed species composition.

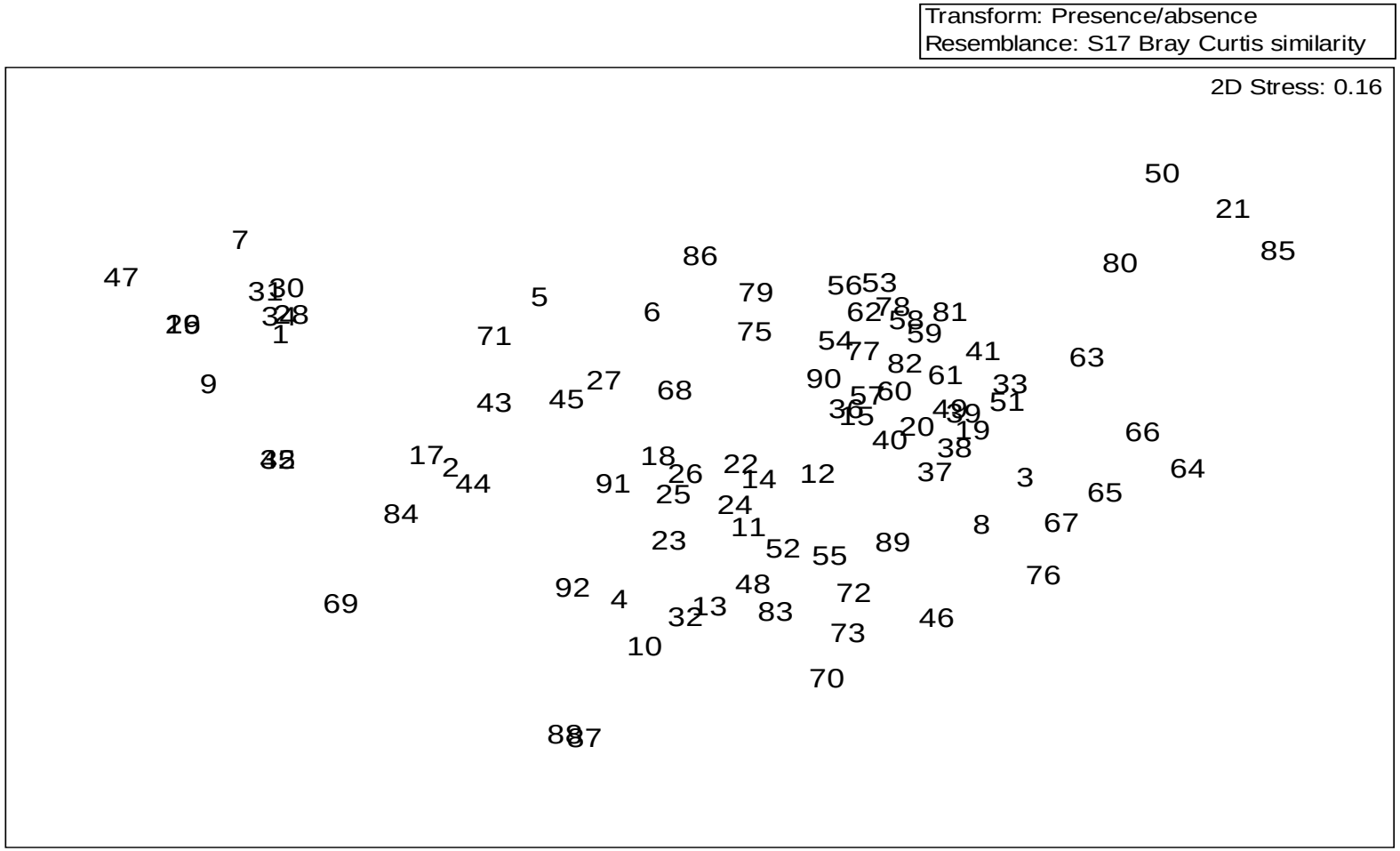

Figure 9 Multi-dimensional scaling (MDS) ordination produced from analysis in PRIMER 6 showing the relationship between quadrats in the Lake Maitland Project, as surveyed in May and November 2007 and May 2009, based on cover and square root transformed species composition.

4.6 Vegetation Associations

Four vegetation associations were identified from the survey; these are based on the geomorphological and floristic similarities and the underlying substrate:

- Salt Lake (playa)
- Kopi Ridge
- Calcrete
- Plains.

Within the broad vegetation associations, a total of 31 vegetation communities were described within the Lake Maitland Project area (**Appendix L**). All of the 91 quadrats, with the exception of one (LM64), were able to be delineated within the 31 vegetation communities (**Appendix N**). A full description of all vegetation communities is provided in **Appendix M**.

4.6.1 Salt Lake (playa) Vegetation

Three vegetation communities were identified by Outback Ecology in the Salt Lake (playa) vegetation association. The Salt Lake (playa) vegetation covers a large area in the south-western section of the Lake Maitland Project. The vegetation consists mainly of Chenopodiaceae and salt tolerant species. The Saline Playa Lake was included in this association although it was not observed to support any vegetation.

4.6.2 Kopi Ridge Vegetation

The Kopi Ridge vegetation association is the smallest and most restricted, as it is comprised of only one vegetation community; four locations were identified towards the southern boundary of the Lake Maitland Project, outside of the proposed mining footprint. At the time of the November 2007 survey, the Kopi Ridge Vegetation was considered to consist of two vegetation communities: Kopi Ridge *Grevillea* (KRG) and Kopi Ridge *Eucalyptus* (KRE); however, during the May 2009 survey these two communities were converted into one, as species composition was uniform throughout these communities with only slightly varying dominance in the overstory between *Eucalyptus striaticalyx* and *Grevillea sarissa* subsp. *bicolor.*

The Kopi Ridge vegetation association was determined to be potentially locally restricted in the 2007 surveys. Its extent outside the Lake Maitland Project area was investigated during the regionally significant vegetation component of the survey. It was determined that the Kopi Ridge vegetation association occurs in small pockets fringing the Lake Maitland playas up to 20 kilometres southeast from the Lake Maitland Project boundary. The extent within the Lake Maitland Project is small compared to the distribution throughout the greater Lake Maitland area

4.6.3 Calcrete Vegetation

The Calcrete vegetation association consists of four vegetation communities, which border the Salt Lake (playa) vegetation association in the centre of the Lake Maitland Project. Three of the vegetation communities have the same dominant overstory of *Casuarina pauper,* with varying understory species composition.

4.6.4 Plains Vegetation

The Plains vegetation association is the dominant vegetation association, consisting of 23 vegetation communities. It is the most widespread vegetation association occurring throughout the Lake Maitland Project area.

The Plains have been subject to fire within the last five years, resulting in a successional vegetation association that differed from the surrounding vegetation. As a consequence, the FRE vegetation community completely covers the eastern boundary of the Lake Maitland Project.

Much of the central section of the Lake Maitland Project area is covered by a combination of two Plains Mosaic vegetation communities: Mosaic of PAW2, PELW, PES, PML and PMW; and a Mosaic of PAF, PAF2, PALW, PALW2, PAOW, PAW2, PEW, PMW and PTH, (see **Figure 7**).

4.7 Vegetation Condition

The vegetation condition of the Lake Maitland Project was assessed using the Keighery scale (Keighery, 1994) (**Appendix E**). Vegetation condition was re-assessed during May 2009 for all sites and ranged from ‘excellent’ to ‘degraded’. The vegetation was noted to be impacted by the grazing activities of cattle, kangaroos and rabbits, as well as fire, vehicle movements and exploration activities.

Grazing of vegetation was most evident on the calcrete areas located to the north, east and west of the Lake Maitland Project, where palatable grass species were present. Cattle tracks within these areas ranged from minor to deep furrows. Evidence of rabbits (e.g. scats and burrows) was noted across the site, particularly within the *Acacia* and *Triodia* vegetation.

Damage to vegetation had been caused by fires, particularly to the south and east of the Lake Maitland Project. The most recent fire occurred in April 2007, areas recently burnt were excluded from the survey. Older fire scars displayed regeneration of vegetation, including *Hakea lorea* subsp. *lorea* and *Eucalyptus eremicola* subsp. *peeneri*, both re-sprouting after fire. It is acknowledged that repeated fires may impact on the recuperative capacity of the vegetation, ultimately leading to a loss of structure or diversity in affected areas.

Repeated fires can have adverse consequences for fire sensitive plant species such as Mulga (*Acacia aneura*) (Fortech, 1999). Mulga is susceptible to fire and its range is restricted by the frequency and the intensity of fire which increases in spinifex-dominated areas (Van Vreeswyk *et al.*, 2004). A study of fire maps from the area indicated that fires had burnt across the area almost annually over the last five years, with some areas having been burnt several times during that period.

Damage to vegetation has also occurred as a consequence of vehicle movement across the Lake Maitland Project area. The scale of impact ranged from total removal of vegetation along firebreaks and access roads within the Lake Maitland Project, to minor damage to vegetation from vehicle movement associated with exploration activities across the playa. Vegetation with low level, infrequent vehicle disturbance was observed to be recovering, with recruitment of native grass species within the vehicle tracks.

There was low level damage to vegetation, primarily on the playa, as a consequence of limited exploration activities. The scale of impact was minimal and the vegetation showed clear signs of recovering from the disturbance.

4.8 Threatened and Priority Ecological Communities

No TEC or PEC, as defined by the DEC, was recorded in the Lake Maitland Project. In addition, none of the vegetation communities described across the Lake Maitland Project were considered to be one of the 'at risk' associations as listed by Cowan (2001) and NLWRA (2002). However, the Calcrete platform vegetation is deemed 'at risk' in other areas of the Goldfields due to various threatening processes, such as feral animals, grazing pressure and potential mining activities

4.9 Targeted Conservation Significant Flora Search

Targeted searching was carried out in and around quadrats and on transit to quadrats within the Lake Maitland Project. Any species with similar floristic characteristics to species being targeted, and any species which appeared superficially different, were collected for confirmation of identification. Intensive searches of the Salt Lake communities were also carried out.

It appeared from targeted searches and ground truthing of the Lake Maitland Project area, that species composition was uniform within these vegetation communities, particularly the Salt Lake communities where *Halosarcia* spp. were dominant. No DRF or Priority flora were identified from the targeted search of the proposed mining footprint.

4.10 Regionally Significant Vegetation

The Kopi Ridge vegetation was determined to be potentially locally restricted in the 2007 surveys. Further ground-truthing and an additional site located in this vegetation confirmed its presence outside the Lake Maitland Project area.

The survey identified five potential range extensions of populations of existing taxa; however, further investigation by specialized taxonomists from the WAH is required to confirm this. These species were:

- *Acacia aneura* var. cf *major*
- *Acacia brumalis*
- *Acacia maxwellii* (formerly *Acacia ramosissima*)
- *Acacia scleroclada*
- *Sida kingii.*

4.11 Limitations and Constraints

The EPA (2004) lists a number of possible limitations and constraints that may impinge on the adequacy of flora and vegetation surveys. Limitations and constraints of the 2007 and 2009 surveys of the Lake Maitland Project area are outlined in **Table 5.**

Table 5 Summary of Flora and Vegetation Survey Limitations and Constraints

Aspect	Constraint	Comment regarding current survey
Competency/experience of consultants	No	The senior botanist on this project has 8 years experience in vegetation surveys in the Murchison region.
Scope	No	The scope was clearly defined and realistically achievable within the designated timeframe.
Proportion of flora identified	No	A limited number of species were not able to be identified due to insufficient floristic structures present to facilitate identification. In addition to this, annual and ephemeral species counts were low.
Information sources	Limited	Prior to the May 2007, no detailed surveys had been conducted over the Lake Maitland Project area.
Proportion of task achieved, and further work which might be needed	No	Additional detailed surveying involving ground-truthing vegetation communities.
Timing / weather / season / cycle	No	Rainfall in the six months preceding the November 2007 survey was lower than long-term averages. Rainfall in the six months prior to the May 2007 survey was close to long-term averages.

Aspect	Constraint	Comment regarding current survey
Disturbances	No	A series of major fires has occurred within the Lake Maitland Project area. These areas are starting to revegetate. In addition to the disturbance by fire, there was evidence of damage to vegetation from grazing activities.
Intensity	No	Survey intensity was adequate.
Completeness	No	An extensive section of vegetation located to the south and the east of the Lake Maitland Project area had been destroyed in a recent fire.
Resources	No	All resources needed were available.
Remoteness / access problems	No	The Lake Maitland Project was readily accessible by vehicle and could easily be traversed by foot.
Availability of contextual information	No	No detailed vegetation surveys were available for the Lake Maitland Project area and limited data is available for the surrounding area. There were no meteorological stations in close proximity from which climate data could be sourced.

5.0 DISCUSSION

5.1 Level 2 Survey

5.1.1 Survey Timing

It is recommended by Guidance 51 (EPA, 2004) to conduct flora and vegetation surveys within peak flowering periods and allow four to six weeks following a peak rainfall event and warm temperature to allow for germination. All three surveys were conducted in the peak flowering seasons; however, both years (2007 and 2009) experienced lower than average rainfall.

The two surveys conducted in 2007 (May and November) were conducted subsequent to a number of months of receiving a low rainfall; this would have been a contributing factor towards the low species numbers observed. The low rainfall in 2007 resulted in what can be considered a floristically poor season.

The follow-up survey in May 2009 was conducted in a peak rainfall season, however, the previous couple of months had slightly lower than average rainfall.

5.1.2 Conservation Significant Flora

Only one potential conservation significant flora species, *Maireana prosthecochaeta* (P3), was identified from the May 2009 follow-up survey. A positive identification cannot be given at this time due to the specimen having insufficient characters. Further collections in the field containing flowering material are required.

The May 2009 survey located no DRF within the Lake Maitland Project area. However, further searching may locate DRF species.

5.2 Vegetation

5.2.1 Salt Lake (playa) Vegetation

The vegetation within the Lake Maitland Project shows a clear delineation between the Salt Lake (playa) vegetation and Plains vegetation. Vegetation on the playa and fringes is relatively uniform, with only minor variations observed; this is largely a consequence of changes in species density, rather than diversity.

5.2.2 Kopi Ridge Vegetation

The two Kopi Ridge vegetation communities defined in the 2007 survey were determined to be the same vegetation community with varying dominance of overstory species *Eucalyptus striaticalyx* and *Grevillea sarissa* subsp. *bicolor.*

5.2.3 Calcrete Vegetation

The Calcrete Platform vegetation may potentially be deemed 'at risk' in other areas of the Goldfields, due to various threatening processes such as feral animals, grazing pressure and potential mining activities. The Calcrete vegetation within the Lake Maitland Project area showed evidence of degradation from feral animals and grazing.

5.2.4 Plains Vegetation

The Plains vegetation is somewhat more complex. It is effectively a mosaic landscape, within which vegetation shows a high level of variation. Sections of the Plains vegetation have been subject to fire within the last one to five years, resulting in successional vegetation communities, which differed from the surrounding vegetation. While there were clear overarching vegetation groups, at the association level, the vegetation is comprised of smaller discreet units, with a mix of species that are common across the Lake Maitland Project.

The fire regeneration community may contain species which germinate following fire and are therefore potentially restricted to this community. Further investigation of this community is required to determine if such species occur. The mosaic communities require further investigation to determine if any communities may be large enough to describe. A number of vegetation communities are not represented in quadrats and have been mapped only through interpolation of aerial photography.

5.3 Vegetation Condition

The vegetation condition for all sites surveyed in the May and November 2007 survey were re-assessed in May 2009, in addition to all the sites established in May 2009. The vegetation condition for most sites was down-graded to a lower condition; evidence of further degradation was recorded with rabbits and cattle posing the greatest threats.

5.4 Targeted Conservation Significant Flora Searches

Habitats that were likely to contain conservation significant species within the Lake Maitland Project area were searched. At the time of the May 2009 survey only one DRF species, *Eremophila rostrata,* was considered to potentially occur within the Lake Maitland Project; however, the specimen was subsequently identified as *Eremophila latrobei* subsp. *latrobei,* which is not a conservation significant species. No other conservation significant species were found from the targeted search within the proposed mining footprint identified prior to the May 2009 survey.

Areas within the proposed mining footprint directly impacted through clearing will require intensive searching for DRF to ensure none are present.

5.5 Regionally Significant Vegetation

A determination of whether the Kopi Ridge vegetation was locally significant in the Lake Maitland Project, or whether a wider distribution outside the Lake Maitland Project exists, was made. A site (quadrat LM84) was established during the May 2009 survey outside the Lake Maitland Project boundary. This site was chosen as it was perceived to contain a similar species composition. The statistical resemblance of this quadrat to the Kopi Ridge vegetation community was confirmed by MSD ordination (**Figure 9**). Additionally, other Kopi Ridge communities were visually confirmed outside of the Lake Maitland Project area during the survey period.

The November 2007 surveys identified a number of potential taxa associated with the Plains that have restricted distributions; however, collection of specimens with flowering material in May 2009, enabled the positive identification of those specimens and a subsequent reduction in the number of species with restricted distributions.

5.6 Recommendations

- Further survey work to positively identify the absence/presence of *Maireana prosthecochaeta* (P3) is required at a time of year when flowering material from this species can be collected.
- Further survey work is required in order to ground truth the interpolated communities and ensure that all of the vegetation communities are represented by a minimum of two

quadrats per vegetation community. It is recommended that this survey be undertaken four to six weeks following a high rainfall month, to enable adequate census of flora to be undertaken.

- Further survey work within the Fire Regeneration Eucalypt vegetation community is recommended due to the potential occurrence of restricted emergent species after fire.
- It is recommended that grazing impacts on the Calcrete vegetation communities are minimised as this may be classified as an 'at risk' ecosystem in the future. Progressive rehabilitation of the undisturbed areas within these communities throughout the life of mine is also recommended.
- It is recommended that grazing impacts on the Kopi Ridge vegetation association are minimised to mitigate any further degradation to this association.

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Appendix A

Vegetation Types - IBRA East Murchison Sub-region

Vegetation types that have at least 85% of their total extent confined to the East Murchison IBRA sub-region (Cowan, 2001)

Beard Veg Code	Vegetation Description
20	Low woodland; mulga mixed with *Allocasuarina cristata* and *Eucalyptus* sp.
105	Hummock grasslands, shrub steppe; mulga over soft spinifex
107	Hummock grasslands, shrub steppe; mulga and *Eucalyptus kingsmillii* over hard spinifex
223	Succulent steppe with open scrub; scattered mulga over saltbush and bluebush
311	Succulent steppe with open low woodland; mulga and *Acacia sclerosperma* with saltbush and bluebush
312	Succulent steppe with very open shrubs; very sparse mulga and *Acacia sclerosperma* over saltbush and bluebush
313	Succulent steppe with open scrub; scattered *Acacia sclerosperma* and *A. victoriae* over bluebush
338	Hummock grasslands, mixed sandplain; bowgada, sugarbrother, mallee, *Triodia basedowii* and *Triodia* sp.
339	Hummock grasslands, mixed sandplain; bowgada, sugarbrother, mallee, *Triodia scariosa* and *Triodia* sp.
400	Succulent steppe with open low woodland; mulga over bluebush
417	Succulent steppe with open scrub; scattered wattles over saltbush
418	Low woodland; mulga, *Casuarina cristata* and cypress pine
484	Shrublands; jam thicket
485	Hummock grassland, mixed sandplain – scattered low trees over sparse dwarf shrubs with spinifex; red mallee over mixed dwarf shrubs with *Triodia basedowii*
504	Low woodland; mulga and red mallee
532	Hummock grassland, mixed sandplain – sparse low trees over sparse dwarf shrubs with spinifex; marble gum and red mallee mixed dwarf shrubs with *Triodia scariosa* and *Triodia* sp.
533	Low woodland; mulga and cypress pine
560	Mosaic: Shrublands; bowgada scrub/succulent steppe; samphire
561	Succulent steppe with low woodland; mulga over saltbush
862	Hummock grasslands, open low tree and mallee steppe; marble gum and mallee (*Eucalyptus kingsmillii*) over hard spinifex *Triodia basedowii*
863	Hummock grassland, mixed sandplain – sparse low trees over sparse dwarf shrubs with spinifex; red mallee over mixed dwarf shrubs with *Triodia scariosa* and *Triodia* sp.
865	Hummock grassland, mixed sandplain – scattered low trees over sparse dwarf shrubs with spinifex; red mallee over mixed dwarf shrubs with *Triodia scariosa* and *Triodia* sp.
1127	Mosaic: Saltbush and bluebush/samphire
2121	Mosaic: Open low woodland; mulga/succulent steppe; saltbush and bluebush on greenstone
2902	Medium woodland; *Allocasuarina cristata* and goldfields blackbutt
2903	Medium woodland; Salmon gum, goldfields blackbutt, gimlet and *Allocasuarina cristata*

Appendix B

Threatened Vegetation Communities – IBRA East Murchison Sub-region

Threatened vegetation communities within the East Murchison IBRA Sub-region (Cowan, 2001)

Vegetation Community	Threatening Processes	Condition	Trend
Subterranean fauna of the Paroo sub-basin of the Lake Way Basin. Calcrete formations near Wiluna	Pollution Changed hydrology – salinity	Good to Pristine	Static
Mount Jumbo Range vegetation complex, Laverton area, northeast goldfields	Grazing pressure Feral animals (goats, rabbits) Changed fire regimes	Good	Static
Mount Linden Range banded ironstone ridge vegetation complex	Grazing pressure Feral animals (goats, rabbits) Changed fire regimes	Fair	Static
Microbialite community of Harpers Lagoon. NNE of Kalgoorlie	Grazing pressure	Fair to Good	Declining to Static
Melaleuca sp. nov. low closed to open forest stand community near Wiluna	Changed fire regimes	Fair	Unknown
Calcyphytic casuarina / acacia woodlands / shrublands of the north-east Goldfields	Changed fire regimes	Fair to Good	Unknown
Calcrete platform woodlands/shrublands of the north-east Goldfields	Grazing pressure Feral animals (goats)	Fair to Good	Unknown
Plain mixed halophyte low shrublands of the north-east Goldfields	Grazing pressure Feral animals (goats)	Fair to Good	Unknown
Silver saltbush (*Atriplex bunburyana*) low shrublands of the north-east Goldfields	Grazing pressure	Fair to Good	Unknown
Mixed chenopod shrublands with mulga *(Acacia aneura*) overstorey of the north-east Goldfields	Grazing pressure	Fair to Good	Unknown
Mulga (*Acacia aneura*) shrublands with scattered chenopod low shrubs of the north-east Goldfields	Grazing pressure	Fair to Good	Unknown
Mulga (*Acacia aneura*) drainage line shrublands / woodlands with chenopod understoreys of the north-east Goldfields	Grazing pressure	Degraded to Good	Unknown

Appendix C
Definitions of Declared Rare and Priority Flora

Definition of Declared Rare and Priority Flora Species (CALM, 2005)

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

Appendix D

Definitions of Threatened Ecological Community Classifications

Definition of Threatened Ecological Community classifications (English, 2003)

TEC Classification	Description
Presumed Totally	Community is unlikely to be able to be rehabilitated.
Critically Endangered	There are immediate threats throughout its range.
Endangered	Threatened throughout most of its range in near future.
Vulnerable	Vulnerable to threatening processes/may move into higher threat

Appendix E
Vegetation Condition Scale

Vegetation Condition Scale (Keighery, 1994)

Code	Description
Pristine	Pristine or nearly so. No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered; obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Appendix F

Classification of Vegetation Structural Formation and Height Classes

Classification of Vegetation Structural Formation and Height Classes - Bush Forever Scale (GoWA, 2000)

Life Form / Height Class	Canopy Cover (percentage)			
	100% - 70%	70% - 30%	30% - 10%	10% - 2%
Trees 10-30m Trees < 10m	Closed Forest Low Closed Forest	Open Forest Low Open Forest	Woodland Low Woodland	Open Woodland Low Open Woodland
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2m Shrubs 1-2m Shrubs <1m	Closed Tall Scrub Closed Heath Closed Low Heath	Tall Open Scrub Open Heath Open Low Heath	Tall Shrubland Shrubland Low Shrubland	Tall Open Shrubland Open Shrubland Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Appendix G

Lake Maitland Identified Flora Species

2007 and 2009 Surveys

Flora Species Recorded over the Project Area – 2007 and 2009 Surveys

Family	Species
Poaceae (031)	*Aristida contorta*
	Aristida holathera
	Aristida holathera var. *holathera*
	Enneapogon caerulescens
	Enneapogon sp.
	Enteropogon ramosus
	Eragrostis eriopoda
	Eragrostis lanipes
	Eragrostis setifolia
	Eragrostis sp.
	Monachather paradoxus
	Panicum decompositum
	Panicum effusum
	Paspalidium basicladum
	Poaceae sp.
	Tragus australianus
	Triodia basedowii
	Triodia concinna
	Triodia desertorum
Phormiaceae (054E)	*Dianella revoluta*
Casuarinaceae (070)	*Casuarina* aff. *obesa*
	Casuarina pauper
Proteaceae (090)	*Grevillea* cf *juncifolia* subsp. *juncifolia*
	Grevillea juncifolia subsp. *juncifolia*
	Grevillea nematophylla
	Grevillea nematophylla subsp. *supraplana*
	Grevillea sarissa subsp. *bicolor*
	Grevillea sarissa subsp. *succincta*
	Grevillea sp.
	Hakea lorea subsp. *lorea*
	Hakea minyma
	Hakea preissii
Santalaceae (092)	*Exocarpos aphyllus*
	Santalum lanceolatum
	Santalum spicatum
Loranthaceae (097)	*Amyema gibberula* var. *tatei*
	Amyema microphylla
	Lysiana murrayi
Polygonaceae (103)	*Muehlenbeckia florulenta*
Chenopodiaceae (105)	*Atriplex amnicola*
	Atriplex bunburyana
	Atriplex codonocarpa
	Atriplex ? lindleyi
	Atriplex aff. *lindleyi* subsp. *inflata*
	Atriplex lindleyi subsp. inflata
	Atriplex nana

Family	Species
Chenopodiaceae (105) cntd.	*Atriplex sp.*
	Chenopodiaceae sp.
	Enchylaena tomentosa
	Enchylaena tomentosa var. tomentosa
	Eremophea spinosa
	Maireana amoena
	Maireana eriosphaera
	Maireana georgei
	Maireana glomerifolia
	Maireana integra
	Maireana oppositifolia
	Maireana ? pentatropis
	Maireana ? prosthecochaeta (Potential P3)
	Maireana pyramidata
	Maireana sedifolia
	Maireana sp.
	Maireana suaedifolia
	Maireana thesioides
	Maireana tomentosa subsp. *tomentosa*
	Maireana trichoptera
	Maireana triptera
	Maireana villosa
	Rhagodia drummondii
	Rhagodia eremaea
	Rhagodia sp.
	Salsola tragus
	Sclerolaena alata
	Sclerolaena convexula
	Sclerolaena cornishiana
	Sclerolaena cuneata
	Sclerolaena deserticola
	Sclerolaena eurotioides
	Sclerolaena fimbriolata
	Sclerolaena parviflora
	Sclerolaena patenticuspis
	Tecticornia halocnemoides
	Tecticornia indica subsp. aff. *bidens*
	Tecticornia peltata
	Tecticornia ? undulata
	Tecticornia aff. *undulata*
	Tecticornia undulata
Amaranthaceae (106)	*Ptilotus aervoides*
	Ptilotus exaltatus var. *exaltatus*
	Ptilotus helipteroides
	Ptilotus obovatus
	Ptilotus sessilifolius
Nyctaginaceae (107)	*Boerhavia* cf *coccinea*

Family	Species
Nyctaginaceae (107) cntd.	*Boerhavia repleta*
	Boerhavia ? *schomburgkiana*
	Boerhavia cf *schomburgkiana*
Gyrostemonaceae (108)	*Codonocarpus cotinifolius*
Aizoaceae (110)	*Trianthema triquetra*
Portulacaceae (111)	* *Portulaca oleracea*
Mimosaceae (163)	*Acacia aneura*
	Acacia aneura var. ?
	Acacia aneura var. *aneura*
	Acacia aneura var. *argentea*
	Acacia aneura var. cf *conifera*
	Acacia aneura var. *fuliginea*
	Acacia aneura var. ? *macrocarpa*
	Acacia aneura var. cf *major*
	Acacia ayersiana
	Acacia brumalis
	Acacia burkittii
	Acacia cuthbertsonii subsp. *linearis*
	Acacia ? *duriuscula*
	Acacia duriuscula
	Acacia heteroneura var. *prolixa*
	Acacia jennerae
	Acacia ligulata
	Acacia maxwellii
	Acacia nyssophylla
	Acacia oswaldii
	Acacia pachyacra
	Acacia ramulosa
	Acacia ramulosa var. *linophylla*
	Acacia rhodophloia
	Acacia scleroclada
	Acacia sibina
	Acacia sp.
	Acacia tetragonophylla
	Acacia xiphophylla
Caesalpiniaceae (164)	*Petalostylis cassioides*
	Senna artemisioides subsp. *filifolia*
	Senna artemisioides subsp. *helmsii*
	Senna glutinosa subsp. *chatelainiana*
	Senna notabilis
	Senna sp. Meekatharra (E. Bailey 1-26)
	Senna stowardii
Papilionaceae (165)	*Jacksonia arida*
	Kennedia prorepens
	Leptosema chambersii
	Swainsona kingii
	Templetonia egena

Family	Species
Zygophyllaceae (173)	*Tribulus occidentalis*
	* *Tribulus terrestris*
	Zygophyllum compressum
	Zygophyllum eremaeum
	Zygophyllum ? *iodocarpum*
	Zygophyllum tetrapterum
Euphorbiaceae (185)	*Beyeria* sp.
	Euphorbia biconvexa
	Euphorbia drummondii
Stackhousiaceae (202)	*Stackhousia muricata*
Sapindaceae (207)	*Dodonaea amblyophylla*
	Dodonaea lobulata
	Dodonaea viscosa subsp. *angustissima*
Malvaceae (221)	*Abutilon otocarpum*
	Alyogyne pinoniana
	Hibiscus krichauffianus
	Lawrencia glomerata
	Lawrencia helmsii
	Lawrencia squamata
	Malvaceae sp.
	Sida cf *ammophila*
	Sida ammophila
	Sida calyxhymenia
	Sida fibulifera
	Sida kingii
	Sida sp. dark green fruits
Frankeniaceae (236)	*Frankenia cinerea*
	Frankenia cordata
	Frankenia fecunda
	Frankenia ? *pauciflora*
	Frankenia pauciflora
	Frankenia ? *setosa*
	Frankenia setosa
Thymelaeaceae (263)	*Pimelea spiculigera* var. *thesioides*
Myrtaceae (273)	*Eucalyptus eremicola* subsp. *peeneri*
	Eucalyptus striaticalyx
	Melaleuca eleuterostachya
	Melaleuca interioris
	Melaleuca leiocarpa
	Melaleuca sp.
	Melaleuca uncinata
	Melaleuca xerophila
	Micromyrtus flaviflora
Plumbaginaceae (294)	*Muellerolimon salicorniaceum*
Asclepiadaceae (305)	*Cynanchum floribundum*
	Rhyncharrhena linearis
Convolvulaceae (307)	*Bonamia* sp.

Family	Species
Boraginaceae (310)	*Halgania cyanea*
Chloanthaceae (311A)	*Dicrastylis flexuosa*
	Dicrastylis sp.
Lamiaceae (313)	*Hemigenia* sp.
	Prostanthera sp.
Solanaceae (315)	*Lycium australe*
	Solanum coactiliferum
	Solanum cf *lasiophyllum*
	Solanum lasiophyllum
	Solanum nummularium
	Solanum orbiculatum
	Solanum cf *orbiculatum* subsp. *orbiculatum*
	Solanum orbiculatum subsp. *orbiculatum*
	Solanum sp.
Acanthaceae (325)	*Rulingia loxophylla*
Myoporaceae (326)	*Eremophila* ? *alternifolia*
	Eremophila falcata
	Eremophila forrestii
	Eremophila forrestii subsp. ? *forrestii*
	Eremophila forrestii subsp. *forrestii*
	Eremophila gilesii
	Eremophila gilesii subsp. *variabilis*
	Eremophila glabra subsp. *albicans*
	Eremophila glabra subsp. *glabra*
	Eremophila jucunda
	Eremophila jucunda subsp. *jucunda*
	Eremophila latrobei
	Eremophila latrobei subsp. *latrobei*
	Eremophila longifolia
	Eremophila maculata
	Eremophila maculata subsp. *brevifolia*
	Eremophila margarethae
	Eremophila miniata
	Eremophila oldfieldii subsp. *angustifolia*
	Eremophila oldfieldii subsp. ? *oldfieldii*
	Eremophila oldfieldii subsp. cf *oldfieldii*
	Eremophila oldfieldii subsp. *oldfieldii*
	Eremophila platythamnos subsp. *platythamnos*
	Eremophila shonae
	Eremophila sp.
	Eremophila subfloccosa subsp. *lanata*
Rubiaceae (331)	*Psydrax suaveolens*
Goodeniaceae (341)	*Goodenia berardiana*
	Goodenia prostrata
	Scaevola collaris
	Scaevola spinescens
Asteraceae (345)	*Angianthus cornutus*

Family	Species
Asteraceae (345) cntd.	*Cratystylis subspinescens*
	Erymophyllum ramosum subsp. *ramosum*
	Gnephosis angianthoides
	Olearia calcarea
	Olearia subspicata
	Pterocaulon sphacelatum

* Denotes introduced species

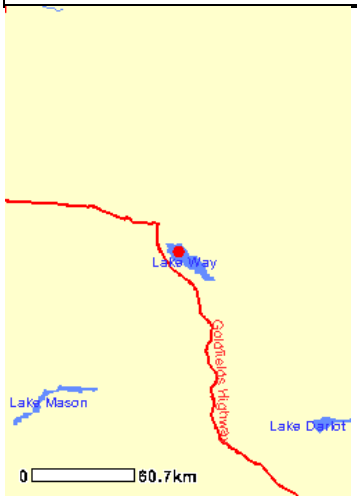
Appendix H

Environment Protection and Biodiversity Conservation (EPBC) Act

Protected Matters Database Search

Environment Protection and Biodiversity Conservation (EPBC) Act Protected Matters Database Search (22 February 2007)

EPBC Act Protected Matters Report
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report. You may wish to print this report for reference before moving to other pages or websites. The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html



Search Type:	Point
Buffer:	100 km
Coordinates:	-26.76583,120.3394
	

Report Contents:	Summary Details • Matters of NES • Other matters protected by the EPBC Act • Extra Information Caveat Acknowledgments

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	6
Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of

the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html. Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps. A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	3
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
*Acanthiza iredalei iredalei** Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata *	Vulnerable	Species or species habitat likely to occur

Malleefowl		within area
Polytelis alexandrae ***** Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Rhinonicteris aurantius (Pilbara form) ***** Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Egernia kintorei ***** Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis ***** Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Leipoa ocellata ***** Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus ***** Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus ***** Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Commonwealth Lands [Dataset Information]		
Unknown		
Places on the RNE [Dataset Information] Note that not all Indigenous sites may be listed.		
Indigenous		
Yeelirrie Pool Mythological and Occupation Site WA		
Yeelirrie Station Mythological Site WA		
Natural		
Wanjarri Nature Reserve WA		

Extra Information

State and Territory Reserves [Dataset Information]		
Wanjarri Nature Reserve, WA		

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

threatened species listed as extinct or considered as vagrants

some species and ecological communities that have only recently been listed

some terrestrial species that overfly the Commonwealth marine area

migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

non-threatened seabirds which have only been mapped for recorded breeding sites;

seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

New South Wales National Parks and Wildlife Service

Department of Sustainability and Environment, Victoria

Department of Primary Industries, Water and Environment, Tasmania

Department of Environment and Heritage, South Australia Planning SA

Parks and Wildlife Commission of the Northern Territory

Environmental Protection Agency, Queensland

Birds Australia

Australian Bird and Bat Banding Scheme

Australian National Wildlife Collection

Natural history museums of Australia

Queensland Herbarium

National Herbarium of NSW

Royal Botanic Gardens and National Herbarium of Victoria

Tasmanian Herbarium

State Herbarium of South Australia

Northern Territory Herbarium

Western Australian Herbarium

Australian National Herbarium, Atherton and Canberra

University of New England

Other groups and individuals

Appendix I
Conservation Significant Flora Database Search

Conservation Significant Flora identified in the database searches (DEC, 2007; Western Australian Herbarium, 2007)

Cons. Code	Species	Number of Records	Habitat	Nearest Pop. to Lake Maitland (approx) (km)
P4	*Acacia balsamea*	2	Occurs on red earth and gravel. Associated with rocky hills, granite breakaways.	81.0
P1	*Apatophyllum macgillivrayi*	1	Found on Kaolin rubble below low granite tor.	58.5
P3	*Baeckea* sp. Melita Stn.	4	Occurs on dark red rocky soil over ironstone. Found in Mulga shrubland.	25.6
P1	*Baeckea* sp. Sandstone	1	Occurs on orange sand and flats.	107.0
P3	*Calytrix erosipetala*	2	Found on rocky sandstone or granite breakaways.	25.7
P3	*Calytrix uncinata*	5	Occurs on white or red sand and sandy clay. Associated with granite or sandstone breakaways and rocky rises.	27.8
P1	*Eremophila congesta* ms	6	Found on lateritic outcrops in greenstone hills and stony quartzite slopes.	115.0
P1	*Eremophila flaccida* subsp. *attenuata* ms	1	Occurs on stony clay over quartzite. Found on hillslopes and ridges.	108.0
P1	*Eremophila gracillima* ms	1	Occurs on stony flats.	26.6
P4	*Eremophila pungens* ms	5	Occurs on sandy loam and clayey sand over laterite. Associated with plains, ridges and breakaways.	16.3
P1*	*Eucalyptus striaticalyx* subsp. *delicata*	1	Occurs on calcareous fine white to brown powdery silt-loams. Associated with gypseous low dunes beside salt lake systems.	90.2
P1	*Euryomyrtus inflata*	5	Occurs on deep red sand on flat plains.	86.3

Cons. Code	Species	Number of Records	Habitat	Nearest Pop. to Lake Maitland (approx) (km)
P2	*Gonocarpus ephemerus*	1	Occurs on sand, along drainage lines.	66.9
P4	*Grevillea inconspicua*	12	Occurs on loam and gravel. Found along drainage lines on rocky outcrops and creeklines.	21.7
P3	*Gunniopsis propinqua*	2	Occurs on stony sandy loam. Associated with lateritic outcrops and winter-wet sites.	73.5
P3	*Halosarcia* sp. Lake Annean (syn. cymbiformis)	1	Occurs on sand. Found on the edges of saline areas near creeklines, floodplains and sand ridges.	106.0
P4	*Hemigenia exilis*	4	Found on laterite, breakaways and slopes.	61.0
P1	*Micromyrtus chrysodema*	1	Occurs on red sands. Found on sandplains.	89.2
P3	*Mimulus repens*	1	Occurs on sand and clay. Associated with the margins of lakes and watercourses.	112.0
P2	*Olearia mucronata*	1	Found on schistose hills and along drainage channels.	56.3
P1	*Ptilotus astrolasius* var. *luteolus*	2	Found on red sandy soils, basalt and stony hills.	110.0
P1	*Stackhousia clementii*	2	Found on skeletal soils and sandstone hills. Recorded near watercourse.	98.6
P1	*Stenanthemum mediale*	1	Occurs on red clayey sand.	99.5
P1	*Thryptomene* sp. Leinster	1	Recorded on skeletal reddish loam on a low breakaway.	89.3

NB: * indicates that this species has changed conservation significance since the database searches.

Appendix J
Flora Species Matrix for the Lake Maitland Project

Flora Species Matrix of Species Recorded over the Lake Maitland project area and Occurances within Quadrats

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Abutilon otocarpum																	
Acacia ? duriuscula																	
Acacia aneura																	
Acacia aneura var. *?*																	
Acacia aneura var. *? macrocarpa*																	
Acacia aneura var. *aneura*																	
Acacia aneura var. *argentea*																	
Acacia aneura var. cf *conifera*																	
Acacia aneura var. cf *major*																	
Acacia aneura var. *fuliginea*																	
Acacia ayersiana																	
Acacia brumalis																	
Acacia burkittii																	
Acacia cuthbertsonii subsp. *linearis*																	
Acacia duriuscula																	
Acacia heteroneura var. *prolixa*																	
Acacia jennerae																	
Acacia ligulata																	
Acacia maxwellii																	
Acacia nyssophylla																	
Acacia oswaldii																	
Acacia pachyacra																	
Acacia ramulosa																	
Acacia ramulosa var. *linophylla*																	
Acacia rhodophloia																	
Acacia sibina																	
Acacia sp.																	
Acacia tetragonophylla																	
Acacia xiphophylla																	
Alyogyne pinoniana																	
Amyema gibberula var. *tatei*																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Amyema microphylla																	
Angianthus cornutus																	
Aristida contorta																	
Aristida holathera																	
Aristida holathera var. *holathera*																	
Atriplex ? lindleyi																	
Atriplex aff. *lindleyi* subsp. *inflata*																	
Atriplex amnicola																	
Atriplex bunburyana																	
Atriplex codonocarpa																	
Atriplex lindleyi subsp. *inflata*																	
Atriplex nana																	
Atriplex sp.																	
Beyeria sp.																	
Boerhavia ? schomburgkiana																	
Boerhavia cf *coccinea*																	
Boerhavia cf *schomburgkiana*																	
Boerhavia repleta																	
Bonamia sp.																	
Casuarina aff. *obesa*																	
Casuarina pauper																	
Chenopodiaceae sp.																	
Codonocarpus cotinifolius																	
Cratystylis subspinescens																	
Cynanchum floribundum																	
Dianella revoluta																	
Dicrastylis flexuosa																	
Dicrastylis sp.																	
Dodonaea amblyophylla																	
Dodonaea lobulata																	
Dodonaea viscosa subsp. *angustissima*																	
Enchylaena tomentosa																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Enchylaena tomentosa var. *tomentosa*																	
Enneapogon caerulescens																	
Enteropogon ramosus																	
Eragrostis eriopoda																	
Eragrostis lanipes																	
Eragrostis setifolia																	
Eragrostis sp.																	
Eremophea spinosa																	
Eremophila ? alternifolia																	
Eremophila falcata																	
Eremophila forrestii																	
Eremophila forrestii subsp. *? forrestii*																	
Eremophila forrestii subsp. *forrestii*																	
Eremophila gilesii																	
Eremophila gilesii subsp. *variabilis*																	
Eremophila glabra subsp. *albicans*																	
Eremophila glabra subsp. *glabra*																	
Eremophila jucunda																	
Eremophila jucunda subsp. *jucunda*																	
Eremophila latrobei																	
Eremophila latrobei subsp. *latrobei*																	
Eremophila longifolia																	
Eremophila maculata																	
Eremophila maculata subsp. *brevifolia*																	
Eremophila margarethae																	
Eremophila miniata																	
Eremophila oldfieldii subsp. *? oldfieldii*																	
Eremophila oldfieldii subsp. *?* sp																	
Eremophila oldfieldii subsp. *angustifolia*																	
Eremophila oldfieldii subsp. cf *oldfieldii*																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Eremophila platythamnos subsp. *platythamnos*																	
Eremophila shonae																	
Eremophila sp.																	
Eremophila subfloccosa subsp. *lanata*																	
Erymophyllum ramosum subsp. *ramosum*																	
Eucalyptus eremicola subsp. *peeneri*																	
Eucalyptus striaticalyx																	
Euphorbia biconvexa																	
Euphorbia drummondii																	
Exocarpos aphyllus																	
Frankenia ? pauciflora																	
Frankenia ? setosa																	
Frankenia cinerea																	
Frankenia cordata																	
Frankenia fecunda																	
Frankenia pauciflora																	
Frankenia setosa																	
Gnephosis angianthoides																	
Goodenia berardiana																	
Goodenia prostrata																	
Grevillea cf *juncifolia* subsp. *juncifolia*																	
Grevillea juncifolia subsp. *juncifolia*																	
Grevillea nematophylla																	
Grevillea nematophylla subsp. *supraplana*																	
Grevillea sarissa subsp. *bicolor*																	
Grevillea sarissa subsp. *succincta*																	
Grevillea sp.																	
Hakea lorea subsp. *lorea*																	
Hakea minyma																	
Hakea preissii																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Halgania cyanea																	
Hemigenia sp.																	
Hibiscus krichauffianus																	
Jacksonia arida																	
Kennedia prorepens																	
Lawrencia glomerata																	
Lawrencia helmsii																	
Lawrencia squamata																	
Leptosema chambersii																	
Lycium australe																	
Lysiana murrayi																	
Maireana ? pentatropis																	
Maireana amoena																	
Maireana eriosphaera																	
Maireana georgei																	
Maireana glomerifolia																	
Maireana integra																	
Maireana oppositifolia																	
Maireana prosthecochaeta																	
Maireana pyramidata																	
Maireana sedifolia																	
Maireana sp.																	
Maireana suaedifolia																	
Maireana thesioides																	
Maireana tomentosa subsp. *tomentosa*																	
Maireana trichoptera																	
Maireana triptera																	
Maireana villosa																	
Malvaceae sp.																	
Melaleuca eleuterostachya																	
Melaleuca interioris																	
Melaleuca leiocarpa																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Melaleuca sp.																	
Melaleuca uncinata																	
Melaleuca xerophila																	
Micromyrtus flaviflora																	
Monachather paradoxus																	
Muehlenbeckia florulenta																	
Muellerolimon salicorniaceum																	
Olearia calcarea																	
Olearia subspicata																	
Panicum decompositum																	
Panicum effusum																	
Paspalidium basicladium																	
Petalostylis cassioides																	
Pimelea spiculigera var. *thesioides*																	
Poaceae sp.																	
* *Portulaca oleracea*																	
Prostanthera sp.																	
Psydrax suaveolens																	
Pterocaulon sphacelatum																	
Ptilotus aervoides																	
Ptilotus exaltatus var. *exaltatus*																	
Ptilotus helipteroides																	
Ptilotus obovatus																	
Ptilotus sessilifolius																	
Rhagodia drummondii																	
Rhagodia eremaea																	
Rhagodia sp.																	
Rhyncharrhena linearis																	
Rulingia loxophleba																	
Salsola tragus																	
Santalum lanceolatum																	
Santalum spicatum																	
Scaevola collaris																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Scaevola spinescens																	
Sclerolaena alata																	
Sclerolaena convexula																	
Sclerolaena cornishiana																	
Sclerolaena cuneata																	
Sclerolaena deserticola																	
Sclerolaena eurotioides																	
Sclerolaena fimbriolata																	
Sclerolaena parviflora																	
Sclerolaena patenticuspis																	
Senna artemisioides subsp. *filifolia*																	
Senna artemisioides subsp. *helmsii*																	
Senna glutinosa subsp. *chatelainiana*																	
Senna notabilis																	
Senna sp. Meekatharra (E. Bailey 1-26)																	
Senna stowardii																	
Sida ammophila																	
Sida calyxhymenia																	
Sida cf *ammophila*																	
Sida fibulifera																	
Sida kingii																	
Sida sp. dark green fruits																	
Solanum cf *lasiophyllum*																	
Solanum cf *orbiculatum* subsp. *orbiculatum*																	
Solanum coactiliferum																	
Solanum lasiophyllum																	
Solanum nummularium																	
Solanum orbiculatum																	
Solanum orbiculatum subsp. *orbiculatum*																	
Solanum sp.																	

Species	LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	LM10	LM11	LM12	LM13	LM14	LM15	LM16	LM17
Stackhousia muricata																	
Swainsona kingii																	
Tecticornia ? undulata																	
Tecticornia aff. *undulata*																	
Tecticornia halocnemoides																	
Tecticornia indica subsp. aff. *bidens*																	
Tecticornia peltata																	
Tecticornia undulata																	
Templetonia egena																	
Tragus australianus																	
Trianthema triquetra																	
Tribulus occidentalis																	
** Tribulus terrestris*																	
Triodia basedowii																	
Triodia concinna																	
Triodia desertorum																	
Zygophyllum ? iodocarpum																	
Zygophyllum compressum																	
Zygophyllum eremaeum																	
Zygophyllum tetrapterum																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Abutilon otocarpum																	
Acacia ? duriuscula																	
Acacia aneura																	
Acacia aneura var. *?*																	
Acacia aneura var. *? macrocarpa*																	
Acacia aneura var. *aneura*																	
Acacia aneura var. *argentea*																	
Acacia aneura var. cf *conifera*																	
Acacia aneura var. cf *major*																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Acacia aneura var. *fuliginea*																	
Acacia ayersiana																	
Acacia brumalis																	
Acacia burkittii																	
Acacia cuthbertsonii subsp. *linearis*																	
Acacia duriuscula																	
Acacia heteroneura var. *prolixa*																	
Acacia jennerae																	
Acacia ligulata																	
Acacia maxwellii																	
Acacia nyssophylla																	
Acacia oswaldii																	
Acacia pachyacra																	
Acacia ramulosa																	
Acacia ramulosa var. *linophylla*																	
Acacia rhodophloia																	
Acacia sibina																	
Acacia sp.																	
Acacia tetragonophylla																	
Acacia xiphophylla																	
Alyogyne pinoniana																	
Amyema gibberula var. *tatei*																	
Amyema microphylla																	
Angianthus cornutus																	
Aristida contorta																	
Aristida holathera																	
Aristida holathera var. *holathera*																	
Atriplex ? lindleyi																	
Atriplex aff. *lindleyi* subsp. *inflata*																	
Atriplex amnicola																	
Atriplex bunburyana																	
Atriplex codonocarpa																	
Atriplex lindleyi subsp. *inflata*																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Atriplex nana																	
Atriplex sp.																	
Beyeria sp.																	
Boerhavia ? schomburgkiana																	
Boerhavia cf *coccinea*																	
Boerhavia cf *schomburgkiana*																	
Boerhavia repleta																	
Bonamia sp.																	
Casuarina aff. *obesa*																	
Casuarina pauper																	
Chenopodiaceae sp.																	
Codonocarpus cotinifolius																	
Cratystylis subspinescens																	
Cynanchum floribundum																	
Dianella revoluta																	
Dicrastylis flexuosa																	
Dicrastylis sp.																	
Dodonaea amblyophylla																	
Dodonaea lobulata																	
Dodonaea viscosa subsp. *angustissima*																	
Enchylaena tomentosa																	
Enchylaena tomentosa var. *tomentosa*																	
Enneapogon caerulescens																	
Enteropogon ramosus																	
Eragrostis eriopoda																	
Eragrostis lanipes																	
Eragrostis setifolia																	
Eragrostis sp.																	
Eremophea spinosa																	
Eremophila ? alternifolia																	
Eremophila falcata																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Eremophila forrestii																	
Eremophila forrestii subsp. *? forrestii*																	
Eremophila forrestii subsp. *forrestii*																	
Eremophila gilesii																	
Eremophila gilesii subsp. *variabilis*																	
Eremophila glabra subsp. *albicans*																	
Eremophila glabra subsp. *glabra*																	
Eremophila jucunda																	
Eremophila jucunda subsp. *jucunda*																	
Eremophila latrobei																	
Eremophila latrobei subsp. *latrobei*																	
Eremophila longifolia																	
Eremophila maculata																	
Eremophila maculata subsp. *brevifolia*																	
Eremophila margarethae																	
Eremophila miniata																	
Eremophila oldfieldii subsp. *? oldfieldii*																	
Eremophila oldfieldii subsp. *?* sp																	
Eremophila oldfieldii subsp. *angustifolia*																	
Eremophila oldfieldii subsp. cf *oldfieldii*																	
Eremophila platythamnos subsp. *platythamnos*																	
Eremophila shonae																	
Eremophila sp.																	
Eremophila subfloccosa subsp. *lanata*																	
Erymophyllum ramosum subsp. *ramosum*																	
Eucalyptus eremicola subsp. *peeneri*																	
Eucalyptus striaticalyx																	
Euphorbia biconvexa																	
Euphorbia drummondii																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Exocarpos aphyllus																	
Frankenia ? pauciflora																	
Frankenia ? setosa																	
Frankenia cinerea																	
Frankenia cordata																	
Frankenia fecunda																	
Frankenia pauciflora																	
Frankenia setosa																	
Gnephosis angianthoides																	
Goodenia berardiana																	
Goodenia prostrata																	
Grevillea cf *juncifolia* subsp. *juncifolia*																	
Grevillea juncifolia subsp. *juncifolia*																	
Grevillea nematophylla																	
Grevillea nematophylla subsp. *supraplana*																	
Grevillea sarissa subsp. *bicolor*																	
Grevillea sarissa subsp. *succincta*																	
Grevillea sp.																	
Hakea lorea subsp. *lorea*																	
Hakea minyma																	
Hakea preissii																	
Halgania cyanea																	
Hemigenia sp.																	
Hibiscus krichauffianus																	
Jacksonia arida																	
Kennedia prorepens																	
Lawrencia glomerata																	
Lawrencia helmsii																	
Lawrencia squamata																	
Leptosema chambersii																	
Lycium australe																	
Lysiana murrayi																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Maireana ? pentatropis																	
Maireana amoena																	
Maireana eriosphaera																	
Maireana georgei																	
Maireana glomerifolia																	
Maireana integra																	
Maireana oppositifolia																	
Maireana prosthecochaeta																	
Maireana pyramidata																	
Maireana sedifolia																	
Maireana sp.																	
Maireana suaedifolia																	
Maireana thesioides																	
Maireana tomentosa subsp. *tomentosa*																	
Maireana trichoptera																	
Maireana triptera																	
Maireana villosa																	
Malvaceae sp.																	
Melaleuca eleuterostachya																	
Melaleuca interioris																	
Melaleuca leiocarpa																	
Melaleuca sp.																	
Melaleuca uncinata																	
Melaleuca xerophila																	
Micromyrtus flaviflora																	
Monachather paradoxus																	
Muehlenbeckia florulenta																	
Muellerolimon salicorniaceum																	
Olearia calcarea																	
Olearia subspicata																	
Panicum decompositum																	
Panicum effusum																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Paspalidium basicladium																	
Petalostylis cassioides																	
Pimelea spiculigera var. *thesioides*																	
Poaceae sp.																	
** Portulaca oleracea*																	
Prostanthera sp.																	
Psydrax suaveolens																	
Pterocaulon sphacelatum																	
Ptilotus aervoides																	
Ptilotus exaltatus var. *exaltatus*																	
Ptilotus helipteroides																	
Ptilotus obovatus																	
Ptilotus sessilifolius																	
Rhagodia drummondii																	
Rhagodia eremaea																	
Rhagodia sp.																	
Rhyncharrhena linearis																	
Rulingia loxophleba																	
Salsola tragus																	
Santalum lanceolatum																	
Santalum spicatum																	
Scaevola collaris																	
Scaevola spinescens																	
Sclerolaena alata																	
Sclerolaena convexula																	
Sclerolaena cornishiana																	
Sclerolaena cuneata																	
Sclerolaena deserticola																	
Sclerolaena eurotioides																	
Sclerolaena fimbriolata																	
Sclerolaena parviflora																	
Sclerolaena patenticuspis																	
Senna artemisioides subsp. *filifolia*																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Senna artemisioides subsp. *helmsii*																	
Senna glutinosa subsp. *chatelainiana*																	
Senna notabilis																	
Senna sp. Meekatharra (E. Bailey 1-26)																	
Senna stowardii																	
Sida ammophila																	
Sida calyxhymenia																	
Sida cf *ammophila*																	
Sida fibulifera																	
Sida kingii																	
Sida sp. dark green fruits																	
Solanum cf *lasiophyllum*																	
Solanum cf *orbiculatum* subsp. *orbiculatum*																	
Solanum coactiliferum																	
Solanum lasiophyllum																	
Solanum nummularium																	
Solanum orbiculatum																	
Solanum orbiculatum subsp. *orbiculatum*																	
Solanum sp.																	
Stackhousia muricata																	
Swainsona kingii																	
Tecticornia ? undulata																	
Tecticornia aff. *undulata*																	
Tecticornia halocnemoides																	
Tecticornia indica subsp. aff. *bidens*																	
Tecticornia peltata																	
Tecticornia undulata																	
Templetonia egena																	
Tragus australianus																	
Trianthema triquetra																	

Species	LM18	LM19	LM20	LM21	LM22	LM23	LM24	LM25	LM26	LM27	LM28	LM29	LM30	LM31	LM32	LM33	LM34
Tribulus occidentalis																	
* *Tribulus terrestris*																	
Triodia basedowii																	
Triodia concinna																	
Triodia desertorum																	
Zygophyllum ? iodocarpum																	
Zygophyllum compressum																	
Zygophyllum eremaeum																	
Zygophyllum tetrapterum																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Abutilon otocarpum																	
Acacia ? duriuscula																	
Acacia aneura																	
Acacia aneura var. *?*																	
Acacia aneura var. *? macrocarpa*																	
Acacia aneura var. *aneura*																	
Acacia aneura var. *argentea*																	
Acacia aneura var. cf *conifera*																	
Acacia aneura var. cf *major*																	
Acacia aneura var. *fuliginea*																	
Acacia ayersiana																	
Acacia brumalis																	
Acacia burkittii																	
Acacia cuthbertsonii subsp. *linearis*																	
Acacia duriuscula																	
Acacia heteroneura var. *prolixa*																	
Acacia jennerae																	
Acacia ligulata																	
Acacia maxwellii																	
Acacia nyssophylla																	
Acacia oswaldii																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Acacia pachyacra																	
Acacia ramulosa																	
Acacia ramulosa var. *linophylla*																	
Acacia rhodophloia																	
Acacia sibina																	
Acacia sp.																	
Acacia tetragonophylla																	
Acacia xiphophylla																	
Alyogyne pinoniana																	
Amyema gibberula var. *tatei*																	
Amyema microphylla																	
Angianthus cornutus																	
Aristida contorta																	
Aristida holathera																	
Aristida holathera var. *holathera*																	
Atriplex ? lindleyi																	
Atriplex aff. *lindleyi* subsp. *inflata*																	
Atriplex amnicola																	
Atriplex bunburyana																	
Atriplex codonocarpa																	
Atriplex lindleyi subsp. *inflata*																	
Atriplex nana																	
Atriplex sp.																	
Beyeria sp.																	
Boerhavia ? schomburgkiana																	
Boerhavia cf *coccinea*																	
Boerhavia cf *schomburgkiana*																	
Boerhavia repleta																	
Bonamia sp.																	
Casuarina aff. *obesa*																	
Casuarina pauper																	
Chenopodiaceae sp.																	
Codonocarpus cotinifolius																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Cratystylis subspinescens																	
Cynanchum floribundum																	
Dianella revoluta																	
Dicrastylis flexuosa																	
Dicrastylis sp.																	
Dodonaea amblyophylla																	
Dodonaea lobulata																	
Dodonaea viscosa subsp. *angustissima*																	
Enchylaena tomentosa																	
Enchylaena tomentosa var. *tomentosa*																	
Enneapogon caerulescens																	
Enteropogon ramosus																	
Eragrostis eriopoda																	
Eragrostis lanipes																	
Eragrostis setifolia																	
Eragrostis sp.																	
Eremophea spinosa																	
Eremophila ? alternifolia																	
Eremophila falcata																	
Eremophila forrestii																	
Eremophila forrestii subsp. *? forrestii*																	
Eremophila forrestii subsp. *forrestii*																	
Eremophila gilesii																	
Eremophila gilesii subsp. *variabilis*																	
Eremophila glabra subsp. *albicans*																	
Eremophila glabra subsp. *glabra*																	
Eremophila jucunda																	
Eremophila jucunda subsp. *jucunda*																	
Eremophila latrobei																	
Eremophila latrobei subsp. *latrobei*																	
Eremophila longifolia																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Eremophila maculata																	
Eremophila maculata subsp. *brevifolia*																	
Eremophila margarethae																	
Eremophila miniata																	
Eremophila oldfieldii subsp. *? oldfieldii*																	
Eremophila oldfieldii subsp. *?* sp																	
Eremophila oldfieldii subsp. *angustifolia*																	
Eremophila oldfieldii subsp. cf *oldfieldii*																	
Eremophila platythamnos subsp. *platythamnos*																	
Eremophila shonae																	
Eremophila sp.																	
Eremophila subfloccosa subsp. *lanata*																	
Erymophyllum ramosum subsp. *ramosum*																	
Eucalyptus eremicola subsp. *peeneri*																	
Eucalyptus striaticalyx																	
Euphorbia biconvexa																	
Euphorbia drummondii																	
Exocarpos aphyllus																	
Frankenia ? pauciflora																	
Frankenia ? setosa																	
Frankenia cinerea																	
Frankenia cordata																	
Frankenia fecunda																	
Frankenia pauciflora																	
Frankenia setosa																	
Gnephosis angianthoides																	
Goodenia berardiana																	
Goodenia prostrata																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Grevillea cf *juncifolia* subsp. *juncifolia*																	
Grevillea juncifolia subsp. *juncifolia*																	
Grevillea nematophylla																	
Grevillea nematophylla subsp. *supraplana*																	
Grevillea sarissa subsp. *bicolor*																	
Grevillea sarissa subsp. *succincta*																	
Grevillea sp.																	
Hakea lorea subsp. *lorea*																	
Hakea minyma																	
Hakea preissii																	
Halgania cyanea																	
Hemigenia sp.																	
Hibiscus krichauffianus																	
Jacksonia arida																	
Kennedia prorepens																	
Lawrencia glomerata																	
Lawrencia helmsii																	
Lawrencia squamata																	
Leptosema chambersii																	
Lycium australe																	
Lysiana murrayi																	
Maireana ? pentatropis																	
Maireana amoena																	
Maireana eriosphaera																	
Maireana georgei																	
Maireana glomerifolia																	
Maireana integra																	
Maireana oppositifolia																	
Maireana prosthecochaeta																	
Maireana pyramidata																	
Maireana sedifolia																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Maireana sp.																	
Maireana suaedifolia																	
Maireana thesioides																	
Maireana tomentosa subsp. *tomentosa*																	
Maireana trichoptera																	
Maireana triptera																	
Maireana villosa																	
Malvaceae sp.																	
Melaleuca eleuterostachya																	
Melaleuca interioris																	
Melaleuca leiocarpa																	
Melaleuca sp.																	
Melaleuca uncinata																	
Melaleuca xerophila																	
Micromyrtus flaviflora																	
Monachather paradoxus																	
Muehlenbeckia florulenta																	
Muellerolimon salicorniaceum																	
Olearia calcarea																	
Olearia subspicata																	
Panicum decompositum																	
Panicum effusum																	
Paspalidium basicladium																	
Petalostylis cassioides																	
Pimelea spiculigera var. *thesioides*																	
Poaceae sp.																	
* *Portulaca oleracea*																	
Prostanthera sp.																	
Psydrax suaveolens																	
Pterocaulon sphacelatum																	
Ptilotus aervoides																	
Ptilotus exaltatus var. *exaltatus*																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Ptilotus helipteroides																	
Ptilotus obovatus																	
Ptilotus sessilifolius																	
Rhagodia drummondii																	
Rhagodia eremaea																	
Rhagodia sp.																	
Rhyncharrhena linearis																	
Rulingia loxophleba																	
Salsola tragus																	
Santalum lanceolatum																	
Santalum spicatum																	
Scaevola collaris																	
Scaevola spinescens																	
Sclerolaena alata																	
Sclerolaena convexula																	
Sclerolaena cornishiana																	
Sclerolaena cuneata																	
Sclerolaena deserticola																	
Sclerolaena eurotioides																	
Sclerolaena fimbriolata																	
Sclerolaena parviflora																	
Sclerolaena patenticuspis																	
Senna artemisioides subsp. *filifolia*																	
Senna artemisioides subsp. *helmsii*																	
Senna glutinosa subsp. *chatelainiana*																	
Senna notabilis																	
Senna sp. Meekatharra (E. Bailey 1-26)																	
Senna stowardii																	
Sida ammophila																	
Sida calyxhymenia																	
Sida cf *ammophila*																	
Sida fibulifera																	

Species	LM35	LM36	LM37	LM38	LM39	LM40	LM41	LM42	LM43	LM44	LM45	LM46	LM47	LM48	LM49	LM50	LM51
Sida kingii																	
Sida sp. dark green fruits																	
Solanum cf *lasiophyllum*																	
Solanum cf *orbiculatum* subsp. *orbiculatum*																	
Solanum coactiliferum																	
Solanum lasiophyllum																	
Solanum nummularium																	
Solanum orbiculatum																	
Solanum orbiculatum subsp. *orbiculatum*																	
Solanum sp.																	
Stackhousia muricata																	
Swainsona kingii																	
Tecticornia ? undulata																	
Tecticornia aff. *undulata*																	
Tecticornia halocnemoides																	
Tecticornia indica subsp. aff. *bidens*																	
Tecticornia peltata																	
Tecticornia undulata																	
Templetonia egena																	
Tragus australianus																	
Trianthema triquetra																	
Tribulus occidentalis																	
* *Tribulus terrestris*																	
Triodia basedowii																	
Triodia concinna																	
Triodia desertorum																	
Zygophyllum ? iodocarpum																	
Zygophyllum compressum																	
Zygophyllum eremaeum																	
Zygophyllum tetrapterum																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Abutilon otocarpum																	
Acacia ? duriuscula																	
Acacia aneura																	
Acacia aneura var. *?*																	
Acacia aneura var. *? macrocarpa*																	
Acacia aneura var. *aneura*																	
Acacia aneura var. *argentea*																	
Acacia aneura var. cf *conifera*																	
Acacia aneura var. cf *major*																	
Acacia aneura var. *fuliginea*																	
Acacia ayersiana																	
Acacia brumalis																	
Acacia burkittii																	
Acacia cuthbertsonii subsp. *linearis*																	
Acacia duriuscula																	
Acacia heteroneura var. *prolixa*																	
Acacia jennerae																	
Acacia ligulata																	
Acacia maxwellii																	
Acacia nyssophylla																	
Acacia oswaldii																	
Acacia pachyacra																	
Acacia ramulosa																	
Acacia ramulosa var. *linophylla*																	
Acacia rhodophloia																	
Acacia sibina																	
Acacia sp.																	
Acacia tetragonophylla																	
Acacia xiphophylla																	
Alyogyne pinoniana																	
Amyema gibberula var. *tatei*																	
Amyema microphylla																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Angianthus cornutus																	
Aristida contorta																	
Aristida holathera																	
Aristida holathera var. *holathera*																	
Atriplex ? lindleyi																	
Atriplex aff. *lindleyi* subsp. *inflata*																	
Atriplex amnicola																	
Atriplex bunburyana																	
Atriplex codonocarpa																	
Atriplex lindleyi subsp. *inflata*																	
Atriplex nana																	
Atriplex sp.																	
Beyeria sp.																	
Boerhavia ? schomburgkiana																	
Boerhavia cf *coccinea*																	
Boerhavia cf *schomburgkiana*																	
Boerhavia repleta																	
Bonamia sp.																	
Casuarina aff. *obesa*																	
Casuarina pauper																	
Chenopodiaceae sp.																	
Codonocarpus cotinifolius																	
Cratystylis subspinescens																	
Cynanchum floribundum																	
Dianella revoluta																	
Dicrastylis flexuosa																	
Dicrastylis sp.																	
Dodonaea amblyophylla																	
Dodonaea lobulata																	
Dodonaea viscosa subsp. *angustissima*																	
Enchylaena tomentosa																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Enchylaena tomentosa var. *tomentosa*																	
Enneapogon caerulescens																	
Enteropogon ramosus																	
Eragrostis eriopoda																	
Eragrostis lanipes																	
Eragrostis setifolia																	
Eragrostis sp.																	
Eremophea spinosa																	
Eremophila ? alternifolia																	
Eremophila falcata																	
Eremophila forrestii																	
Eremophila forrestii subsp. *? forrestii*																	
Eremophila forrestii subsp. *forrestii*																	
Eremophila gilesii																	
Eremophila gilesii subsp. *variabilis*																	
Eremophila glabra subsp. *albicans*																	
Eremophila glabra subsp. *glabra*																	
Eremophila jucunda																	
Eremophila jucunda subsp. *jucunda*																	
Eremophila latrobei																	
Eremophila latrobei subsp. *latrobei*																	
Eremophila longifolia																	
Eremophila maculata																	
Eremophila maculata subsp. *brevifolia*																	
Eremophila margarethae																	
Eremophila miniata																	
Eremophila oldfieldii subsp. *? oldfieldii*																	
Eremophila oldfieldii subsp. *?* sp																	
Eremophila oldfieldii subsp. *angustifolia*																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Eremophila oldfieldii subsp. cf *oldfieldii*																	
Eremophila platythamnos subsp. *platythamnos*																	
Eremophila shonae																	
Eremophila sp.																	
Eremophila subfloccosa subsp. *lanata*																	
Erymophyllum ramosum subsp. *ramosum*																	
Eucalyptus eremicola subsp. *peeneri*																	
Eucalyptus striaticalyx																	
Euphorbia biconvexa																	
Euphorbia drummondii																	
Exocarpos aphyllus																	
Frankenia ? pauciflora																	
Frankenia ? setosa																	
Frankenia cinerea																	
Frankenia cordata																	
Frankenia fecunda																	
Frankenia pauciflora																	
Frankenia setosa																	
Gnephosis angianthoides																	
Goodenia berardiana																	
Goodenia prostrata																	
Grevillea cf *juncifolia* subsp. *juncifolia*																	
Grevillea juncifolia subsp. *juncifolia*																	
Grevillea nematophylla																	
Grevillea nematophylla subsp. *supraplana*																	
Grevillea sarissa subsp. *bicolor*																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Grevillea sarissa subsp. *succincta*																	
Grevillea sp.																	
Hakea lorea subsp. *lorea*																	
Hakea minyma																	
Hakea preissii																	
Halgania cyanea																	
Hemigenia sp.																	
Hibiscus krichauffianus																	
Jacksonia arida																	
Kennedia prorepens																	
Lawrencia glomerata																	
Lawrencia helmsii																	
Lawrencia squamata																	
Leptosema chambersii																	
Lycium australe																	
Lysiana murrayi																	
Maireana ? pentatropis																	
Maireana amoena																	
Maireana eriosphaera																	
Maireana georgei																	
Maireana glomerifolia																	
Maireana integra																	
Maireana oppositifolia																	
Maireana prosthecochaeta																	
Maireana pyramidata																	
Maireana sedifolia																	
Maireana sp.																	
Maireana suaedifolia																	
Maireana thesioides																	
Maireana tomentosa subsp. *tomentosa*																	
Maireana trichoptera																	
Maireana triptera																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Maireana villosa																	
Malvaceae sp.																	
Melaleuca eleuterostachya																	
Melaleuca interioris																	
Melaleuca leiocarpa																	
Melaleuca sp.																	
Melaleuca uncinata																	
Melaleuca xerophila																	
Micromyrtus flaviflora																	
Monachather paradoxus																	
Muehlenbeckia florulenta																	
Muellerolimon salicorniaceum																	
Olearia calcarea																	
Olearia subspicata																	
Panicum decompositum																	
Panicum effusum																	
Paspalidium basicladium																	
Petalostylis cassioides																	
Pimelea spiculigera var. *thesioides*																	
Poaceae sp.																	
* *Portulaca oleracea*																	
Prostanthera sp.																	
Psydrax suaveolens																	
Pterocaulon sphacelatum																	
Ptilotus aervoides																	
Ptilotus exaltatus var. *exaltatus*																	
Ptilotus helipteroides																	
Ptilotus obovatus																	
Ptilotus sessilifolius																	
Rhagodia drummondii																	
Rhagodia eremaea																	
Rhagodia sp.																	
Rhyncharrhena linearis																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Rulingia loxophleba																	
Salsola tragus																	
Santalum lanceolatum																	
Santalum spicatum																	
Scaevola collaris																	
Scaevola spinescens																	
Sclerolaena alata																	
Sclerolaena convexula																	
Sclerolaena cornishiana																	
Sclerolaena cuneata																	
Sclerolaena deserticola																	
Sclerolaena eurotioides																	
Sclerolaena fimbriolata																	
Sclerolaena parviflora																	
Sclerolaena patenticuspis																	
Senna artemisioides subsp. *filifolia*																	
Senna artemisioides subsp. *helmsii*																	
Senna glutinosa subsp. *chatelainiana*																	
Senna notabilis																	
Senna sp. Meekatharra (E. Bailey 1-26)																	
Senna stowardii																	
Sida ammophila																	
Sida calyxhymenia																	
Sida cf *ammophila*																	
Sida fibulifera																	
Sida kingii																	
Sida sp. dark green fruits																	
Solanum cf *lasiophyllum*																	
Solanum cf *orbiculatum* subsp. *orbiculatum*																	
Solanum coactiliferum																	

Species	LM52	LM53	LM54	LM55	LM56	LM57	LM58	LM59	LM60	LM61	LM62	LM63	LM64	LM65	LM66	LM67	LM68
Solanum lasiophyllum																	
Solanum nummularium																	
Solanum orbiculatum																	
Solanum orbiculatum subsp. *orbiculatum*																	
Solanum sp.																	
Stackhousia muricata																	
Swainsona kingii																	
Tecticornia ? undulata																	
Tecticornia aff. *undulata*																	
Tecticornia halocnemoides																	
Tecticornia indica subsp. aff. *bidens*																	
Tecticornia peltata																	
Tecticornia undulata																	
Templetonia egena																	
Tragus australianus																	
Trianthema triquetra																	
Tribulus occidentalis																	
** Tribulus terrestris*																	
Triodia basedowii																	
Triodia concinna																	
Triodia desertorum																	
Zygophyllum ? iodocarpum																	
Zygophyllum compressum																	
Zygophyllum eremaeum																	
Zygophyllum tetrapterum																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Abutilon otocarpum																	
Acacia ? duriuscula																	
Acacia aneura																	
Acacia aneura var. *?*																	
Acacia aneura var. *? macrocarpa*																	
Acacia aneura var. *aneura*																	
Acacia aneura var. *argentea*																	
Acacia aneura var. cf *conifera*																	
Acacia aneura var. cf *major*																	
Acacia aneura var. *fuliginea*																	
Acacia ayersiana																	
Acacia brumalis																	
Acacia burkittii																	
Acacia cuthbertsonii subsp. *linearis*																	
Acacia duriuscula																	
Acacia heteroneura var. *prolixa*																	
Acacia jennerae																	
Acacia ligulata																	
Acacia maxwellii																	
Acacia nyssophylla																	
Acacia oswaldii																	
Acacia pachyacra																	
Acacia ramulosa																	
Acacia ramulosa var. *linophylla*																	
Acacia rhodophloia																	
Acacia sibina																	
Acacia sp.																	
Acacia tetragonophylla																	
Acacia xiphophylla																	
Alyogyne pinoniana																	
Amyema gibberula var. *tatei*																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Amyema microphylla																	
Angianthus cornutus																	
Aristida contorta																	
Aristida holathera																	
Aristida holathera var. *holathera*																	
Atriplex ? lindleyi																	
Atriplex aff. *lindleyi* subsp. *inflata*																	
Atriplex amnicola																	
Atriplex bunburyana																	
Atriplex codonocarpa																	
Atriplex lindleyi subsp. *inflata*																	
Atriplex nana																	
Atriplex sp.																	
Beyeria sp.																	
Boerhavia ? schomburgkiana																	
Boerhavia cf *coccinea*																	
Boerhavia cf *schomburgkiana*																	
Boerhavia repleta																	
Bonamia sp.																	
Casuarina aff. *obesa*																	
Casuarina pauper																	
Chenopodiaceae sp.																	
Codonocarpus cotinifolius																	
Cratystylis subspinescens																	
Cynanchum floribundum																	
Dianella revoluta																	
Dicrastylis flexuosa																	
Dicrastylis sp.																	
Dodonaea amblyophylla																	
Dodonaea lobulata																	
Dodonaea viscosa subsp. *angustissima*																	
Enchylaena tomentosa																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Enchylaena tomentosa var. *tomentosa*																	
Enneapogon caerulescens																	
Enteropogon ramosus																	
Eragrostis eriopoda																	
Eragrostis lanipes																	
Eragrostis setifolia																	
Eragrostis sp.																	
Eremophea spinosa																	
Eremophila ? alternifolia																	
Eremophila falcata																	
Eremophila forrestii																	
Eremophila forrestii subsp. *? forrestii*																	
Eremophila forrestii subsp. *forrestii*																	
Eremophila gilesii																	
Eremophila gilesii subsp. *variabilis*																	
Eremophila glabra subsp. *albicans*																	
Eremophila glabra subsp. *glabra*																	
Eremophila jucunda																	
Eremophila jucunda subsp. *jucunda*																	
Eremophila latrobei																	
Eremophila latrobei subsp. *latrobei*																	
Eremophila longifolia																	
Eremophila maculata																	
Eremophila maculata subsp. *brevifolia*																	
Eremophila margarethae																	
Eremophila miniata																	
Eremophila oldfieldii subsp. *? oldfieldii*																	
Eremophila oldfieldii subsp. *?* sp																	
Eremophila oldfieldii subsp. *angustifolia*																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Eremophila oldfieldii subsp. cf *oldfieldii*																	
Eremophila platythamnos subsp. *platythamnos*																	
Eremophila shonae																	
Eremophila sp.																	
Eremophila subfloccosa subsp. *lanata*																	
Erymophyllum ramosum subsp. *ramosum*																	
Eucalyptus eremicola subsp. *peeneri*																	
Eucalyptus striaticalyx																	
Euphorbia biconvexa																	
Euphorbia drummondii																	
Exocarpos aphyllus																	
Frankenia ? pauciflora																	
Frankenia ? setosa																	
Frankenia cinerea																	
Frankenia cordata																	
Frankenia fecunda																	
Frankenia pauciflora																	
Frankenia setosa																	
Gnephosis angianthoides																	
Goodenia berardiana																	
Goodenia prostrata																	
Grevillea cf *juncifolia* subsp. *juncifolia*																	
Grevillea juncifolia subsp. *juncifolia*																	
Grevillea nematophylla																	
Grevillea nematophylla subsp. *supraplana*																	
Grevillea sarissa subsp. *bicolor*																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Grevillea sarissa subsp. *succincta*																	
Grevillea sp.																	
Hakea lorea subsp. *lorea*																	
Hakea minyma																	
Hakea preissii																	
Halgania cyanea																	
Hemigenia sp.																	
Hibiscus krichauffianus																	
Jacksonia arida																	
Kennedia prorepens																	
Lawrencia glomerata																	
Lawrencia helmsii																	
Lawrencia squamata																	
Leptosema chambersii																	
Lycium australe																	
Lysiana murrayi																	
Maireana ? pentatropis																	
Maireana amoena																	
Maireana eriosphaera																	
Maireana georgei																	
Maireana glomerifolia																	
Maireana integra																	
Maireana oppositifolia																	
Maireana prosthecochaeta																	
Maireana pyramidata																	
Maireana sedifolia																	
Maireana sp.																	
Maireana suaedifolia																	
Maireana thesioides																	
Maireana tomentosa subsp. *tomentosa*																	
Maireana trichoptera																	
Maireana triptera																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Maireana villosa																	
Malvaceae sp.																	
Melaleuca eleuterostachya																	
Melaleuca interioris																	
Melaleuca leiocarpa																	
Melaleuca sp.																	
Melaleuca uncinata																	
Melaleuca xerophila																	
Micromyrtus flaviflora																	
Monachather paradoxus																	
Muehlenbeckia florulenta																	
Muellerolimon salicorniaceum																	
Olearia calcarea																	
Olearia subspicata																	
Panicum decompositum																	
Panicum effusum																	
Paspalidium basicladium																	
Petalostylis cassioides																	
Pimelea spiculigera var. *thesioides*																	
Poaceae sp.																	
* *Portulaca oleracea*																	
Prostanthera sp.																	
Psydrax suaveolens																	
Pterocaulon sphacelatum																	
Ptilotus aervoides																	
Ptilotus exaltatus var. *exaltatus*																	
Ptilotus helipteroides																	
Ptilotus obovatus																	
Ptilotus sessilifolius																	
Rhagodia drummondii																	
Rhagodia eremaea																	
Rhagodia sp.																	
Rhyncharrhena linearis																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Rulingia loxophleba																	
Salsola tragus																	
Santalum lanceolatum																	
Santalum spicatum																	
Scaevola collaris																	
Scaevola spinescens																	
Sclerolaena alata																	
Sclerolaena convexula																	
Sclerolaena cornishiana																	
Sclerolaena cuneata																	
Sclerolaena deserticola																	
Sclerolaena eurotioides																	
Sclerolaena fimbriolata																	
Sclerolaena parviflora																	
Sclerolaena patenticuspis																	
Senna artemisioides subsp. *filifolia*																	
Senna artemisioides subsp. *helmsii*																	
Senna glutinosa subsp. *chatelainiana*																	
Senna notabilis																	
Senna sp. Meekatharra (E. Bailey 1-26)																	
Senna stowardii																	
Sida ammophila																	
Sida calyxhymenia																	
Sida cf *ammophila*																	
Sida fibulifera																	
Sida kingii																	
Sida sp. dark green fruits																	
Solanum cf *lasiophyllum*																	
Solanum cf *orbiculatum* subsp. *orbiculatum*																	
Solanum coactiliferum																	

Species	LM69	LM70	LM71	LM72	LM73	LM75	LM76	LM77	LM78	LM79	LM80	LM81	LM82	LM83	LM84	LM85	LM86
Solanum lasiophyllum																	
Solanum nummularium																	
Solanum orbiculatum																	
Solanum orbiculatum subsp. *orbiculatum*																	
Solanum sp.																	
Stackhousia muricata																	
Swainsona kingii																	
Tecticornia ? undulata																	
Tecticornia aff. *undulata*																	
Tecticornia halocnemoides																	
Tecticornia indica subsp. aff. *bidens*																	
Tecticornia peltata																	
Tecticornia undulata																	
Templetonia egena																	
Tragus australianus																	
Trianthema triquetra																	
Tribulus occidentalis																	
** Tribulus terrestris*																	
Triodia basedowii																	
Triodia concinna																	
Triodia desertorum																	
Zygophyllum ? iodocarpum																	
Zygophyllum compressum																	
Zygophyllum eremaeum																	
Zygophyllum tetrapterum																	

Species	LM87	LM88	LM89	LM90	LM91	LM92
Abutilon otocarpum						
Acacia ? duriuscula						
Acacia aneura						
Acacia aneura var. *?*						
Acacia aneura var. *? macrocarpa*						
Acacia aneura var. *aneura*						
Acacia aneura var. *argentea*						
Acacia aneura var. cf *conifera*						
Acacia aneura var. cf *major*						
Acacia aneura var. *fuliginea*						
Acacia ayersiana						
Acacia brumalis						
Acacia burkittii						
Acacia cuthbertsonii subsp. *linearis*						
Acacia duriuscula						
Acacia heteroneura var. *prolixa*						
Acacia jennerae						
Acacia ligulata						
Acacia maxwellii						
Acacia nyssophylla						
Acacia oswaldii						
Acacia pachyacra						
Acacia ramulosa						
Acacia ramulosa var. *linophylla*						
Acacia rhodophloia						
Acacia sibina						
Acacia sp.						
Acacia tetragonophylla						
Acacia xiphophylla						
Alyogyne pinoniana						
Amyema gibberula var. *tatei*						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Amyema microphylla						
Angianthus cornutus						
Aristida contorta						
Aristida holathera						
Aristida holathera var. *holathera*						
Atriplex ? lindleyi						
Atriplex aff. *lindleyi* subsp. *inflata*						
Atriplex amnicola						
Atriplex bunburyana						
Atriplex codonocarpa						
Atriplex lindleyi subsp. *inflata*						
Atriplex nana						
Atriplex sp.						
Beyeria sp.						
Boerhavia ? schomburgkiana						
Boerhavia cf *coccinea*						
Boerhavia cf *schomburgkiana*						
Boerhavia repleta						
Bonamia sp.						
Casuarina aff. *obesa*						
Casuarina pauper						
Chenopodiaceae sp.						
Codonocarpus cotinifolius						
Cratystylis subspinescens						
Cynanchum floribundum						
Dianella revoluta						
Dicrastylis flexuosa						
Dicrastylis sp.						
Dodonaea amblyophylla						
Dodonaea lobulata						
Dodonaea viscosa subsp. *angustissima*						
Enchylaena tomentosa						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Enchylaena tomentosa var. *tomentosa*						
Enneapogon caerulescens						
Enteropogon ramosus						
Eragrostis eriopoda						
Eragrostis lanipes						
Eragrostis setifolia						
Eragrostis sp.						
Eremophea spinosa						
Eremophila ? alternifolia						
Eremophila falcata						
Eremophila forrestii						
Eremophila forrestii subsp. *? forrestii*						
Eremophila forrestii subsp. *forrestii*						
Eremophila gilesii						
Eremophila gilesii subsp. *variabilis*						
Eremophila glabra subsp. *albicans*						
Eremophila glabra subsp. *glabra*						
Eremophila jucunda						
Eremophila jucunda subsp. *jucunda*						
Eremophila latrobei						
Eremophila latrobei subsp. *latrobei*						
Eremophila longifolia						
Eremophila maculata						
Eremophila maculata subsp. *brevifolia*						
Eremophila margarethae						
Eremophila miniata						
Eremophila oldfieldii subsp. *? oldfieldii*						
Eremophila oldfieldii subsp. *?* sp						
Eremophila oldfieldii subsp. *angustifolia*						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Eremophila oldfieldii subsp. cf *oldfieldii*						
Eremophila platythamnos subsp. *platythamnos*						
Eremophila shonae						
Eremophila sp.						
Eremophila subfloccosa subsp. *lanata*						
Erymophyllum ramosum subsp. *ramosum*						
Eucalyptus eremicola subsp. *peeneri*						
Eucalyptus striaticalyx						
Euphorbia biconvexa						
Euphorbia drummondii						
Exocarpos aphyllus						
Frankenia ? pauciflora						
Frankenia ? setosa						
Frankenia cinerea						
Frankenia cordata						
Frankenia fecunda						
Frankenia pauciflora						
Frankenia setosa						
Gnephosis angianthoides						
Goodenia berardiana						
Goodenia prostrata						
Grevillea cf *juncifolia* subsp. *juncifolia*						
Grevillea juncifolia subsp. *juncifolia*						
Grevillea nematophylla						
Grevillea nematophylla subsp. *supraplana*						
Grevillea sarissa subsp. *bicolor*						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Grevillea sarissa subsp. *succincta*						
Grevillea sp.						
Hakea lorea subsp. *lorea*						
Hakea minyma						
Hakea preissii						
Halgania cyanea						
Hemigenia sp.						
Hibiscus krichauffianus						
Jacksonia arida						
Kennedia prorepens						
Lawrencia glomerata						
Lawrencia helmsii						
Lawrencia squamata						
Leptosema chambersii						
Lycium australe						
Lysiana murrayi						
Maireana ? pentatropis						
Maireana amoena						
Maireana eriosphaera						
Maireana georgei						
Maireana glomerifolia						
Maireana integra						
Maireana oppositifolia						
Maireana prosthecochaeta						
Maireana pyramidata						
Maireana sedifolia						
Maireana sp.						
Maireana suaedifolia						
Maireana thesioides						
Maireana tomentosa subsp. *tomentosa*						
Maireana trichoptera						
Maireana triptera						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Maireana villosa						
Malvaceae sp.						
Melaleuca eleuterostachya						
Melaleuca interioris						
Melaleuca leiocarpa						
Melaleuca sp.						
Melaleuca uncinata						
Melaleuca xerophila						
Micromyrtus flaviflora						
Monachather paradoxus						
Muehlenbeckia florulenta						
Muellerolimon salicorniaceum						
Olearia calcarea						
Olearia subspicata						
Panicum decompositum						
Panicum effusum						
Paspalidium basicladium						
Petalostylis cassioides						
Pimelea spiculigera var. *thesioides*						
Poaceae sp.						
* *Portulaca oleracea*						
Prostanthera sp.						
Psydrax suaveolens						
Pterocaulon sphacelatum						
Ptilotus aervoides						
Ptilotus exaltatus var. *exaltatus*						
Ptilotus helipteroides						
Ptilotus obovatus						
Ptilotus sessilifolius						
Rhagodia drummondii						
Rhagodia eremaea						
Rhagodia sp.						
Rhyncharrhena linearis						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Rulingia loxophleba						
Salsola tragus						
Santalum lanceolatum						
Santalum spicatum						
Scaevola collaris						
Scaevola spinescens						
Sclerolaena alata						
Sclerolaena convexula						
Sclerolaena cornishiana						
Sclerolaena cuneata						
Sclerolaena deserticola						
Sclerolaena eurotioides						
Sclerolaena fimbriolata						
Sclerolaena parviflora						
Sclerolaena patenticuspis						
Senna artemisioides subsp. *filifolia*						
Senna artemisioides subsp. *helmsii*						
Senna glutinosa subsp. *chatelainiana*						
Senna notabilis						
Senna sp. Meekatharra (E. Bailey 1-26)						
Senna stowardii						
Sida ammophila						
Sida calyxhymenia						
Sida cf *ammophila*						
Sida fibulifera						
Sida kingii						
Sida sp. dark green fruits						
Solanum cf *lasiophyllum*						
Solanum cf *orbiculatum* subsp. *orbiculatum*						
Solanum coactiliferum						

Species	LM87	LM88	LM89	LM90	LM91	LM92
Solanum lasiophyllum						
Solanum nummularium						
Solanum orbiculatum						
Solanum orbiculatum subsp. *orbiculatum*						
Solanum sp.						
Stackhousia muricata						
Swainsona kingii						
Tecticornia ? undulata						
Tecticornia aff. *undulata*						
Tecticornia halocnemoides						
Tecticornia indica subsp. aff. *bidens*						
Tecticornia peltata						
Tecticornia undulata						
Templetonia egena						
Tragus australianus						
Trianthema triquetra						
Tribulus occidentalis						
* *Tribulus terrestris*						
Triodia basedowii						
Triodia concinna						
Triodia desertorum						
Zygophyllum ? iodocarpum						
Zygophyllum compressum						
Zygophyllum eremaeum						
Zygophyllum tetrapterum						

* Denotes introduced species

Appendix K

Site Observations from Data Recorded within Quadrats during May and November 2007 Surveys

Lake Maitland **Site** LM01

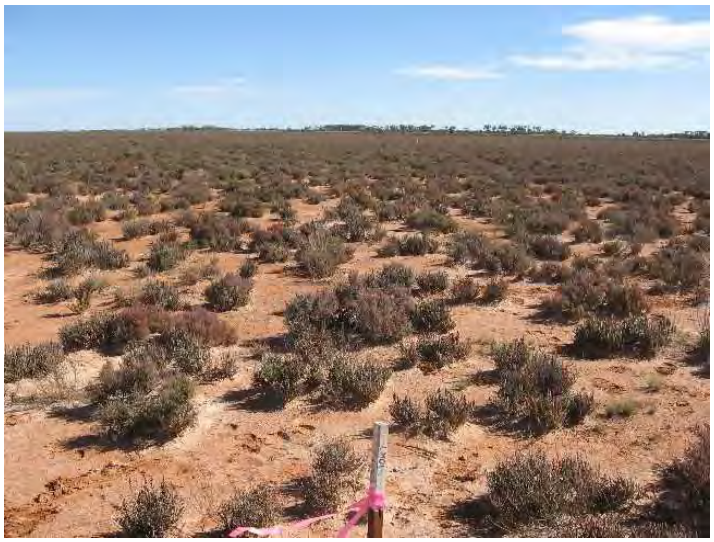
Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310001 **mE** 6990702 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Old track, vegetation doing very well

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex nana			0.15 m	BN008	just outside quadrat
	Eragrostis lanipes	15		0.1 m	BN007	
	Maireana amoena	2		0.3 m	BN005	
	Maireana sp.	2		0.2 m	BN004	
	Scaevola collaris	2		0.15 m	BN006	
	Tecticornia aff. undulata	15		0.2 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	20		0.5 m	BN002	
	Tecticornia indica subsp. aff. bidens	20		0.3 m	BN001	
	Zygophyllum compressum			0.2 m	BN010	just outside quadrat



Quadrat LM01

Lake Maitland **Site** LM02

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310194 **mE** 6990389 **mN**
Habitat Undulating dune
Soil Kopi
Rock Type Kopi crust
Vegetatio
Veg Very good
Fire Age
Notes Car tracks, plant deaths, fire, cattle

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia oswaldii			1.5 m	BN020	outside quadrat
	Atriplex amnicola			0.4 m	BN021	outside quadrat
	Enneapogon caerulescens				BN022	outside quadrat
	Eragrostis lanipes	5		0.1 m	BN007	
	Eragrostis setifolia				BN023	outside quadrat
	Eucalyptus striaticalyx	30		6-10 m	BN017	
	Grevillea sarissa subsp. bicolor	20		1.8 m	BN012	
	Lawrencia helmsii	10		0.8 m	BN011	
	Sclerolaena fimbriolata	2		0.2 m	BN015	
	Tecticornia aff. undulata	5		0.6 m	BN016	
	Zygophyllum compressum	1		0.7 m	BN010	
	Zygophyllum tetrapterum	<1		0.2 m	BN019	

Quadrat LM02

Lake Maitland **Site** LM03

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310241 **mE** 6990163 **mN**
Habitat Plain (1-2% slope)
Soil Orange red clay loam
Rock Type
Vegetatio
Veg Very good- Ex.
Fire Age
Notes Cattle, rabbits, still has structure

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	5		3 m	BN029	
	Acacia jennerae	5		1.5 m	BN030	
	Acacia oswaldii	5		1 m	BN020	
	Alyogyne pinoniana			0.8 m	BN033	outside quadrat
	Aristida contorta	5		0.2 m	BN025	
	Boerhavia repleta	<1		0.05 m	BN031	
	Dodonaea viscosa subsp. angustissima			2.5 m	BN035	outside quadrat
	Eragrostis eriopoda	<1		0.3 m	BN038	
	Eremophila miniata	15		2.5 m	BN024	
	Pimelea spiculigera var. thesioides			1.5 m	BN034	outside quadrat
	Ptilotus exaltatus var. exaltatus	<1		0.5 m	BN027	
	Rhagodia eremaea	1		0.6 m	BN037	
	Salsola tragus	<1		0.2 m		
	Sclerolaena cornishiana	<1		0.2 m	BN036	
	Senna artemisioides subsp. filifolia	5		1.5 m	BN028	
	Solanum sp.			0.2 m		
	Triodia basedowii	45		0.5 m	BN026	

Quadrat LM03

Lake Maitland **Site** LM04

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310159 **mE** 6990254 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Cattle and rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex amnicola	60		0.2 m	BN021	
	Atriplex codonocarpa	<1		0.1 m	BN043	
	Enneapogon caerulescens	20		0.2 m	BN022	
	Maireana sp.	1		0.05 m	BN004	
	Panicum effusum	12		0.2 m	BN042	
	Scaevola spinescens	5		0.6 m	BN041	
	Sclerolaena cornishiana	2		0.15 m	BN036	
	Sclerolaena fimbriolata	2		0.15 m	BN015	
	Sida fibulifera	10		0.1 m	BN040	

Quadrat LM04

Lake Maitland **Site** LM05

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309150 **mE** 6989981 **mN**
Habitat Plain
Soil Fine sandy; white surface, pale red subsurface
Rock Type
Vegetatio Excellent
Veg
Fire Age
Notes Track, local degradation, all species components present

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Angianthus cornutus					outside quadrat
	Aristida contorta	20			BN025	
	Eragrostis eriopoda	<1		0.2	BN038	
	Eragrostis lanipes	10		0.05 m	BN007	
	Eremophila glabra subsp. albicans			1.5 m	BN046	outside quadrat
	Eremophila subfloccosa subsp. lanata			1.45 m	BN045	outside quadrat
	Gnephosis angianthoides					outside quadrat
	Muehlenbeckia cunninghamii			0.5 m	BN047	outside quadrat
	Muellerolimon salicorniaceum			0.4 m	BN044	outside quadrat
	Panicum effusum	10		0.015 m	BN042	
	Stenopetalum sphaerocarpum					outside quadrat
	Tecticornia aff. undulata	25		0.5-0.6 m	BN003/16	
	Tecticornia halocnemoides subsp. halocnemoides	20		0.3 m	BN002	
	Tecticornia indica subsp. aff. bidens	3		0.2 m	BN001	

Quadrat LM05

Lake Maitland **Site** LM06

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309107 **mE** 6990191 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type
Vegetatio
Veg Very good-excellent, closer to very good
Fire Age
Notes Cattle and drillers

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Aristida contorta	10		0.2	BN025	
	Eragrostis eriopoda	10		0.1	BN038	
	Eragrostis setifolia	10		0.05	BN023	
	Frankenia fecunda	5		0.2	BN048	
	Lawrencia squamata	35		0.8	BN049	
	Maireana sp.	1		0.05	BN004	
	Maireana trichoptera	1		0.1	BN050	

Quadrat LM06

Lake Maitland **Site** LM07

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309047 **mE** 6990709 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Some plant stress

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Lawrencia glomerata					outside quadrat
	Maireana amoena	1		0.1 m	BN005	
	Scaevola collaris	<1		0.01 m	BN006	
	Tecticornia aff. undulata	10		0.1 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	35		0.2 m	BN002	
	Tecticornia indica subsp. aff. bidens	18		0.2 m	BN001	

Quadrat LM07

Lake Maitland **Site** LM08

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309627 **mE** 6991383 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Good- degraded
Fire Age
Notes Lots of deaths, lots of cattle, rabbits, fire, understorey gone

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	5		3 m	BN029	
	Acacia oswaldii	<1		1.2 m	BN020	
	Aristida contorta	30		0.3 m	BN025	
	Atriplex sp.	<1		0.2 m	LM08	
	Eragrostis eriopoda	5		0.3 m	BN038	
	Eremophila miniata	25		2.5 m	BN024	
	Grevillea sarissa subsp. bicolor	8		1.8 m	BN054	
	Rhagodia eremaea	5		1.2 m	BN037	
	Sclerolaena deserticola	<1		0.5 m	BN058	
	Senna artemisioides subsp. filifolia	<1		1 m	B028	
	Sida fibulifera	5			BN055	
	Solanum coactiliferum	<1		0.3 m	BN056	

Quadrat LM08

Lake Maitland **Site** LM09

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310371 **mE** 6993499 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Cows, rabbits, plant stress

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	2		0.1 m	BN007	
	Erymophyllum ramosum subsp. ramosum					OUTSIDE quadrat
	Lawrencia glomerata					OUTSIDE quadrat
	Maireana amoena					OUTSIDE quadrat
	Maireana oppositifolia	22		0.4 m	BN059	
	Maireana sp.	2		0.1 m	BN004	
	Tecticornia ? undulata	10		0.7 m	CK806b	
	Tecticornia halocnemoides	28		0.3 m	CK805	
	Tecticornia indica subsp. aff. bidens	10		0.2 m	BN001	
	Tecticornia peltata	+			CK808	
	Zygophyllum ? iodocarpum	+			CK807	
	Zygophyllum compressum					OUTSIDE quadrat

Quadrat LM09

Lake Maitland **Site** LM10

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309425 **mE** 6994450 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, cows, rabbit warrens, heavily grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Enneapogon caerulescens	68		0.1 m	BN022/61	
	Lycium australe	10		0.8 m	BN062	
	Salsola tragus	28		0.2 m	BN060	
	Sclerolaena cornishiana	5		0.1 m	BN036	

Quadrat LM10

Lake Maitland **Site** LM11

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307499 **mE** 6995613 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type Calcrete
Vegetatio
Veg Good-very good
Fire Age
Notes Track, understorey lost, fire, grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia tetragonophylla	2		1.8 m		
	Atriplex bunburyana	5		0.3 m		
	Beyeria sp.	2			BN065	
	Casuarina pauper	30		4 m	BN063	
	Enneapogon caerulescens	15		0.03 m	BN022/61	
	Eremophila forrestii	<1		0.4 m	BN068	
	Eremophila oldfieldii subsp. oldfieldii	<1		1 m	BN067	
	Maireana eriosphaera	10		0.2 m	BN064	
	Paspalidium basicladium	2		0.15 m	BN066	
	Ptilotus exaltatus var. exaltatus	<1				
	Ptilotus obovatus var. obovatus	5		0.3 m		
	Salsola tragus	3		0.1 m	BN060	
	Sclerolaena deserticola	5		0.1 m	BN058	
	Sclerolaena fimbriolata	<1		0.1 m	BN015	
	Senna artemisioides subsp. filifolia	4		1.8 m	BN028	
	Solanum lasiophyllum	<1		0.15 m		

Quadrat LM11

Lake Maitland **Site** LM12

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307482 **mE** 6993129 **mN**
Habitat Plain
Soil Orange red clay
Rock Type Calcrete
Vegetatio
Veg Good
Fire Age
Notes Cow pads, cammel, fire, all grass understorey gone

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	30		4 m	BN070	
	Acacia cuthbertsonii subsp. linearis	1		2 m	BN073	
	Aristida contorta	25		0.2 m	BN025	
	Atriplex bunburyana	20		1 m		
	Enneapogon caerulescens	10		0.25 m	BN022	
	Enteropogon acicularis	5		0.3 m	BN077	
	Eremophila jucunda subsp. jucunda	15		1.5 m	BN069	
	Maireana pyramidata	20		1 m		
	Maireana triptera	2		0.3 m	BN071	
	Ptilotus obovatus var. obovatus	5		0.6 m		
	Senna artemisioides subsp. filifolia	1		1.2 m	BN028	
	Senna glutinosa subsp. chatelainiana	+			CK739	
	Senna notabilis				BN75	outside quadrat
	Sida fibulifera	1		0.5 m	BN072	
	Solanum lasiophyllum	<1		0.5 m		

Quadrat LM12

Lake Maitland **Site** LM13

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308214 **mE** 6993227 **mN**
Habitat Plains
Soil Red clay
Rock Type Small calcrete pebbles
Vegetatio
Veg Very good
Fire Age
Notes Heavily grazed, rabbits, lots of kangaroos

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Enneapogon caerulescens	53		0.1 m	BN022/61	
	Eragrostis eriopoda	<1		0.3 m	BN038	
	Lycium australe	15		1.2 m	BN062	
	Salsola tragus	10		0.3 m	BN060	
	Sclerolaena cornishiana	12		0.05 m	BN036	

Quadrat LM13

Lake Maitland **Site** LM14

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308097 **mE** 6992926 **mN**
Habitat Plains
Soil Red clay
Rock Type Calcreete pebbles
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, heavily grazed, cow pads, goats

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	10		3 m	BN070	
	Aristida contorta	40		0.2 m	BN025	
	Atriplex bunburyana	5		0.5 m		
	Enneapogon caerulescens	2		0.3 m	BN022	
	Enteropogon ramosus	10		0.2 m	BN075	
	Lycium australe	1		0.6 m	BN062	
	Maireana pyramidata	25		1 m		
	Maireana triptera	<1		0.2 m	BN071	
	Ptilotus obovatus var. obovatus	1		0.6 m		grazed
	Salsola tragus	1		0.2 m	BN060	
	Senna stowardii					outside quadrat
	Sida fibulifera	1		0.3 m	BN040	
	Solanum lasiophyllum	1		0.5 m	BN076	

Quadrat LM14

Lake Maitland **Site** LM15

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311827 **mE** 6997312 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Grazed, track

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	5		3 m	BN070	
	Acacia aneura var. fuliginea	4		2.5 m	BN080	
	Acacia tetragonophylla	2		2.5 m		
	Aristida contorta	12		0.25 m	BN025	
	Atriplex bunburyana	15		0.6 m		
	Cratystylis subspinescens	15		1.7 m	BN079	
	Dodonaea amblyophylla	+			CK708	
	Enteropogon acicularis	10		0.3 m	BN077	
	Eremophila latrobei subsp. latrobei	1		1.2 m	BN081	
	Eremophila maculata	6		1 m	BN078	
	Eremophila miniata	+			CK709	
	Eremophila oldfieldii subsp. oldfieldii	5		3 m	BN067	
	Frankenia fecunda	4		0.6 m	BN048	
	Grevillea sp.	+			CK707	
	Maireana pyramidata	10		1 m		
	Ptilotus obovatus var. obovatus	2		0.5 m		
	Scaevola spinescens	5		0.8 m	BN041	
	Sclerolaena cornishiana	<1		0.1 m	BN036	
	Sida fibulifera	2		0.25 m	BN040	
	Triodia basedowii	10		0.2 m	BN026	

Quadrat LM15

Lake Maitland **Site** LM16

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311937 **mE** 6994275 **mN**
Habitat Plain
Soil Orange with white Kopi crust
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Plant stress, vehicle track, rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	2		0.05 m	BN007	
	Tecticornia aff. undulata	1		0.1 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	10		0.4 m	BN002	
	Tecticornia indica subsp. aff. bidens	20		0.3 m	BN001	

Quadrat LM16

Lake Maitland **Site** LM17

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312074 **mE** 6994251 **mN**
Habitat Plain
Soil Kopi
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, understorey grazed (original was probably very little but rabbits have destroyed what would have been there

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Enneapogon caerulescens	<1		0.12 m	BN022	
	Eragrostis lanipes	2		0.2 m	BN007	
	Eremophila latrobei subsp. latrobei			1.5 m	BN082	not in quadrat, edge of
	Eucalyptus striaticalyx				BN017	not in quadrat, edges
	Grevillea sarissa subsp. bicolor	5		1.7 m	BN012	
	Lawrencia helmsii	25		1 m		
	Sclerolaena fimbriolata	<1		0.05 m	BN015	
	Tecticornia aff. undulata	<1		0.1 m	BN003	
	Zygophyllum compressum				BN010	not in quadrat, edges

Quadrat LM17

Lake Maitland **Site** LM18

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312453 **mE** 6994344 **mN**
Habitat Plain (reassessed as: calcrete ridge)
Soil Red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, cows, erosion

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex bunburyana	10		0.5 m		
	Casuarina pauper	25		4 m	BN063	
	Enneapogon caerulescens	2		0.2 m	BN022	
	Eragrostis eriopoda	2		0.3 m	BN038	
	Eragrostis lanipes	5		0.2 m	BN007	
	Eremophila oldfieldii subsp. oldfieldii	<1		0.6 m	BN067	
	Lycium australe	12		1.2 m	BN062	
	Maireana sedifolia	<1		0.1 m	BN075a	
	Ptilotus exaltatus var. exaltatus	<1		0.05 m		
	Rhagodia eremaea	2		0.6 m	BN037	
	Senna artemisioides subsp. filifolia	2		1.9 m	BN028	
	Zygophyllum compressum	<1		0.1 m	BN010	
	Zygophyllum tetrapterum	<1		0.4 m	BN019	

Quadrat LM18

Lake Maitland **Site** LM19

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312916 **mE** 6994550 **mN**
Habitat Plain
Soil Red clay loam
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Cattle through it

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Abutilon otocarpum	<1		0.1 m	BN086	
	Acacia aneura				bn070	outside quadrat
	Acacia aneura var. fuliginea	5		4 m	BN088	
	Aristida contorta	3		0.1 m	BN025	
	Enchylaena tomentosa	<1		0.2 m		
	Eragrostis eriopoda	1		0.3 m	BN038	
	Eremophila oldfieldii subsp. oldfieldii				bn067	outside quadrat
	Eremophila platythamnos subsp. platythamnos				BN083	outside quadrat
	Eucalyptus eremicola subsp. peeneri	15		5 m	BN085	
	Ptilotus exaltatus var. exaltatus	<1		0.05 m		
	Ptilotus obovatus var. obovatus	1		0.4 m		
	Rhagodia eremaea	1		1 m	BN037	
	Santalum spicatum				BN089	outside quadrat
	Senna artemisioides subsp. filifolia	12			BN028	
	Sida atrovirens	<1		0.15 m	BN087	
	Solanum lasiophyllum	<1		0.4 m		
	Tribulus terrestris				BN084	outside quadrat
	Triodia basedowii	30		0.5 m	BN026	

Quadrat LM19

Lake Maitland **Site** LM20

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312908 **mE** 6993958 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, cattle, fire, has structure but a lot of bare ground

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	18		4 m	BN070	
	Acacia ayersiana	5		1.5 m	BN029	
	Acacia cuthbertsonii subsp. linearis	2		1.2 m	BN073	
	Aristida contorta	60		0.2 m	BN025	
	Atriplex bunburyana	2		0.5 m		
	Enchylaena tomentosa	<1		0.2 m		
	Eragrostis eriopoda	2		0.6 m	BN038	
	Eremophila margarethae	1		1.2 m	BN092	
	Eremophila oldfieldii subsp. oldfieldii	4		2 m	BN067	
	Eremophila platythamnos subsp. platythamnos	<1		1.8 m	BN091	
	Maireana pyramidata	4		1.5 m		
	Ptilotus obovatus var. obovatus	1		0.4 m		
	Sclerolaena cornishiana	4		0.2 m	BN036	
	Senna artemisioides subsp. filifolia	5		2 m	BN028	
	Solanum lasiophyllum	<1		0.5 m		
	Solanum nummularium	<1		0.4 m	BN090	
	Triodia basedowii	2		0.2 m	BN026	

Quadrat LM20

Lake Maitland **Site** LM21

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 314250 **mE** 6990917 **mN**
Habitat Plain
Soil Sandy loam
Rock Type
Vegetatio
Veg Excellent
Fire Age 5
Notes

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia sibina	10		1 m	Bn098	
	Alyogyne pinoniana	<1		1 m	BN033	
	Eucalyptus eremicola subsp. peeneri	10		2 m	BN085	
	Kennedia prorepens	<1		0.15 m	BN097	
	Triodia basedowii	50		0.5 m	BN026	

Quadrat LM21

Lake Maitland **Site** LM22

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307777 **mE** 6997593 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Fire, cows, rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	<1		4 m	BN070	
	Atriplex bunburyana	8		1 m		
	Enneapogon caerulescens	1		0.2 m	BN022	
	Eragrostis setifolia	2		0.2 m	BN023	
	Eremophila oldfieldii subsp. oldfieldii	<3		2 m	BN067	
	Lawrencia squamata	<1		1.5 m	BN049	
	Lycium australe	2		1.7 m	BN062	
	Panicum effusum	<1		0.2 m	BN042	
	Pterocaulon sphacelatum				BN100	outside quadrat
	Ptilotus exaltatus var. exaltatus	<1		0.05 m		
	Rhagodia eremaea	2		0.8 m	BN037	
	Sclerolaena deserticola	<1		0.3 m	BN058	
	Sclerolaena fimbriolata	<1		0.2 m	BN015	
	Senna artemisioides subsp. filifolia	2		1.5 m	BN028	
	Solanum coactiliferum	<1		0.5 m	BN056	
	Solanum lasiophyllum	<1		0.02 m		
	Solanum nummularium	<1		0.4 m	BN090	
	Triodia basedowii	60		0.7 m	BN026	

Quadrat LM22

Lake Maitland **Site** LM23

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308053 **mE** 6997989 **mN**
Habitat Plain
Soil Red clay
Rock Type Calcrete pebbles
Vegetatio
Veg Good - very good
Fire Age
Notes Rabbits, fire, track, grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex bunburyana					outside quadrat
	Enneapogon caerulescens	22		0.1m	BN022/61	
	Eragrostis setifolia	5		0.1m	BN023	
	Lawrencia squamata	18		0.6 m	BN049	
	Lycium australe	18		1 m	BN062	
	Ptilotus obovatus var. obovatus					outside quadrat
	Rhagodia eremaea				BN037	outside quadrat
	Sclerolaena cornishiana	2		0.1 m	BN036	
	Senna stowardii	<1		1 m	BN102	

Quadrat LM23

Lake Maitland **Site** LM24

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308089 **mE** 6998366 **mN**
Habitat Plain
Soil Red clay
Rock Type Calcrete pebbles
Vegetatio
Veg Good
Fire Age
Notes Fire, grazed, rabbits, loss of understorey
quad is half in LM100/101

Species List:

Quad Name	Cove	C Class	Height	Specimen	Notes
Acacia aneura	10		3 m	BN070	
Acacia burkittii	1		2.5m	CK776	
Acacia tetragonophylla	4		2.5 m		
Atriplex bunburyana					outside quadrat
Casuarina pauper				BN063	outside quadrat
Enneapogon caerulescens	25		0.3 m	BN02261	
Enteropogon acicularis	1		0.5 m	BN077	
Eragrostis eriopoda	2		0.3 m	BN038	
Eragrostis setifolia	5		0.2 m	BN023	
Lycium australe	8		1.2 m	BN062	
Poaceae sp.	+			CK803	
Poaceae sp.	+			CK804	
Ptilotus obovatus var. obovatus	15		0.2 m		
Sclerolaena cornishiana	2		0.2 m	BN036	
Sclerolaena fimbriolata	5		1 m	CK806a	
Solanum lasiophyllum	+		0.4m		

Quadrat LM24

Lake Maitland **Site** LM25

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308080 **mE** 6998382 **mN**
Habitat Plain
Soil Yellow orange clay
Rock Type Calcrete pebbles
Vegetatio
Veg Good
Fire Age
Notes Fire, grazed, rabbits, loss of understorey

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia burkittii	+		3.0m	CK776	
	Acacia oswaldii			1.3 m	BN103	outside quadrat
	Acacia tetragonophylla	5		2.5 m		
	Atriplex bunburyana	1		1 m		upto 15% outside
	Cratystylis subspinescens	10		0.5 m	BN079	
	Enneapogon caerulescens	+		0.2 m	BN022/61	
	Eragrostis setifolia	2		0.15 m	BN023	
	Lycium australe	5		1.5 m	BN062	
	Ptilotus obovatus var. obovatus	1		0.5 m		upto 15% outside

Quadrat LM25

Lake Maitland **Site** LM26

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308957 **mE** 6997553 **mN**
Habitat Plain
Soil Orange clay
Rock Type Calcrete pebbles
Vegetatio
Veg Very good - excellent
Fire Age
Notes Cow tracks + pads, track close

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex bunburyana	1		0.4 m		
	Enneapogon caerulescens	4		0.15 m	BN022/61	
	Eragrostis setifolia	8		0.15 m	BN023	
	Frankenia cinerea	<1		0.15 m	BN051	
	Lawrencia squamata	8		1 m	BN049	
	Lycium australe	3		0.4 m	BN062	
	Maireana eriosphaera	2		0.2 m	BN064	
	Olearia subspicata	<1		0.4 m	BN104	
	Ptilotus exaltatus var. exaltatus	<1		0.2 m		
	Sclerolaena cornishiana	6		0.2 m	BN036	
	Triodia basedowii	70		0.5 m	BN026	

Quadrat LM26

Lake Maitland **Site** LM27

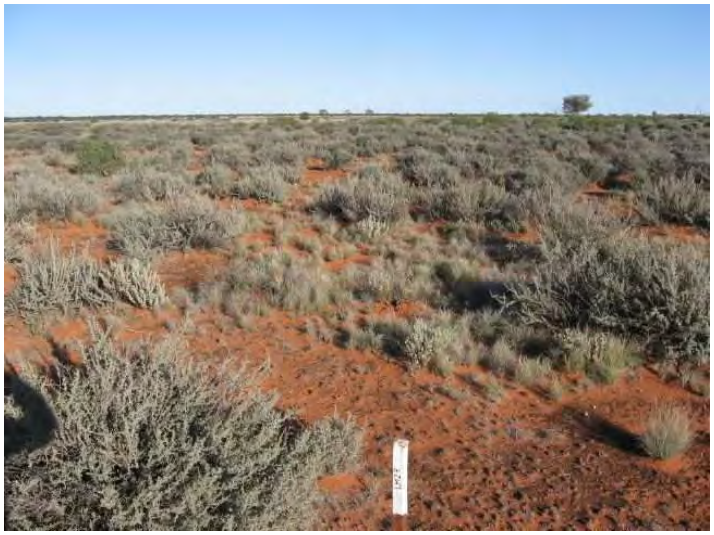
Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309012 **mE** 6997187 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Tracks, cattle/tracks

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex bunburyana	6		0.4 m		
	Enteropogon acicularis	1		0.4 m	BN077	
	Eragrostis setifolia	15		0.3 m	BN023	
	Frankenia fecunda	3		0.3 m	BN048	
	Lawrencia squamata	30		0.75-1m	CK746	
	Lycium australe	<1		0.4 m	BN062	
	Maireana amoena	2		0.3 m	BN005	
	Maireana glomerifolia	1		0.3 m	BN106	
	Maireana sp.	1		0.4 m	BN004	
	Maireana triptera	2		0.3 m	BN071	
	Olearia subspicata	30		1 m	Bn104	
	Ptilotus exaltatus var. exaltatus	<1		0.05 m		
	Solanum lasiophyllum	<1		0.25 m	BN076	
	Trianthema triquetra	+		0.05m	CK745	



Quadrat LM27

Lake Maitland **Site** LM28

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309284 **mE** 6996791 **mN**
Habitat Plain
Soil Light orange clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Cow track, track

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	10		0.1 m	BN007	
	Frankenia cinerea	6		0.1 m	BN051	
	Maireana amoena	3		0.25 m	BN005	
	Scaevola collaris	<1		0.15 m	BN006	
	Tecticornia aff. undulata	10		0.2 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	8		0.3 m	BN002	
	Tecticornia indica subsp. aff. bidens	10		0.2 m	BN001	
	Zygophyllum compressum	<1		0.15 m	BN010	

Quadrat LM28

Lake Maitland **Site** LM29

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309508 **mE** 6996512 **mN**
Habitat Plain
Soil Light orange clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Some plant stress, old cow track

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	<1		0.1 m	BN007	
	Tecticornia aff. undulata	15		0.4 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	15		0.4 m	BN002	
	Tecticornia indica subsp. aff. bidens	10		0.2 m	BN001	

Quadrat LM29

Lake Maitland **Site** LM30

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309818 **mE** 6996198 **mN**
Habitat Plain
Soil Light orange clay
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Cow tracks

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	1		0.15 m	BN007	
	Frankenia cinerea	5		0.2 m	BN051	
	Maireana amoena	3		0.4 m	BN005	
	Scaevola collaris	1		0.15 m	BN006	
	Tecticornia aff. undulata	5		0.2 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	8		0.3 m	BN002	
	Tecticornia indica subsp. aff. bidens	6		0.2 m	BN001	

Quadrat LM30

Lake Maitland **Site** LM31

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309127 **mE** 6996370 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good - good
Fire Age
Notes Some plant stress, cow tracks

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	5		0.1 m	BN007	
	Maireana amoena	2		0.2 m	BN005	
	Scaevola collaris	2		0.1 m	BN006	
	Tecticornia aff. undulata	5		0.1 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	24		0.2 m	BN002	
	Tecticornia indica subsp. aff. bidens	20		0.2 m	BN001	

Quadrat LM31

Lake Maitland **Site** LM32

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311306 **mE** 6996782 **mN**
Habitat
Soil Orange red clay loam
Rock Type Calcrete
Vegetatio Proximity to tracks; some drilling historically; some rabbit scratchings
Veg very good
Fire Age
Notes Cow pats, plant stress and deaths, tracks

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia heteroneura var. prolixa	15		2.5-3m	CK730	
	Acacia tetragonophylla	12		2.5 m		
	Enneapogon caerulescens	20		0.1-0.15m	BN022/61	
	Eragrostis setifolia	2		0.1 m	BN023	
	Hakea preissii	7		2 m	BN053	
	Lawrencia squamata	3		0.5 m	BN049	
	Sclerolaena cornishiana	1		0.2 m	BN036	

Quadrat LM32

Lake Maitland **Site** LM33

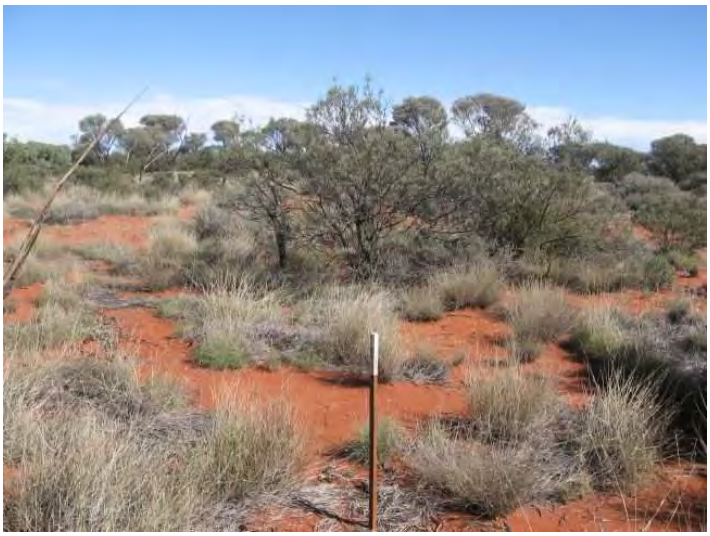
Described by BGN **Date** 4/05/2007 **Type:**
Season: P **Uniformit**

Location Project area

MGA Zone 50 312286 **mE** 6996844 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Fire, grazing cattle, old track through quadrat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	6		4.5 m	BN029	
	Acacia tetragonophylla	3		2 m		
	Aristida contorta	5		0.1 m	BN110	
	Atriplex bunburyana	2		1 m		
	Enchylaena tomentosa	3		0.2 m		
	Enteropogon acicularis	1		0.4	BN077	
	Eremophila margarethae	5		1 m	BN092	
	Eremophila miniata	5		2.5 m	BN024	
	Eremophila sp.	+		1.5m	CK706	
	Eremophila subfloccosa subsp. lanata	1		1 m	BN045	
	Exocarpos aphyllus	1		1 m	BN109	
	Frankenia fecunda	5		0.3 m	BN048	
	Hakea preissii	1.2		2 m	BN053	
	Maireana trichoptera	10		1 m	BN049	
	Santalum lanceolatum	2		2.4 m	BN108	
	Triodia basedowii	10		0.5 m	BN026	



Quadrat LM33

Lake Maitland **Site** LM34

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307476 **mE** 6997264 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age
Notes Plant stress, downgraded veg condition due to plant stress

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eragrostis lanipes	8		0.2 m	BN007	
	Maireana amoena	2		0.25 m	BN005	
	Scaevola collaris	<1		0.15 m	BN006	
	Tecticornia aff. undulata	22		0.3 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	10		0.2 m	BN002	
	Tecticornia indica subsp. aff. bidens	18		0.2 m	BN001	
	Zygophyllum compressum	<1		0.05 m	BN010	

Quadrat LM24

Lake Maitland **Site** LM35

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307554 **mE** 6996543 **mN**
Habitat Plain
Soil Orange red clay
Rock Type Calcrete
Vegetatio
Veg Excellent
Fire Age
Notes Rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex nana	<1		0.15 m	BN111	
	Eragrostis lanipes	10		0.2 m	BN007	
	Lawrencia helmsii	15		1 m	BN011	
	Sclerolaena fimbriolata	3		0.15 m	BN015	
	Tecticornia aff. undulata	15		0.2 m	BN003	
	Zygophyllum compressum	<1		0.1 m	BN010	

Quadrat LM35

Lake Maitland **Site** LM36

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312284 **mE** 6997550 **mN**
Habitat Flat
Soil Red clay loam
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Cattle degradation, camel droppings

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	10		4 m	BN070	
	Acacia aneura var. argentea	4		2 m	CK704	
	Acacia tetragonophylla	+		2 m	CK700	
	Aristida contorta	2		0.2 m	BN110	
	Atriplex bunburyana	2		0.2 m		
	Enchylaena tomentosa	2		0.5 m		
	Enneapogon caerulescens	15		0.1 m	BN022	
	Eremophila jucunda subsp. jucunda	8		1.5 m	BN069	
	Eremophila latrobei subsp. latrobei	1		2 m	BN082	
	Eremophila longifolia	+		1.8 m	CK703	
	Eremophila oldfieldii subsp. oldfieldii	2		1 m	BN067	
	Exocarpos aphyllus	1		1 m	BN109	
	Grevillea sarissa subsp. succincta	+		2 m	CK701	
	Hakea preissii	5		2 m	BN053	
	Maireana eriosphaera	1		0.2 m	BN064	
	Scaevola spinescens	2		1-1.2 m	BN041/112	
	Triodia basedowii	5		0.3 m	CK702	

Quadrat LM36

Lake Maitland **Site** LM37

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312396 **mE** 6998478 **mN**
Habitat Plain
Soil Red clay loam
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Fire

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura var. argentea	2		1 m	CK712	
	Acacia aneura var. fuliginea	15		2.5 m	BN088	
	Acacia ayersiana	10		4 m	BN114	
	Aristida contorta	15		0.2 m	BN110	
	Cratystylis subspinescens	8		1.5 m	BN079	
	Enteropogon acicularis	3		0.2 m	BN077	
	Eremophila gilesii subsp. variabilis	+		0.6	CK710	
	Eremophila latrobei subsp. latrobei	4		1.5 m	BN116/117	
	Frankenia cordata	1		0.3 m	BN118	
	Maireana eriosphaera	1		0.2 m	BN064	
	Maireana suaedifolia	1		0.6 m	BN115	
	Melaleuca interioris	12		2 m	BN113	
	Ptilotus exaltatus var. exaltatus	<1		0.2 m		
	Ptilotus obovatus var. obovatus	<1		0.5 m		
	Rhagodia eremaea	2		0.1 m	BN037	
	Scaevola spinescens	3		1.1 m	BN041	
	Sclerolaena alata	+		0.3	CK711	
	Senna artemisioides subsp. filifolia	3		1.5 m	BN028	
	Sida atrovirens	<1		0.2 m	BN087	
	Sida fibulifera	<1		0.1 m	BN040	

Quadrat LM37

Lake Maitland **Site** LM38

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312555 **mE** 6998863 **mN**
Habitat Plain
Soil Red clay loam
Rock Type
Vegetatio
Veg Good-very good
Fire Age
Notes Fire, plant deaths, rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	8		3 m	BN070	
	Acacia ayersiana	10		4 m	BN114	
	Aristida contorta	8		1.5 m	BN110	
	Cratystylis subspinescens	10		1.5 m	BN079	
	Enchylaena tomentosa	2		0.5 m		
	Enteropogon acicularis	2		0.2 m	BN077	
	Eremophila jucunda subsp. jucunda	2		1.2 m	BN069	
	Eremophila oldfieldii subsp. ? oldfieldii	2		1.5 m	CK713	
	Frankenia ? pauciflora	+		0.4 m	CK714	
	Maireana eriosphaera	1		0.2 m	BN064	
	Melaleuca interioris	18		2.5 m	BN113	
	Ptilotus exaltatus var. exaltatus	<1		0.2 m		
	Rhagodia eremaea	2		1.2 m	BN037	
	Scaevola spinescens	5		1 m	BN041	
	Senna artemisioides subsp. filifolia	+		1.2		

Quadrat LM38

Lake Maitland **Site** LM39

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312279 **mE** 6999533 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Good-very good
Fire Age
Notes Tracks, lost some of its grass layer, fire, rabbit droppings

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	8		3.5 m	BN070	
	Acacia oswaldii	<1		2.5 m	BN103	
	Aristida contorta	5		0.15 m	BN110	
	Cratystylis subspinescens	2		1.5 m	BN079	
	Enchylaena tomentosa	<1		0.4 m		
	Eragrostis eriopoda	5		0.4 m	BN038	
	Eremophila latrobei subsp. latrobei	<1		1.2 m	BN116	
	Eremophila margarethae	1		1 m	BN092	
	Eremophila platythamnos subsp. platythamnos	2		1.8 m	BN091	
	Exocarpos aphyllus	2		2.5 m	BN109	
	Hakea preissii	8		2.5 m	BN053	
	Maireana sedifolia	<1		0.2 m	BN075	
	Maireana suaedifolia	1		1.2 m	BN115	
	Rhagodia eremaea	<1		1.8 m	BN037	
	Scaevola spinescens	3		1.2 m	BN041	
	Senna artemisioides subsp. filifolia	3		1.8 m	BN028	
	Solanum lasiophyllum	<1		0.2 m		
	Triodia basedowii	12		0.5 m	BN026	

Quadrat LM39

Lake Maitland **Site** LM40

Described by BGN **Date** 4/05/2007 **Type:**
Season: P **Uniformit**

Location Project area

MGA Zone 50 312140 **mE** 6999605 **mN**
Habitat Plain
Soil
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Fire, rubbish, rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	5		4 m	BN070	
	Acacia ayersiana	5		1 m	BN114	
	Aristida contorta	8		0.1 m	BN110	
	Enneapogon caerulescens	8		0.2 m	BN022	
	Enteropogon acicularis	2		0.2 m	BN077	
	Eremophila oldfieldii subsp. oldfieldii	1		1 m	BN67	
	Eucalyptus eremicola subsp. peeneri	15		5 m	BN120	
	Exocarpos aphyllus	2		1 m	BN109	
	Grevillea nematophylla	10			BN121	outside quadrat
	Hakea preissii	5		3 m	BN053	
	Maireana triptera	2		0.5 m	BN071	
	Ptilotus exaltatus var. exaltatus	4		0.05 m		
	Ptilotus obovatus var. obovatus	1		0.5 m		
	Scaevola spinescens	5		1.6 m	BN41	
	Senna artemisioides subsp. filifolia	1		1 m	BN028	
	Triodia basedowii	15		0.05 m	BN026	

Quadrat LM40

Lake Maitland **Site** LM41

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310536 **mE** 7001203 **mN**
Habitat
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Good-very good
Fire Age
Notes Rabbits, cattle, some growth, structure

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	25		4 m	BN114	
	Acacia tetragonophylla	2		2 m		
	Atriplex bunburyana	2		0.5 m		
	Cratystylis subspinescens	3		1 m	BN079	
	Enteropogon acicularis	2		0.5 m	BN077	
	Eragrostis eriopoda	1		0.3 m	BN038	
	Eremophila glabra subsp. glabra	5		1.5 m	BN039	
	Eremophila margarethae	5		0.13 m	BN092	
	Eremophila subfloccosa subsp. lanata	6		0.5 m	BN045	
	Exocarpos aphyllus	3		2.5 m		
	Frankenia cordata	2		0.3 m	BN118	
	Grevillea sarissa subsp. succincta	3		1.5 m	BN094	
	Maireana suaedifolia	<1		0.5 m	BN115	
	Melaleuca interioris	15		2.5 m	BN113	
	Rhagodia eremaea	<1		0.2 m	BN37	
	Scaevola spinescens	2		0.5 m	BN041	
	Triodia basedowii	8		0.5 m	BN026	

Quadrat LM41

Lake Maitland **Site** LM42

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310045 **mE** 6991736 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Plant stress/deaths, old track

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex nana	3		0.1 m	BN008	
	Eragrostis lanipes	4		0.1 m	BN007	
	Lawrencia helmsii	20		1 m	BN011	
	Sclerolaena fimbriolata	2		0.1 m	BN015	
	Tecticornia aff. undulata	8		0.2 m	BN003	
	Zygophyllum compressum	2		0.1 m	BN010	

Quadrat LM42

Lake Maitland **Site** LM43

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309888 **mE** 6991721 **mN**
Habitat Plain
Soil Light orange sandy clay
Rock Type
Vegetatio
Veg Very good-excellent
Fire Age
Notes No disturbance

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex amnicola	2		0.4 m	BN021	
	Enneapogon caerulescens	2		0.15 m	BN022	
	Eragrostis lanipes	5		0.2 m	BN007	
	Frankenia fecunda	3		0.15 m	BN048	
	Frankenia setosa					
	Lawrencia squamata	20		0.4 m	BN049	
	Lycium australe	1		0.5 m	BN062	
	Maireana amoena	2		0.1 m	BN005	
	Panicum effusum	2		0.1 m	BN042	
	Ptilotus exaltatus var. exaltatus	2		0.1 m		
	Tecticornia aff. undulata	2		0.15 m	BN003	
	Tecticornia indica subsp. aff. bidens	<1		0.2 m	BN001	
	Zygophyllum eremaeum					outside quadrat
	Zygophyllum tetrapterum	1		0.2 m	BN019	

Quadrat LM43

Lake Maitland **Site** LM44

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310320 **mE** 6988292 **mN**
Habitat Kopi
Soil Kopi
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Old vehicle tracks, cow pads, rabbits- grazed, prints

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex amnicola	<1		0.6 m	BN021	
	Atriplex nana	<1		0.3 m	BN008	
	Enchylaena tomentosa	<1		0.3 m		
	Enneapogon caerulescens	<1		0.1 m	BN022	
	Eragrostis setifolia	3		0.2 m	BN023	
	Eucalyptus striaticalyx	5		5 m	BN017	
	Frankenia fecunda	<1		0.3 m	BN048	
	Grevillea sarissa subsp. bicolor	2		1.2 m	BN012	
	Hemigenia sp.	+		0.4	MH843	
	Lawrencia helmsii	6		1 m	BN011	
	Sclerolaena fimbriolata	2		0.1 m	BN015	
	Tecticornia aff. undulata	5		0.5 m	BN016	
	Zygophyllum compressum	<1		0.1 m	BN010	

Quadrat LM44

Lake Maitland **Site** LM45

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307533 **mE** 6997547 **mN**
Habitat Plain
Soil red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes No obvious disturbance

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Aristida contorta	3		0.2 m	BN110	
	Atriplex bunburyana	6		0.3 m		
	Enneapogon caerulescens	4		0.1 m	BN022	
	Lawrencia squamata	25		0.6 m	BN049	
	Maireana amoena	<1		0.15 m	BN005	
	Maireana villosa	3		0.2 m	BN052	
	Panicum effusum	5		0.2 m	BN042	
	Tecticornia aff. undulata	3		0.3 m	BN003	

Quadrat LM45

Lake Maitland **Site** LM46

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307914 **mE** 6997273 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Camel, fire, rabbits

Species List:

Quad Name	Cove	C Class	Height	Specimen	Notes
Aristida contorta	8		0.2 m	BN133	
Hakea preissii	3		1.8-2.5 m	BN053/135	
Halgania cyanea	<1		0.3 m	BN134	
Lawrencia squamata	5		1 m	BN049	to 20% cover outside
Ptilotus obovatus var. obovatus	<1		0.5 m		
Rhagodia eremaea	2		0.6 m	BN037	
Sclerolaena parviflora	<1		0.3 m	BN132	
Triodia desertorum	40		0.8 m	BN130	

Quadrat LM46

Lake Maitland **Site** LM47

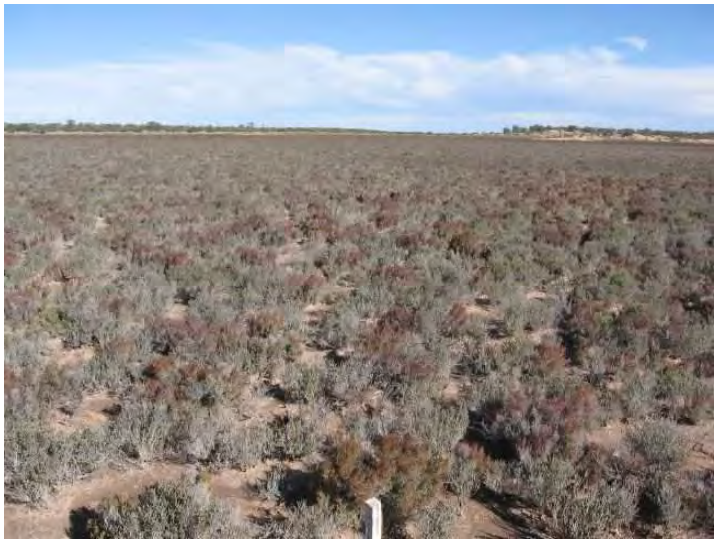
Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312873 **mE** 6988299 **mN**
Habitat Plain
Soil Light brown clay
Rock Type
Vegetatio
Veg Very good- excellent
Fire Age
Notes Plant stress

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Tecticornia aff. undulata	35		0.3 m	BN003	
	Tecticornia halocnemoides subsp. halocnemoides	30		0.3 m	BN002	
	Tecticornia indica subsp. aff. bidens	10		0.2 m	BN001	



Quadrat LM47

Lake Maitland **Site** LM48

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309420 **mE** 6997527 **mN**
Habitat Plain
Soil Orange red clay
Rock Type Calcret pebbles
Vegetatio
Veg Good-very good
Fire Age
Notes Fire, grazing (camel), tracks, Note: old triodia grassland - ridges

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia tetragonophylla	6		1.6 m		
	Aristida contorta	35		0.7 m	BN025	
	Enneapogon caerulescens	4		0.05-0.1	BN022/61	
	Eremophea spinosa	+		0.4 m	CK744	
	Eremophila latrobei subsp. latrobei				BN116	outside quadrat
	Hakea preissii	2		1.5-1.8 m		
	Lawrencia squamata	<1		0.5	BN049	
	Lycium australe	5		1 m	CK743	
	Paspalidium basicladium	+		0.3-0.4 m	CK731	
	Salsola tragus	<1		0.2 m		
	Sclerolaena deserticola	6		0.1 m	BN058	
	Senna artemisioides subsp. filifolia	+		0.4 m		
	Triodia concinna	40		0.7 m	CK742	

Quadrat LM48

Lake Maitland **Site** LM49

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 313645 **mE** 6991532 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type
Vegetation
Veg Excellent
Fire Age
Notes Excellent because of fire, dog prints, some rabbit diggings, note: understorey OK not much grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	10		5 m	BN029	
	Aristida contorta	3		0.2 m	BN110	
	Atriplex bunburyana	1		0.5 m		
	Cratystylis subspinescens	5		1.5 m	BN79	
	Enchylaena tomentosa	1		0.3 m		
	Enteropogon acicularis	<1		0.5 m	BN077	
	Eragrostis eriopoda	15		0.5 m	BN038	
	Eremophila margarethae	15		1. m	BN092	
	Eremophila platythamnos subsp. platythamnos	1		0.5 m	BN83	
	Frankenia cordata	3		0.3 m	BN118	
	Hakea lorea subsp. lorea	2		2.5 m	BN125	
	Hakea preissii	5		2 m	BN053	
	Ptilotus obovatus var. obovatus	2		0.3 m		
	Scaevola spinescens	1		1.3 m	BN041	
	Sclerolaena parviflora	<1		0.2 m	BN132	
	Triodia basedowii	1		0.15 m	BN026	

Quadrat LM49

Lake Maitland **Site** LM50

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 315032 **mE** 6988408 **mN**
Habitat Plain
Soil Orange red clay loam
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Fire, rubbish - bottle, recovering from fire

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	2		1 m	BN070	
	Acacia scleroclada				BN147	outside quadrat
	Acacia xiphophylla	<1			BN144	
	Alyogyne pinoniana	1		0.06 m	BN124	
	Dianella revoluta	2		0.8 m	BN140	
	Eucalyptus eremicola subsp. peeneri				BN148	outside quadrat
	Hakea lorea subsp. lorea	4		2 m	BN125	
	Hakea minyma	<1		1 m	BN095	
	Kennedia prorepens	4		0.2 m	BN097	
	Leptosema chambersii	2		0.3 m	BN099	
	Melaleuca leiocarpa	2		1 m	MH841	
	Micromyrtus flaviflora				BN146	outside quadrat
	Petalostylis cassioides	2		0.5 m	BN142	
	Sida kingii	5		3 m	BN143	
	Triodia basedowii	35		0.6 m	MH842	

Quadrat LM50

Lake Maitland **Site** LM51

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 313697 **mE** 6989241 **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, fire, very little/no grass layer

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Abutilon otocarpum	5		4 m	BN086	
	Acacia ayersiana	10		4 m	BN029	
	Aristida contorta	5		0.3 m	BN110	
	Cratystylis subspinescens	12		1 m	BN079	
	Enchylaena tomentosa	<1		0.2 m		
	Enteropogon acicularis	3		0.3 m	BN077	
	Eragrostis eriopoda	3		0.3 m	BN038	
	Eremophila margarethae	5		1 m	BN092	
	Frankenia cordata	2		0.3 m	BN118	
	Hakea preissii	1		1.2 m	BN053	
	Scaevola spinescens	2		1 m	BN041	
	Triodia basedowii	4		0.3 m	BN026	

Quadrat LM51

Lake Maitland **Site** LM52

Described by BGN **Date** 4/05/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307488 **mE** 6999086 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Good
Fire Age
Notes Rabbits, cattle

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia cuthbertsonii subsp. linearis	8		2.5 m	BN073	
	Acacia tetragonophylla	20		2 m		
	Atriplex bunburyana	5		1 m		
	Casuarina pauper	10		7 m	BN063	
	Enneapogon caerulescens	10		0.1 m	BN022	
	Ptilotus obovatus var. obovatus	4		0.5 m		
	Rhagodia eremaea	3		0.5 m	BN037	
	Sclerolaena cornishiana	5		0.2 m	BN036	
	Senna artemisioides subsp. filifolia	2		1 m	BN028	

Quadrat LM52

Lake Maitland **Site** LM53

Described by BGN **Date** 1/11/2007 **Type:** Q 30x30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312660 **mE** 6997310 **mN**
Habitat Plain
Soil Red sandy loam
Rock Type NA
Vegetatio
Veg Excellent
Fire Age No visible signs
Notes Evidence of disturbance from roos, cattle, rabbits

Species List:

Quad Name	Cove	C Class	Height	Specimen Notes
Acacia aneura	2		1.4 m	BN70
Acacia aneura var. aneura	1		1.2 m	CK750
Acacia aneura var. aneura	10		5-6 m	CK997
Acacia aneura var. argentea	+		0.5 m	CK724
Acacia ramulosa var. linophylla	+		2 m	CK996
Aristida contorta	2		0.3 m	
Atriplex aff. lindleyi subsp. inflata	15		1.2 m	MH816
Atriplex sp.	+		0.3	LM08
Cratystylis subspinescens	8		1m	
Eragrostis eriopoda	2		0.5m	
Eremophila forrestii subsp. ? forrestii	5		1-1.2 m	CK751
Eremophila gilesii subsp. variabilis	+		1 m	CK999
Eremophila jucunda subsp. jucunda	3		1.5m	BN069
Lawrencia squamata	1		0.6 m	BN049
Maireana trichoptera	<1		0.10 m	BN050
Maireana triptera	+		0.3 m	CK998
Prostanthera sp.	<1		0.6 m	BN149
Rhagodia drummondii	1		1 m	CK786
Triodia basedowii	25		0.7 m	

Quadrat LM53

Lake Maitland **Site** LM54

Described by BJ **Date** 1/11/107 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312270 **mE** 6997347 **mN**
Habitat Plain
Soil Red brown sandy loam
Rock Type
Vegetatio Mulga woodland over E. forrestii shrubland over T. basdowii hummock grassland and E. eriopda open grassland
Veg Very good-excellent
Fire Age No evidence
Notes Fire, camels, rabbits, note: understorey in tact, bare in patches, recovering well from fire

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Abutilon otocarpum	+		0.05m	CK1001	
	Acacia aneura	3.0		5-6m	BJ005	near quadrat
	Acacia aneura var. aneura	35		5.5 m	BJ001	
	Acacia aneura var. argentea	3.0			CK1005	
	Acacia duriuscula	15		4-5 m	CK1006	
	Acacia oswaldii				BJ004	near quadrat
	Aristida contorta	3.0		0.3 m	CK734	
	Atriplex bunburyana	<2		1.0 m		
	Atriplex sp.	1.0		0.75-1.0m	CK1002	
	Cratystylis subspinescens					near quadrat
	Enchylaena tomentosa var. tomentosa	+		0.3m	CK943	
	Enneapogon caerulescens	+		0.2 m		
	Eragrostis eriopoda	40		0.4 m		
	Eremophila forrestii	5		1-1.2m		
	Eremophila forrestii subsp. ? forrestii	5.0		1-1.2 m	CK751	
	Eremophila longifolia	+		1.75m	CK703	
	Eremophila oldfieldii subsp. oldfieldii	<2		2.2 m	BJ002	
	Grevillea sarissa subsp. succincta	2.0		1.5-1.75	CK701	
	Grevillea sp.				BJ003	near quadrat
	Maireana georgei	<2		0.25 m		
	Maireana pyramidata	<2		1.15 m		
	Maireana triptera	+		0.25		
	Ptilotus obovatus var. obovatus	+		0.25m	CK772	
	Ptilotus obovatus var. obovatus	<2		0.6 m		
	Ptilotus sessilifolius	+		0.4m	CK1003	
	Rhagodia drummondii	1.0		0.8 m	CK786	
	Sida ammophila	+		0.3m	CK1000	
	Triodia basedowii	10		0.5-0.75m	CK1007	

Quadrat LM54

Lake Maitland **Site** LM55

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311955 **mE** 6997770 **mN**
Habitat Plain
Soil Red clay (reassessed soil: brown clay calcrete)
Rock Type Calcrete
Vegetatio
Veg Good
Fire Age
Notes Cattle, track, fire, rabbits, very grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia burkittii	10		2-6 m	CK776	
	Acacia cuthbertsonii subsp. linearis	10		2 m	BN073	
	Acacia nyssophylla	4		2.5 m	BN151	
	Casuarina pauper	15		8 m	BN063	
	Chenopodiaceae sp.	+		0.3-0.4 m	CK777	
	Cratystylis subspinescens					near quadrat
	Enneapogon caerulescens	+		0.2 m		
	Enteropogon acicularis	1		60 m	BN077	
	Eragrostis setifolia	5		20 m	BN023	
	Eremophila glabra subsp. glabra				BN039	near quadrat
	Eremophila oldfieldii subsp. oldfieldii				BN067	near quadrat
	Exocarpos aphyllus					near quadrat
	Hakea preissii	2		0.75-3m		
	Paspalidium basicladium	+		0.3-0.4 m	CK731	
	Prostanthera sp.				BN149	near quadrat
	Ptilotus obovatus var. obovatus	+		0.4-0.7 m	CK772	
	Salsola tragus	<1		30 m		
	Scaevola spinescens				BN112	near quadrat
	Sclerolaena cornishiana	1		10 m	BN036	
	Solanum lasiophyllum	+		0.05 m		
	Swainsona kingii	+		0.05	CK757	

Quadrat LM55

Lake Maitland **Site** LM56

Described by BJ **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312482 **mE** 6997850 **mN**
Habitat Plain
Soil Red brown sandy loam
Rock Type
Vegetatio Mulga woodland over mixed open shrubland over Triodia Hummock Grassland
Veg Very good - excellent
Fire Age
Notes Fire, rabbits, cattle, grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	5		5.5-6.5m	BJ005	
	Acacia aneura var. argentea	20		5.5-6.5m	BJ007	
	Acacia ramulosa var. linophylla	+		2 m	CK767	
	Cratystylis subspinescens	1		1.5m		
	Enchylaena tomentosa var. tomentosa	+		1.2 m	CK774	
	Eragrostis eriopoda	2		0.4m		
	Eremophila forrestii	<2		5 m		
	Eremophila forrestii subsp. ? forrestii	1		1-1.75 m	CK751	
	Eremophila gilesii	+		1 m	CK775	
	Eremophila oldfieldii subsp. ? oldfieldii	+		1.75 m	CK719	
	Frankenia setosa				BJ009	near quadrat; may be F.
	Grevillea sp.	10		2.2 m	BJ003	
	Grevillea sp.	5		2-3 m	CK738	
	Maireana georgei	<2		015 m		
	Maireana thesioides	<2		0.5 m	BJ008	
	Maireana triptera	1		0.5-0.6 m	CK773	
	Monachather paradoxus	<2		0.2 m		
	Ptilotus obovatus var. obovatus	+		0.5-0.75	CK772	
	Scaevola collaris	<2		0.15 m	BJ006	
	Scaevola spinescens				BN041	near quadrat
	Senna artemisioides subsp. filifolia	+		2.5 m		
	Templetonia egena	+		1-1.5 m	CK717	
	Triodia basedowii	25		0.5m		

Quadrat LM56

Lake Maitland **Site** LM57

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311733 **mE** 6998366 **mN**
Habitat Plain
Soil Brown red fine sand over clay
Rock Type NA
Vegetatio
Veg Very good
Fire Age
Notes Rabbits and fire

Species List:

Quad Name	Cove	C Class	Height	Specimen	Notes
Acacia aneura var. aneura	+		1.2m	CK792	
Acacia ayersiana	15		5 m	BN154a	
Acacia ramulosa var. linophylla	1		3.0 m	CK791	
Aristida contorta	10		0.15 m		
Atriplex bunburyana	5		1 m		
Atriplex sp.	3		1.2-1.5 m	CK787	
Boerhavia cf schomburgkiana	+			CK790	Prostrate flat
Casuarina pauper					near quadrat
Enchylaena tomentosa var. tomentosa	1		0.5 m	CK788	
Enneapogon caerulescens	+		0.15	CK715	
Eragrostis eriopoda	10		0.3 m		
Eremophila forrestii subsp. ? forrestii	3		1.2 m	CK751	
Euphorbia drummondii	+		0.15 m	CK789	
Grevillea sarissa subsp. succincta	5		2 m	BN155a	
Maireana pyramidata	2		1.2 m		
Maireana triptera	+		0.1-0.15m		
Melaleuca interioris	4		3-5 m	CK785	
Ptilotus obovatus var. obovatus	2		1 m	BN150	
Rhagodia drummondii	5		1.2 m	CK786	
Scaevola spinescens	+		0.4m	BN112	
Senna artemisioides subsp. filifolia	+		1.5		
Sida ammophila	+		0.3 m	CK758	
Sida fibulifera	<1		1.9	BN72	
Triodia basedowii	1		0.4m		

Quadrat LM57

Lake Maitland **Site** LM58

Described by BJ **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312495 **mE** 6998134 **mN**
Habitat Plain
Soil Red-brown snady loam clay -on surface
Rock Type
Vegetatio Open Mulga woodland over Melaleuca shrubland over Triodia basedowii Hummuck Grassland
Veg excellent
Fire Age
Notes Grazed, fire

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura var. aneura	1		3.5 m	CK992	
	Acacia aneura var. argentea	5		5 m	CK990	
	Acacia ramulosa	<2		1.75 m	BJ011	
	Acacia ramulosa var. linophylla	1		1.2 m	CK993	
	Aristida contorta	+		0.2 m		
	Chenopodiaceae sp.	+		0.05 m	CK995	
	Cratystylis subspinescens	<2		1.6 m		
	Dodonaea lobulata	+		0.7 m	CK727	
	Enchylaena tomentosa var. tomentosa	+		0.1 m	CK994	
	Eragrostis eriopoda	<2		0.3 m		
	Eremophila forrestii subsp. ? forrestii	+		1.0 m	CK751	
	Exocarpos aphyllus					near quadrat
	Frankenia ? setosa	<2		0.45 m	BJ009	Maybe F. georgei P3
	Maireana georgei	<2		0.35 m		
	Maireana tomentosa subsp. tomentosa	<2		0.75 m	BJ012	
	Melaleuca interioris	25		2 m	CK752	
	Monachather paradoxus	<2		0.2 m		
	Ptilotus exaltatus var. exaltatus	<2		0.4 m		dead
	Ptilotus obovatus var. obovatus	1		1 m	CK772	
	Scaevola spinescens	+		0.8 m	CK725	
	Sclerolaena patenticuspis	<2		0.15	BJ006	
	Senna artemisioides subsp. filifolia	+		1.5 m		
	Triodia basedowii	30		0.4 m		

Quadrat LM58

Lake Maitland **Site** LM59

Described by BGN **Date** 1/11/2007 **Type:** Q 30X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312077 **mE** 6998855 **mN**
Habitat Plain
Soil Red-brown sandy loam
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Fire, cattle, rabbits, grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	10		4.5-6m m	BN070	
	Acacia aneura var. ?	+		1.2 m	CK768	
	Acacia aneura var. aneura	5		1.5-5 m	CK765	
	Acacia aneura var. fuliginea	5		5 m	BN80	
	Acacia ayersiana	1		3 m	BN154	
	Acacia ramulosa var. linophylla	+		1.75 m	CK767	
	Aristida contorta	+		.15 m		
	Cratystylis subspinescens	7		1.5 m		
	Enchylaena tomentosa var. tomentosa	1		0.3-0.5m	CK729	
	Enchylaena tomentosa var. tomentosa	1		0.3-0.5m	BN071	
	Eragrostis eriopoda	2		0.3-0.5m		
	Eremophila forrestii subsp. forrestii	2		1.5-2m	BN153	
	Eremophila maculata subsp. brevifolia	+		1.2 - 1.5	CK766	
	Eremophila margarethae	<1		1 m	BN092	
	Eremophila oldfieldii subsp. oldfieldii	+		1.5-2m	BN067	
	Eremophila shonae	+		1.5 m	CK770	
	Grevillea nematophylla subsp. supraplana	3		5 m	BN158	
	Grevillea sarissa subsp. succincta	4		2 m	BN155	
	Grevillea sp.	1		2.5 m	CK738	
	Hibiscus krichauffianus	+		0.4 m	CK764	
	Maireana integra	<1		0.2 m	BN057	
	Maireana villosa	+		0.4 m	CK754	
	Melaleuca uncinata				BN157	near quadrat
	Portulaca oleracea	+		0.05 m	CK769	baby
	Ptilotus aervoides	+		0.05-0.1	CK771	
	Ptilotus obovatus var. obovatus	+		0.3-1m	BN150	
	Rhagodia drummondii	2		1.5 m		
	Scaevola spinescens	2		1.2 m		
	Senna artemisioides subsp. filifolia	<1		1 m		
	Sida ammophila	+		0.4 m	CK758	
	Solanum lasiophyllum	+		0.4 m		
	Triodia basedowii	5		0.75 m		

Quadrat LM60

Lake Maitland **Site** LM60

Described by BJ **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312314 **mE** 6998599 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio Mulga wood land over melalueca tall shrubland over C. subpinescens over A. contorta open
Veg Very good
Fire Age
Notes Rabbit activity, grazing of woolly butt evident, lots of kangaroo scats. Some old dead mulga

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	25		6.5 m	BJ005	
	Acacia aneura var. aneura	10		5 m	BJ001	
	Acacia rhodophloia	5		6 m	BJ015	
	Aristida contorta	35		0.15 m		
	Cratystylis subspinescens	15		1.2 m		
	Enchylaena tomentosa	<2		0.6 m		
	Enneapogon caerulescens	<2		0.2 m	BJ016	
	Enteropogon ramosus	<2		0.5 m	BJ013	
	Eragrostis eriopoda	<2		0.2 m		
	Eremophila falcata	15		3.5 m	BN159	
	Eremophila platythamnos subsp. platythamnos	<2		1.9 m	BN091	
	Euphorbia drummondii	+		0.01		
	Exocarpos aphyllus	<2		3.3 m		
	Grevillea sp.				BJ003	
	Maireana pyramidata					
	Melaleuca interioris	5-10		4 m		
	Ptilotus exaltatus var. exaltatus	+		0.01		
	Ptilotus obovatus var. obovatus	<2		0.4 m		
	Rhagodia eremaea	3		1 m	BN037	
	Scaevola spinescens	3		1.2 m	BN041	
	Sida ammophila	+		0.3	MH 852	
	Triodia basedowii	5		0.3		

Quadrat LM60

Lake Maitland **Site** LM61

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311958 **mE** 6999394 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits, cattle, drilling nearby

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	5		2 m	BN070	
	Acacia aneura var. aneura	5		8 m		
	Acacia ayersiana	2		2 m	BN114	
	Acacia nyssophylla	<1		1m	BN151	
	Aristida contorta	3		0.3 m		
	Dodonaea lobulata	+			MH851	
	Eragrostis eriopoda	10		0.3 m		
	Eremophila falcata	4		1.8 m	BN159	
	Eremophila gilesii	+			MH850	
	Eremophila oldfieldii subsp. oldfieldii	<1		2 m	BN067	
	Eucalyptus eremicola subsp. peeneri	12		5 m	BN120	
	Grevillea nematophylla subsp. supraplana	1		2 m	BN158	
	Grevillea sarissa subsp. succincta	5		2 m	BN094	
	Maireana suaedifolia	2		1 m	BN115	
	Olearia subspicata	<1		1 m		
	Ptilotus obovatus var. obovatus	1		0.5 m		
	Rhagodia drummondii	2		1 m		
	Scaevola spinescens	3		1.4 m		
	Senna artemisioides subsp. filifolia	<1		2 m		
	Triodia basedowii	10		1 m		

Quadrat LM61

Lake Maitland **Site** LM62

Described by BJ **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 312565 **mE** 6999520 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio Mulga woodland over mixed shrubland of C. subspinescens,S. spinescens, E. forrestii, D. lobulata over A. contorta Grass
Veg Very good
Fire Age
Notes Fire, understorey missing, low (triodia), rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	10		5.5-7 m	BJ005	
	Acacia aneura var. aneura	25		5-6m	CK750	
	Aristida contorta	20		0.15 m		
	Cratystylis subspinescens	2		1.2-1.5m		
	Cynanchum floribundum	+		-	CK763	
	Dodonaea lobulata	5		1 m	BN096	
	Enneapogon caerulescens				BJ016	near quadrat
	Eragrostis eriopoda	+		0.3m		
	Eremophila forrestii subsp. ? forrestii	5		1.5m	CK751	
	Eremophila maculata subsp. brevifolia	+		1.2 m	CK756	
	Exocarpos aphyllus					near quadrat
	Goodenia berardiana	+		0.3 m	CK760	
	Grevillea nematophylla	5		6 m	CK753	
	Grevillea nematophylla subsp. supraplana	8		5.5 m	BN158	
	Grevillea sp.	+		2 M	CK738	
	Grevillea sp.				BJ003	near quadrat
	Maireana villosa	+		0.8m	CK754	near quadrat
	Melaleuca interioris	+		1.5m	CK752	
	Monachather paradoxus	<2		0.25		
	Psydrax suaveolens	+		4-5 m	CK762	
	Ptilotus obovatus var. obovatus	<2		0.3 m		
	Rhagodia drummondii	+		1.0-1.2 m	CK755	
	Scaevola spinescens	5		1.5m	BN041	
	Sida ammophila	+		0.3-0.4 m	CK758	
	Sida calyxhymenia	+		0.05-0.1	CK759	
	Sida fibulifera	+		0.1m	CK761	
	Swainsona kingii	+		0.15 m	CK757	
	Triodia basedowii	+		0.4 m		

Quadrat LM62

Lake Maitland **Site** LM63

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311987 **mE** 6989781 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Good-very good
Fire Age
Notes Fire, some grazing, understorey and mid storey are gone

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura var. argentea	10		6-7m	CK941	
	Amyema microphylla	+		-	CK940	
	Enchylaena tomentosa var. tomentosa	+		0.4 m	CK943	
	Eragrostis eriopoda	5		0.4-0.5m		
	Eremophila glabra subsp. glabra	1		1.2 m	BN039	
	Eremophila maculata subsp. brevifolia	+		0.4 m	CK945	
	Eremophila margarethae	7		1 m	BN092	
	Eremophila miniata	1		2 m	CK944	
	Grevillea sarissa subsp. succincta	3		2.5 m	BN094	
	Maireana prosthecochaeta	+		0.3m	CK942	
	Melaleuca xerophila	10		6m	MH821	
	Senna artemisioides subsp. filifolia	+		0.4		
	Triodia basedowii	20		1.2 m		

Quadrat LM63

Lake Maitland **Site** LM64

Described by BJ **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310071 **mE** 6990027 **mN**
Habitat South face of low sand dune
Soil Red/orange sand
Rock Type
Vegetatio J. arida shrubland (with other species) over Triodia hummock grassland
Veg Excellent-very good- more on the excellent side
Fire Age
Notes Rabbits, cattle but impact not great

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia brumalis	+			BJ027	
	Acacia ligulata	+			BJ022	
	Aristida holathera	1.2		0.3m	BJ024	
	Dodonaea viscosa subsp. angustissima	1.2		1.7m	BJ023	
	Eragrostis eriopoda	1.2		0.4m		
	Eremophila miniata	+			BJ025	
	Eremophila platythamnos subsp. platythamnos	+			BJ026	
	Halgania cyanea	+			BJ028	
	Jacksonia arida	5		1-2m	BJ021	
	Olearia subspicata				BJ029	near quadrat
	Santalum lanceolatum	+		2.2 m		
	Triodia basedowii	70		0.2-0.4m		
	Triodia desertorum	3		0.8		

Quadrat LM64

Lake Maitland **Site** LM65

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311917 **mE** 6989985 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Fire, cattle, rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ayersiana	5		4 m	BN114	
	Acacia nyssophylla	3		3 m	BN151	
	Dodonaea viscosa subsp. angustissima	1		1.2 m	BN035	
	Eragrostis eriopoda	15		0.6 m		
	Eremophila forrestii subsp. forrestii	1		1.5 m	BN163	
	Eremophila miniata	3		3 m	BN024	
	Grevillea sarissa subsp. succincta	5		2.5 m	BN094	
	Hakea preissii	2		3 m		
	Sida fibulifera	+		0.15 m		
	Triodia basedowii	2		0.3m		
	Triodia desertorum	45		1.6 m		

Quadrat LM65

Lake Maitland **Site** LM66

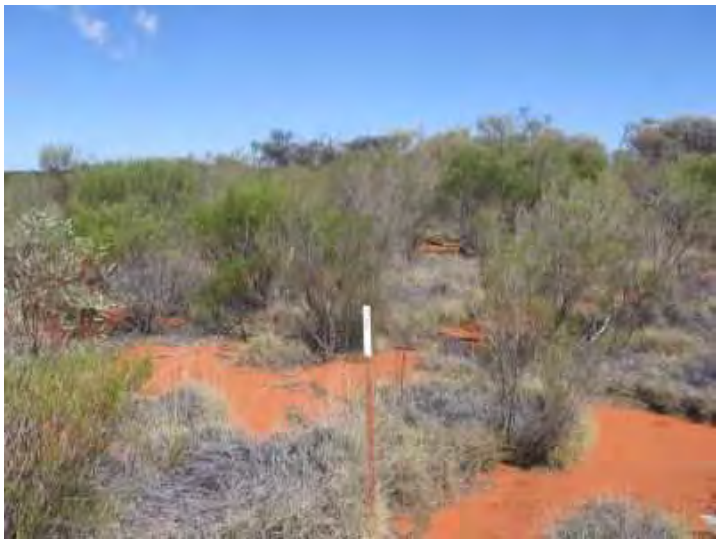
Described by **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 309666 **mE** 6990060 **mN**
Habitat Gentle face of low sand dune
Soil Red/orange sand
Rock Type
Vegetatio Dodoneaea and A. ligulata shrubland over Triodia
Veg Excellent
Fire Age
Notes Rabbits, fire

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia brumalis	2		2.5 m	BJ027	
	Acacia jennerae	2		1.75 m	CK837	
	Acacia ligulata	15		1.5- 2m	CK830	
	Acacia ramosissima	<2		1.85 m	BJ011	
	Acacia ramulosa var. linophylla	1		2.0 m	CK836	
	Dodonaea viscosa subsp. angustissima	20		1.5-2.0m	CK835	
	Eragrostis eriopoda	+		0.3 m	CK831	
	Eremophila miniata	+		2 m	CK832	
	Eremophila platythamnos subsp. platythamnos	1		1.5m	CK834	
	Grevillea juncifolia subsp. juncifolia	1		3m	CK833	not common
	Scaevola spinescens	1		1.5 M	CK725	
	Triodia basedowii	30		1m		



Quadrat LM66

Lake Maitland **Site** LM67

Described by BGN **Date** 1/11/2007 **Type:** Q 30 X30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311575 **mE** 6990153 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes No disturbance

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia jennerae	+		1.7-1.8 m	CK837	
	Acacia ligulata	+		1.5 m	CK830	
	Acacia nyssophylla	4		3 m	BN151	
	Acacia oswaldii	7		2.5-3 m	BN020	
	Atriplex aff. lindleyi subsp. inflata	+		0.4 m	MH816	Flowers
	Dodonaea viscosa subsp. angustissima	12		2 m	BN035	
	Eragrostis eriopoda	8		0.6 m		
	Eremophila ? alternifolia	+		1.6 m	CK946	
	Eremophila miniata	3		1.6 m	CK944	
	Eremophila oldfieldii subsp. ? oldfieldii	+		1.5 m	CK948	
	Eremophila platythamnos subsp. platythamnos	<1		1 m	BN091	
	Eucalyptus eremicola subsp. peeneri	25		8-10 m	CK947	Bark rough, grey
	Frankenia ? pauciflora	+		0.8 m	MH820	
	Grevillea sarissa subsp. succincta	5		2.5m	BN094	
	Hakea preissii	2		1.5-3 m	CK949	
	Olearia subspicata	1		1 m		
	Prostanthera sp.	1		1 m	BN149	
	Rhagodia drummondii	+		1.2 m		
	Scaevola spinescens	1		1 m		
	Senna artemisioides subsp. filifolia	5		1.5 m		
	Triodia desertorum	20		1.2 m		

Quadrat LM67

Lake Maitland **Site** LM68

Described by BJ **Date** 1/11/2007 **Type:** Q 30 x 30
Season: E **Uniformit**

Location Project area

MGA Zone 50 311854 **mE** 6996931 **mN**
Habitat Plain
Soil Red/brown clay loam
Rock Type
Vegetatio Mix of C. subspineescens,F. pauciflora, M. pyramidata
Veg Excellent-very good
Fire Age
Notes Old tracks

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Aristida contorta	+		0.1 m	MH855	
	Atriplex bunburyana	<2		0.4 m		
	Atriplex lindleyi subsp. inflata	<2		0.15 m	BJ034	
	Cratystylis subspinescens	20		0.9 m		
	Enchylaena tomentosa var. tomentosa	+		0.2 m		
	Enneapogon caerulescens	+		0.2 m		
	Eremophea spinosa	+		0.3 m	MH861	
	Frankenia pauciflora	3		0.2 m	BJ038	
	Lawrencia squamata	20		1 m	BN049	
	Maireana amoena	+		0.2 m	MH860	
	Maireana georgei	<2		0.15 m		
	Maireana pyramidata	20		0.9 m		
	Maireana tomentosa subsp. tomentosa	<2		0.3 m	BJ032	
	Maireana triptera	<2		0.4 m		
	Panicum decompositum	+		0.3 m	MH857	
	Paspalidium basicladium	+		0.1 m	MH858	
	Poaceae sp.	+		0.1 m	MH854	
	Portulaca oleracea	+		0.2 m		
	Ptilotus obovatus var. obovatus	<2		0.45 m		
	Salsola tragus	<2		0.2 m		
	Sclerolaena cuneata	<2		0.35 m	BJ035	
	Sclerolaena eurotioides	<2		0.25 m	BJ033	
	Sclerolaena patenticuspis	<2		0.3 m	BJ006	
	Tragus australianus	+		0.1 m	MH856	(reassessed sp. Only)
	Trianthema triquetra	1		0.02	CK745	

Quadrat LM68

Lake Maitland **Site** LM69

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311007 **mE** 6990808 **mN**
Habitat Ridge
Soil Kopi + gypsum
Rock Type
Vegetatio
Veg Good
Fire Age
Notes Tracks, bulldozer, rabbits-active warren nearby, the rabbits have chewed/grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Eucalyptus striaticalyx	15		6-8M	CK839	Mallee, bark copper
	Grevillea sarissa subsp. bicolor	2		1.5-1.75	CK840	
	Lawrencia helmsii	3		1 m		
	Sclerolaena fimbriolata	+		0.1 m	CK838	

Quadrat LM69

Lake Maitland **Site** LM70

Described by BJ **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311015 **mE** 6997038 **mN**
Habitat Plain
Soil Pale red brown fine sand over clay loam
Rock Type
Vegetatio
Veg Good
Fire Age
Notes Rabbits grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia sp.	2		2.2 m	BJ043	
	Enneapogon caerulescens	+		0.2m		
	Eragrostis eriopoda	5		0.2 m	BJ040	
	Goodenia prostrata	1			CK735	Prostrate flat
	Hakea preissii	2		2.0 m		
	Lawrencia squamata	5		0.5 m	CK732	
	Lycium australe	+		0.5 m	CK743	
	Panicum decompositum	+		0.3 m	CK737	
	Poaceae sp.	20		0.3 m	CK736	
	Sclerolaena convexula	1		0.15 m	BJ041	

Quadrat LM70

Lake Maitland **Site** LM71

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone **mE** **mN**
Habitat Plain
Soil Orange red clay
Rock Type
Vegetatio
Veg Very good-excellent
Fire Age
Notes Evidence of cattle activity

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex bunburyana	10		0.5 m		
	Cratystylis subspinescens					not in quadrat
	Eragrostis lanipes	20		0.1 m	BN007	
	Frankenia cinerea	2		0.2 m	BN051	
	Frankenia fecunda	2		0.2 m	BN048	
	Lawrencia squamata	5		1 m	BN049	
	Maireana villosa	1		0.1 m	BN052	
	Tecticornia aff. undulata	4		0.3 m	BN003	
	Tecticornia indica subsp. aff. bidens	1		0.2 m	BN001	

Quadrat LM71

Lake Maitland **Site** LM72

Described by BJ **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307863 **mE** 6999181 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type Calcrete pebbles
Vegetatio
Veg Good
Fire Age
Notes Cattle, rabbits grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia burkittii	20		3 m	BJ046	
	Acacia sp.	5		2-4 m	MH823	
	Acacia telmica					
	Casuarina pauper	20		8-10 m		
	Enneapogon caerulescens	<2		0.15 m	BJ016	
	Eremophila oldfieldii subsp. oldfieldii	<2		1.2 m	BJ002	
	Eremophila rostrata				BJ049	DRF not in quadrat
	Hakea preissii	1-2		3 m		
	Olearia calcarea				BJ048	not in quadrat
	Ptilotus obovatus var. obovatus	2		0.5 m		
	Salsola tragus	<2		0.35 m		
	Scaevola spinescens	2		1m		
	Senna artemisioides subsp. filifolia	8		1.8 m		

Quadrat LM72

Lake Maitland **Site** LM73

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 311137 **mE** 6997665 **mN**
Habitat Plain
Soil Brown loam calcrete
Rock Type Calcrete
Vegetatio
Veg Good
Fire Age
Notes Rabbit, fire, cows

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia cuthbertsonii subsp. linearis	<1		1.5 m	BN073	
	Acacia jennerae	<1		1.2 m	BN032	
	Acacia nyssophylla	15		2 m	BN151	
	Acacia sp.	1		1.2-1.5 m	CK726	
	Acacia sp.	1		1.75 m	CK779	Acacia pods
	Atriplex amnicola	1		0.3 m	BN021	
	Casuarina pauper	15		5-8m	BN063	
	Chenopodiaceae sp.	+		0.15-0.4	CK777	
	Enneapogon caerulescens	10		0.15 m	BN022	
	Eremophila oldfieldii subsp. angustifolia	+		0.8m	CK783	
	Exocarpos aphyllus	1		2.0 m	CK781	
	Hakea preissii	20		1.5 m		
	Maireana oppositifolia	2		0.1 m	BN059	
	Malvaceae sp.	1		0.5-0.75	CK778	small
	Paspalidium basicladium	+		0.2 m	CK731	
	Poaceae sp.	+		1.2 m	CK784	
	Prostanthera sp.	<1		0.6 m	BN149	
	Ptilotus exaltatus var. exaltatus	+		0.1 m	CK780	
	Salsola tragus	<1		0.2 m		
	Scaevola spinescens	1		1.2 m	CK782	
	Sclerolaena deserticola	2		0.2 m	BN058	
	Senna artemisioides subsp. filifolia	+		1.5 m		
	Senna glutinosa subsp. chatelainiana	1		1-2m	CK739	
	Senna stowardii	1		1 m	BN102	

Quadrat LM73

Lake Maitland **Site** LM75

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308359 **mE** 6999255 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Roos; some rabbits

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	4		4 m	BN070	fire
	Acacia tetragonophylla	+		1.6 m	MH824	
	Aristida contorta	+		0.05-0.15 m	MH808	
	Atriplex bunburyana	40		1.2 m		
	Enchylaena tomentosa var. tomentosa	+		0.1-0.2 m	MH826	
	Eremophila latrobei	+			MH827	
	Eremophila oldfieldii subsp. oldfieldii	<1		2 m	BN067	
	Eremophila sp.	<1		1.2 m	BN164	
	Frankenia fecunda	8		0.2 m	BN048	
	Prostanthera sp.	<1		0.4 m	BN149	
	Ptilotus obovatus var. obovatus	<1		0.6 m		
	Rhagodia drummondii	1		0.5 m		

Quadrat LM75

Lake Maitland **Site** LM76

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307456 **mE** 6999413 **mN**
Habitat Plain
Soil Light orange clay
Rock Type Calcrete
Vegetatio
Veg Very good - good
Fire Age
Notes Cattle tracks; signs of grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia cuthbertsonii subsp. linearis	<1		1 m	BN073	
	Acacia ramulosa var. linophylla	+		2	MH814	
	Atriplex aff. lindleyi subsp. inflata	+		10 ?	MH816	
	Eragrostis eriopoda	20		0.05 m		heavily grazed
	Melaleuca xerophila	20		4 m	MH821	
	Ptilotus obovatus var. obovatus	1		0.5 m		
	Scaevola spinescens	+		1.2 m		
	Sclerolaena deserticola	<1		0.2 m	BN058	

Quadrat LM76

Lake Maitland **Site** LM77

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 307963 **mE** 7000445 **mN**
Habitat Plain
Soil Red clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Roo disturbance

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura var. aneura	5		6-8m	BJ001	
	Acacia aneura var. argentea	+		1.2 m	MH810	
	Acacia aneura var. cf major	2		4.0 m	MH819	
	Acacia ayersiana	8		5 m	BN114	
	Acacia ramulosa var. linophylla	2		2.0 m	MH814	
	Atriplex bunburyana	1		1 m		
	Cratystylis subspinescens	1		1.7 m		
	Eragrostis eriopoda	4		0.6 m		
	Eremophila longifolia	+		1.0 m	MH803	
	Exocarpos aphyllus	1		4 m		
	Frankenia ? pauciflora	+		0.4 m	MH820	
	Grevillea sarissa subsp. bicolor	1		3 m	BN012	
	Lycium australe	+		1.8 m		
	Maireana triptera	+		0.1 m		
	Melaleuca uncinata	8		2.1 m	BJ010	
	Rhagodia drummondii	1		1 m		
	Scaevola spinescens					not in quadrat
	Senna artemisioides subsp. filifolia	<1		1 m		
	Triodia basedowii	30		1.2 m		

Quadrat LM77

Lake Maitland **Site** LM78

Described by BJ **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 51 307506 **mE** 7000380 **mN**
Habitat Plain
Soil Red/brown sandy loam
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Rabbits and cattle evident

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura				Bj005	not in quadrat
	Acacia aneura var. ? macrocarpa	6		1-2m	MH802	
	Acacia aneura var. aneura	3		4.5 m	BJ001	
	Acacia aneura var. argentea	+		0.4 m	MH810	
	Acacia aneura var. cf conifera	+		1.0 m	MH817	
	Acacia ramulosa var. linophylla	2-3		2.5 m	MH814	
	Acacia tetragonophylla	<2		0.5 m		
	Atriplex aff. lindleyi subsp. inflata	+		1.0 m	MH816	
	Atriplex bunburyana	+		0.25 m		
	Casuarina pauper					not in quadrat
	Cratystylis subspinescens	5		1.5 m		
	Enteropogon ramosus	<2		0.4 m	BJ013	
	Eragrostis eriopoda	3		0.35 m		
	Eremophila forrestii					not in quadrat
	Eremophila jucunda	+		1.5 m		
	Eremophila oldfieldii subsp. oldfieldii	<2		1.8 m	BJ002	not in quadrat
	Exocarpos aphyllus	2		1.9 m		
	Frankenia setosa					not in quadrat may be F.
	Maireana georgei					not in quadrat
	Maireana thesioides	<2		0.7 m	BJ008	
	Maireana tomentosa subsp. tomentosa	<2		0.2 m	BJ012	
	Maireana triptera	<2		0.3 m		
	Melaleuca sp.	40		3 m	BJ010	
	Monachather paradoxus	<2		0.3 m		
	Ptilotus obovatus var. obovatus	5		0.8 m		
	Rhyncharrhena linearis	+		1.5 m	MH815	
	Scaevola spinescens	<2		0.7 m	BN041	
	Sclerolaena cuneata				BJ035	not in quadrat
	Senna artemisioides subsp. filifolia	+		2 m		
	Triodia basedowii	20		0.3 m		

Quadrat LM78

Lake Maitland **Site** LM79

Described by BGN **Date** 1/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308053 **mE** 7001913 **mN**
Habitat Plain
Soil Red/brown sandy clay
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Signs of cattle grazing

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Aristida contorta	4		0.1-2 m	MH808	
	Cratystylis subspinescens	15		1.5 m		
	Eremophila jucunda subsp. jucunda	2		0.5 m	BN069	
	Frankenia cinerea	3		0.25 m	BN051	
	Grevillea sarissa subsp. succincta	5		2.5 m	BN094	
	Lycium australe	2		1.5 m		
	Maireana amoena	1		0.1 m	MH806	
	Maireana suaedifolia	+		1.5 m	MH807	
	Prostanthera sp.	6		0.25 m	BN149	
	Rhagodia drummondii	2		0.6 m		
	Scaevola spinescens	1		1.5 m		
	Sclerolaena parviflora	+		0.3 m	MH809	
	Triodia basedowii	<1		0.2 m		

Quadrat LM79

Lake Maitland **Site** LM80

Described by BJ **Date** 2/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 308268 **mE** 7002178 **mN**
Habitat Plain
Soil Red/brown sand
Rock Type
Vegetatio
Veg Very good - excellent
Fire Age 2-3
Notes Cattle tracks, rabbits, digging, scats?

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	10		5.5 m	BJ005	
	Acacia aneura var. ? macrocarpa	+		0.4 m	MH802	
	Acacia pachyacra	<2		1.6 m	BJ051	resprouting
	Acacia sp.				BJ043	not ided not in quadrat
	Alyogyne pinoniana				Bn124	not in quadrat
	Codonocarpus cotinifolius	+		0.5m		not in quadrat; post fire
	Dicrastylis flexuosa	25		0.65 m	MH800	
	Dicrastylis sp.	2		0.4 m		
	Eragrostis eriopoda	<2		0.3 m		
	Eremophila longifolia	+		1.2 m	MH803	
	Leptosema chambersii	<2		0.35 m	BN099	
	Melaleuca eleuterostachya	+		0.4 m	MH801	not ided; resprouting
	Rulingia loxophleba	<2		0.35 m	BN143a	
	Solanum coactiliferum	<2		0.3 m	BJ052	
	Solanum nummularium	+		0.5 m	MH804	
	Solanum orbiculatum subsp. orbiculatum	2		0.4m	MH813	
	Triodia basedowii	30		0.2 m		

Quadrat LM80

Lake Maitland **Site** LM81

Described by BGN **Date** 2/11/2007 **Type:** Q 30 x 30
Season: P **Uniformit**

Location Project area

MGA Zone 50 310492 **mE** 7002222 **mN**
Habitat Plain
Soil Red/brown sandy loam and clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Structure good, grazed

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura	20		6-7 m		
	Acacia aneura var. aneura	20		6-7 m	CK795	
	Acacia ramulosa var. linophylla	1		2-2.25 m	CK791	
	Acacia sp.	+		2m	CK793	
	Acacia tetragonophylla	1		2 m		
	Atriplex ? lindleyi	+		1 m	CK796	
	Eragrostis eriopoda	5		0.3m		grazed
	Eremophila margarethae	25		1 m	CK974	
	Grevillea sarissa subsp. bicolor	1		1.5 m	BN012	
	Grevillea sarissa subsp. succincta	3		2.5 m	BN094	
	Grevillea sp.	2		1.75-3 m	CK738	
	Malvaceae sp.	+		0.5-0.6 m	CK778	
	Senna artemisioides subsp. filifolia	1		3.5 m		
	Triodia basedowii	25		0.4-0.5m		

Quadrat LM81

Lake Maitland **Site** LM82

Described by **Date** 5/05/2009 **Type:** Q

Season: **Uniformit**

Location

MGA Zone 51 312027 **mE** 6999567 **mN**

Habitat Plain

Soil Brown-orange loamy sand

Rock Type

Vegetatio

Veg Very good

Fire Age 3-5 years

Notes Fire, rabbits, grazing (camels), old track

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ? duriuscula	15		5-6 m	CK728	
	Acacia aneura var. aneura	5		6-8 m		
	Acacia aneura var. argentea	+		0.75 m	CK724	
	Acacia aneura var. cf major	+		0.75 m	CK723	
	Acacia aneura var. cf major	+		1.2 m	CK722	
	Acacia ayersiana	5		2.5-3 m		
	Acacia sp.	+		1 m	CK726	
	Acacia sp.	+		4m	CK718	
	Cratystylis subspinescens	+		1.2 m	CK720	
	Dodonaea lobulata	+		1 m	CK727	
	Dodonaea lobulata	1		1.5 m	CK727	
	Enchylaena tomentosa var. tomentosa	+		0.4 m	CK729	
	Enneapogon caerulescens	+		0.3 m	CK715	
	Eragrostis eriopoda	2		0.3 m		
	Eremophila gilesii	+		1.5 m	CK721	
	Eremophila oldfieldii subsp. ? oldfieldii	+		1m	CK719	
	Eremophila oldfieldii subsp. oldfieldii	+		1.7 m		
	Eucalyptus eremicola subsp. peeneri	25		8-10 m		
	Exocarpos aphyllus	+		1.75 m		
	Exocarpos aphyllus	+		3 m	CK716	Flowers/fruit green
	Ptilotus obovatus var. obovatus	+		0.6 m		
	Scaevola spinescens	+				
	Senna artemisioides subsp. filifolia	+		1.5 m		
	Templetonia egena	+		1m	CK717	Not Striated
	Triodia basedowii	40		0.3 m		

Lake Maitland **Site** LM83

Described by CK **Date** 5/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location

MGA Zone 51 311272 **mE** 6996897 **mN**
Habitat
Soil Brown-orange, sand with loam
Rock Type
Vegetatio Acacia open woodland, PAS (2nd site)
Veg Very good - good
Fire Age
Notes Topography: edge of lake/plain,
Aspect: flat,
Disturbance description: some plant deaths, cow tracks, tracks, exploration activity/bore holes

Species List:

Quad Name	Cove	C Class	Height	Specimen	Notes
Acacia heteroneura var. prolixa	5		2.5-3 m	CK730	
Amyema gibberula var. tatei	+		-	CK741	In Grevillea CK738
Aristida contorta	+		0.1-0.2 m	CK734	
Aristida holathera var. holathera	+		0.3-0.4 m	CK733	Outside plot
Atriplex bunburyana	+		0.3 m		
Enneapogon caerulescens	+		0.3-0.5 m		
Goodenia prostrata	+		0.05-0.1	CK735	Prostrate
Grevillea sp.	1		2.5-3 m	CK738	
Hakea preissii	+		1.5 m		
Lawrencia squamata	2		0.5 m	CK732	
Panicum decompositum	+		0.2-0.3 m	CK737	
Paspalidium basicladium	+		0.3 m	CK731	
Poaceae sp.	+		0.1-0.2 m	CK736	
Scaevola spinescens	+		0.5-0.7		
Sclerolaena cornishiana	+		0.2 m		
Senna glutinosa subsp. chatelainiana	+		0.5 m	CK739	
Solanum orbiculatum	+		0.5 m	CK740	

Quadrat LM83

Lake Maitland **Site** LM84

Described by **Date** **Type:** Q

Season: **Uniformit**

Location

MGA Zone 51 312511 **mE** 6987395 **mN**

Habitat

Soil White/orange, gypsum crust over orange clay loam

Rock Type

Vegetatio

Veg

Fire Age

Notes Disturbance: rabbits
Topography: Kopi Ridge
Note: same as KRG, KRE

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Enchylaena tomentosa var. tomentosa	+		0.2 m	CK951	
	Eragrostis lanipes	+		0.3m		
	Eragrostis sp.	+		<0.1 m	CK950	
	Eremophila ? alternifolia	5		1.5-2.0 m	CK946	
	Eucalyptus striaticalyx	30		8-10 m		
	Grevillea sarissa subsp. bicolor	5		2.5 m		
	Lawrencia helmsii	2		0.4-0.7 m		

Quadrat LM84

Lake Maitland **Site** LM85

Described by **Date** 9/05/2009 **Type:** Q 30X30

Season: **Uniformit**

Location Track to Tonys well

MGA Zone 51 314374 **mE** 6990345 **mN**

Habitat

Soil Red, sandy loam

Rock Type

Vegetatio Euc. Malee shrubland

Veg Excellent

Fire Age

Notes Aspect: flat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia sibina	1-2		1m		
	Alyogyne pinoniana	+		0.6	MH835	
	Bonamia sp.	+		0.3	MH840	
	Eremophila oldfieldii subsp. cf oldfieldii	+		0.1	MH836	
	Eremophila platythamnos subsp. platythamnos	+		1.1	MH833	
	Eucalyptus peeneri	10		1-2m		
	Grevillea cf juncifolia subsp. juncifolia	+		2.5m	MH837	
	Hakea minyma	0		2.3m	MH831	Outside quadrant
	Hibiscus krichauffianus	+		0.6	MH839	
	Leptosema chambersii	1-2		0.3	MH832	Dying off mostly
	Melaleuca eleuterostachya	1		+	MH801	
	Stackhousia muricata	+		40	MH838	Resprouting
	Triodia basedowii	60		0.3m		

Quadrat LM85

Lake Maitland **Site** LM86

Described by MJH **Date** **Type:** Q 30x30

Season: **Uniformit**

Location

MGA Zone 51 308006 **mE** 7001795 **mN**

Habitat

Soil Red/brown, sandy loamy clay

Rock Type

Vegetatio Mulga over saltbush

Veg Excellent- very good

Fire Age

Notes Aspect: flat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia aneura var. aneura	2		8 m		
	Acacia aneura var. argentea	+		1 m	MH810	
	Cratystylis subspinescens	25		1-1.2 m		
	Lycium australe	1-2		1.2 m		
	Maireana amoena	+		0.1 m	MH812	
	Maireana amoena	1		0.05 m	MH806	
	Rhagodia drummondii	1		0.8 m		
	Scaevola spinescens	+		1 m		
	Sclerolaena parviflora	+		0.1 m	MH809	
	Solanum cf orbiculatum subsp. orbiculatum	+		0.4 m	MH813	

Lake Maitland **Site** LM87

Described by CK **Date** 7/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location

MGA Zone 51 307944 **mE** 6998379 **mN**
Habitat
Soil Orange, sandy loamy clay with calcrete on top
Rock Type
Vegetatio
Veg Good
Fire Age
Notes Topography: plain,
Aspect: flat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia nyssophylla	10		1.5-2.5m	CK802	
	Atriplex ? lindleyi	+		0.5m	CK796	
	Casuarina aff. obesa	10		6-8m	CK801	
	Eremophea spinosa	+		0.05m	CK744	
	Lycium australe	+		1.2m	CK743	
	Poaceae sp.	+		<0.05	CK804	Chewed severely
	Poaceae sp.	7		<0.05	CK803	Chewed severely
	Sclerolaena fimbriolata	+		0.2-0.3m	CK800	
	Senna glutinosa subsp. chatelainiana	+		0.7m	CK739	

Quadrat LM87

Lake Maitland **Site** LM88

Described by CK **Date** 7/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location

MGA Zone 51 308032 **mE** 6998330 **mN**
Habitat
Soil Orange, Sandy loamy clay with calcrete on top
Rock Type
Vegetatio Lots of grass layer
Veg Good
Fire Age
Notes Topography: plain,
Aspect: flat,
Disturbance description: fire, grazed severely, rabbits, cattle track

Species List:

Quad Name	Cove	C Class	Height	Specimen	Notes
Acacia nyssophylla	10.0		2-2.5	CK802	
Casuarina aff. obesa	5.0		6-7m	CK801	
Lycium australe	2.0		0.5	CK743	
Poaceae sp.	+		<0.05	CK804	Grazed
Poaceae sp.	5.0		<0.05	CK803	Grazed
Sclerolaena fimbriolata	+		0.5-0.2	CK800	
Senna glutinosa subsp. chatelainiana	+		0.4	CK739	

Quadrat LM88

Lake Maitland **Site** LM89

Described by CK **Date** 8/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location Lake Maitland

MGA Zone 51 307444 **mE** 6993004 **mN**
Habitat
Soil Red-brown, fine sand/clay
Rock Type
Vegetatio
Veg Very good - good
Fire Age
Notes Topography: plain,
Apspect: flat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Aristida contorta	+		0.3	CK734	
	Atriplex aff. lindleyi subsp. inflata	2.0		0.75	MH816	
	Atriplex sp.	7.0		1.2	CK823	
	Boerhavia cf schomburgkiana	+		<0.05	CK826	Prostrate
	Chenopodiaceae sp.	+		0.3	CK777	
	Enchylaena tomentosa var. tomentosa	+		0.3-0.4	CK729	
	Enchylaena tomentosa var. tomentosa	+		0.5	CK824	
	Enneapogon caerulescens	1.0		0.2	CK821	
	Eragrostis eriopoda	1.0		0.3	CK822	
	Eremophila forrestii subsp. forrestii	2.0		1.5-1.75	CK829	
	Eremophila longifolia	1.0		1.5m	CK703	
	Euphorbia drummondii	+		<0.05	CK819	Prostrate
	Malvaceae sp.	15.0		6-8m	CK778	
	Poaceae sp.	+		0.4	CK736	
	Portulaca oleracea	+		<0.05	CK820	
	Ptilotus exaltatus var. exaltatus	+		0.2	CK817	
	Ptilotus helipteroides	+		0.1	CK818	
	Ptilotus obovatus var. obovatus	3.0		0.4-0.5	CK772	
	Rhagodia drummondii	1.0		1.0-1.2	CK828	Atriplex bunbury
	Senna artemisioides subsp. filifolia	+		0.8-0.9		
	Senna artemisioides subsp. helmsii	+		0.75	CK825	? Oligophylla
	Senna sp. Meekatharra (E. Bailey 1-26)	+		1.4	CK827	
	Sida cf ammophila	+		0.3-0.4	CK816	
	Sida fibulifera	+		0.2	CK761	Prostrate
	Solanum lasiophyllum	+		0.4		
	Tribulus occidentalis	+		<0.1	CK815	Prostrate

Quadrat LM89

Lake Maitland **Site** LM90

Described by CK **Date** 10/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location PHH= LM015

MGA Zone 51 311913 **mE** 6997530 **mN**
Habitat
Soil Red-brown, caly
Rock Type
Vegetatio
Veg Very good
Fire Age
Notes Topography: plain,
Disturbance description: fire, grazed, camel dammage, rabbit warren on edge

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia ? duriuscula	10		4-5	CK728	
	Acacia aneura var. argentea	1		1.2	MH810	
	Acacia tetragonophylla	+		1.0	CK700	
	Aristida contorta	2		0.2	CK734	Chewed
	Aristida contorta	+		0.3	MH808	
	Atriplex sp.	5		1.0	CK787	
	Boerhavia cf coccinea	+		0.3	CK1008	
	Enneapogon caerulescens	+		0.1	CK1014	
	Enteropogon ramosus	+		0.4	CK1010	
	Eragrostis eriopoda	+		0.4	CK1013	
	Eremophila forrestii subsp. ? forrestii	2		1.2	CK751	
	Frankenia ? pauciflora	+		0.4	CK1012	Pink flower
	Grevillea sarissa subsp. succincta	1		1.2	CK701	
	Lawrencia squamata	2		1.0	CK746	
	Portulaca oleracea	+		<0.05	CK1011	Prost
	Ptilotus obovatus var. obovatus	+		0.2-0.4	CK772	
	Rhagodia drummondii	2		0.8	CK828	
	Senna artemisioides subsp. filifolia	+		1.2		
	Trianthema triquetra	+		<0.05	CK1009	Fresh mat prost
	Triodia basedowii	3		0.5	CK1015	

Quadrat LM90

Lake Maitland **Site** LM91

Described by CK **Date** 8/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location PCW3=LM18

MGA Zone 51 312391 **mE** 6994544 **mN**
Habitat
Soil White/orange, Kopi, Gypsum, Clay loam
Rock Type
Vegetatio
Veg Very good-good
Fire Age
Notes Topography: ridge,
Aspect: Southwest

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Acacia heteroneura var. prolixa	1		3.5	CK904	
	Aristida contorta	+		0.3		
	Enneapogon caerulescens	+		0.2		
	Eragrostis lanipes	+		0.3		
	Eremophea spinosa	+		0.3	CK906	
	Eremophila longifolia	+		1.5	CK703	
	Grevillea sarissa subsp. bicolor	5		2.5-3	CK900	
	Lawrencia helmsii	+		0.6		
	Lycium australe	2		1.2		
	Lysiana murrayi	+			CK903	CK904 Acacia on it
	Maireana ? pentatropis	+		0.3	CK901	
	Ptilotus obovatus var. obovatus	+		0.4	CK772	
	Rhagodia sp.	1		0.6	CK902	
	Senna artemisioides subsp. filifolia	1		1.75		
	Solanum cf lasiophyllum	+		0.4	CK905	

Lake Maitland Site LM92

Described by CK **Date** 8/05/2009 **Type:** Q 30x30
Season: **Uniformit**

Location PCM LM43

MGA Zone 51 309711 **mE** 6991623 **mN**
Habitat
Soil Orange brown, sand with clay
Rock Type
Vegetatio
Veg Excellent
Fire Age
Notes Topography: plain,
Aspect: flat

Species List:

Quad	Name	Cove	C Class	Height	Specimen	Notes
	Atriplex sp.	+		0.2-0.4 m	CK848	
	Boerhavia ? schomburgkiana	+		0.1	CK851	
	Chenopodiaceae sp.	+		0.2 m	CK841	
	Enneapogon caerulescens	+		0.15 m	CK845	
	Euphorbia biconvexa	+		<0.05 m	CK846	Prostrate
	Frankenia ? setosa	+		0.4 m	CK844	
	Lawrencia squamata	40		0.5 m	CK732	
	Lycium australe	1		0.2-0.3 m	CK743	
	Ptilotus aervoides	+		<0.05 m	CK847	
	Rhagodia drummondii	3		0.5 m	CK843	
	Tragus australianus	+		0.1 m	CK842	
	Tribulus occidentalis	+		<0.05 m	CK849	Prostrate

Quadrat LM92

Appendix L
Lake Maitland Vegetation Units

Lake Maitland Vegetation Unit Descriptions

Salt Lake (playa) Vegetation

Salt Lake Tecticornia (SLT)

Low heath of *Frankenia cinerea, Maireana amoena, Tecticornia* aff. *undulata*, *Tecticornia halocnemoides* subsp. *halocnemoides,* and *Tecticornia indica* subsp. aff. *bidens,* over very open herbs of *Scaevola collaris* and open low grass of *Eragrostis lanipes*.

Salt Lake Lawrencia (SLL)

Low scrubland/heath of *Atriplex nana, Lawrencia helmsii* and *Tecticornia* aff. *undulata* over very open herb of *Sclerolaena fimbriolata, Zygophyllum compressum* and open low grass of *Eragrostis lanipes*.

Saline Playa Lake (SPL)

No vegetation present

Kopi Ridge Vegetation

Kopi Ridge Eucalypt (KRE)

Low woodland of *Eucalyptus striaticalyx* and *Grevillea sarissa* subsp*. bicolor* over low scrub of *Lawrencia helmsii, Sclerolaena fimbriolata* and *Tecticornia* aff. *undulata.*

Plains Vegetation

Plains *Acacia* Low Forest (PAF)

Low Forest of *Acacia aneura, A. aneura* var. *fuliginea, A. ayersiana* and *Melaleuca interioris* over *Cratystylis subspinescens, Rhagodia eremaea, Scaevola spinescens* and open low grasses *Aristida contorta* and *Enteropogon ramosus*.

Plains *Acacia* Low Forest 2 (PAF2)

Low Forest of *Acacia aneura* over Atriplex bunburyana, *Eremophila jucunda* subsp, *jucunda,* Maireana pyramidata, Malvaceae sp. and *Ptilotus obovatus* over low grasses *Aristida contorta, Enneapogon caerulescens* and *Enteropogon ramosus.*

Plains *Atriplex* Heath (PAH)

Dense Low Heath of *Acacia ? duriuscula*, *Atriplex amnicola, Atriplex sp*. and *Sclerolaena fimbriolata* over open herbs *Scaevola spinescens*, *Sida fibulifera* and open low grasses *Enneapogon caerulescens* and *Panicum effusum.*

Plains *Acacia* Low Woodland (PALW)

Open Low Woodland of *Acacia aneura,* Acacia *tetragonophylla,* and *Lycium australe* over *Cratystylis subspinescens, Ptilotus obovatus*, *Sclerolaena fimbriolata* and, open low grass of *Aristida contorta, Enneapogon caerulescens and Eragrostis setifolia.*

Plains *Acacia* Low Woodland 2 (PALW2)

Open Low Woodland of *Acacia aneura, Acacia aneura var. aneura* and *Acacia rhodophloia* over *Atriplex bunburyana, Cratystylis subspinescens*, *Eremophila falcata, Maireana pyramidata* and *Melaleuca interioris* over hummock grassland *Triodia basedowii* and low grassland *Aristida contorta* and *Enteropogon ramosus.*

Plains *Acacia* Open Low Woodland (PAOW)

Open Low Woodland of *Acacia aneura, A. aneura* var. *aneura* and *A. aneura* var. *argentea* over *Senna artemisioides* subsp, *filifolia, Cratystylis subspinescens*, *Eremophila forrestii subsp. ? forrestii*, *Maireana georgei, Triodia basedowii* and open low grasses *Aristida contorta*, *Eragrostis eriopoda* and *Monachather paradoxus.*

Plains *Acacia* Open Low Woodland 2 (PAOW2)

Open Low Woodland of *Acacia aneura* var*. aneura, A. ayersiana* and *A. ramulosa* var. *linophylla* over *Atriplex bunburyana, Triodia basedowii* and open low grasses *Aristida contorta* and *Eragrostis eriopoda.*

Plains *Acacia* Shrubland (PAS)

Open shrubland of *Acacia heteroneura* var. *prolix, A. tetragonophylla, Hakea preissii* and *Lawrencia squamata* over open low grass *Enneapogon caerulescens.*

Plains *Atriplex* Shrubland (PAS2)

Open shrubland of *Acacia aneura* over *Atriplex bunburyana, Frankenia fecunda* and *Rhagodia drummondii*.

Plains *Acacia* Woodland (PAW)

Low Woodland of *Acacia aneura, A. aneura var. aneura,* over *Atriplex aff. lindleyi* subsp. *inflata, Cratystylis subspinescens, Eremophila jucunda* subsp *jucunda*, *E. forrestii subsp. ? forrestii* and *Hakea preissii* over hummock grassland *Triodia basedowii*, and very open low grasses *Enneapogon caerulescens* and *Aristida contorta*.

Plains *Acacia* Woodland 2 (PAW2)

Low Woodland of *Acacia aneura* over *A. ayersiana, A. cuthbertsonii* var, *linearis, Eremophila oldfieldii* subsp. *oldfieldii* and *Senna artemisioides* subsp, *filifolia,* very open herbs *Ptilotus obovatus,* hummock grassland *Triodia basedowii* and low grass *Aristida contorta* and *Eragrostis eriopoda.*

Plains *Cratystylis* Low Heath (PCL)

Open Low heath of *Cratystylis subspinescens, Grevillea sarissa* subsp. *succinct, Lycium australa, Prostanthera* sp. and *Rhagodia drummondii* over low grass *Aristida contorta.*

Plains *Casuarina and Acacia* Woodland (PCAW)

Open woodland of *Casuarina* aff. *obese* and *Acacia nyssophylla* over *Lycium australe*

Plains *Eremophila* Low Woodland (PELW)

Open Low Woodland of *Acacia aneura,* and *Eremophila oldfieldii subsp. oldfieldii* over *Atriplex bunburyana, Eremophila maculata, Cratystylis subspinescens, Maireana pyramidata* and *Scaevola spinescens* scrub, *Triodia basedowii* hummock grassland and open low grass of *Aristida contorta* and *Enteropogon ramosus.*

Plains *Eremophila* Scrub (PES)

Eremophila miniata, and Acacia ayersiana over *Aristida contorta* and *Triodia basedowii* hummock grassland and open low grass of *Eragrostis eriopoda.*

Plains Eucalypt Woodland (PEW)

Open Low Woodland of *Eucalyptus eremicola* subsp, *peeneri, Acacia aneura*, *A. aneura var. aneura, Acacia ? duriuscula, Acacia* ayersiana and *Grevillea nematophylla* and *Hakea preissii* over open herbs of *Ptilotus exaltatus* var *exaltatus and Scaevola spinescens,* very over *Triodia*

basedowii hummock grassland and open low grass of *Enneapogon caerulescens* and *Aristida contorta.*

Plains *Lawrencia* Heath (PLH)

Open Low heath of *Atriplex bunburyana, Lawrencia squamata, Maireana* amoena and *Maireana triptera* over open low grass *Aristida contorta,*

Plains Lawrencia Heath 2 (PLH2)

Open Low heath of *Frankenia fecunda*, *Lawrencia squamata, Lycium australe* and *Rhagodia drummondii* over very open low grass *Eragrostis lanipes,*

Plains Low Woodland (PML)

Low Woodland of *Acacia nyssophylla, Eucalyptus eremicola* subsp, *peeneri, Grevillea sarissa* subsp. *succinct* and *Senna artemisioides* subsp, *filifolia* over open herbs of *Scaevola spinescens, Triodia basedowii* hummock grassland and open low grass of *Aristida contorta and Eragrostis eriopoda*

Plains *Melaleuca* Low Woodland (PMW)

Open Low Woodland of *Melaleuca interioris* and *Acacia ayersiana* over *A. tetragonophylla, Cratystylis subspinescens, Eremophila margarethae, Exocarpos aphyllus, Frankenia cordata, Scaevola spinescens* over *Triodia basedowii* hummock grassland over open low grass of *Enteropogon ramosus* and *Eragrostis eriopoda.*

Plains *Triodia* Grassland (PTG)

Open Low Scrub of *Hakea lorea* subsp. *lorea* and *Hakea preissii* over *Ptilotus obovatus, Sclerolaena parviflora,* over *Triodia basedowii and Triodia desertorum* hummock grassland and open low grass *Aristida contorta*.

Plains Tecticornia Heath (PTH)

Open Low heath of *Tecticornia halocnemoides, Tecticornia indica* subsp. aff. *bidens, Tecticornia ? undulata* and *Maireana oppositifolia* over open low grass *Eragrostis lanipes.*

Fire Regeneration Eucalyptus (FRE)

Open Low Woodland of *Eucalyptus eremicola* subsp, *peeneri* over *Acacia sibina, Alyogyne pinoniana, Kennedia prorepens and Leptosema chambersii*, over very dense *Triodia basedowii* hummock grassland.

Calcrete Vegetation

Plains *Casuarina* Low Woodland (PCW)

Open Low Woodland of *Casuarina pauper* over *Acacia cuthbertsonii* var *linearis, Acacia nyssophylla, Hakea preissii*, *Rhagodia eremaea, Salsola tragus and Sclerolaena cornishiana* over open low grass *Enneapogon caerulescens.*

Plains *Casuarina* Low Woodland 2 (PCW2)

Low Woodland of *Casuarina pauper* over *Acacia burkittii, Atriplex bunburyana, Eremophila oldfieldii* subsp, *oldfieldii, Maireana eriosphaera, Ptilotus obovatus, Salsola tragus, Senna artemisioides* subsp, *filifolia* and *Sclerolaena deserticola,* and open low grass *Enneapogon caerulescens.*

Plains *Casuarina* Low Woodland 3 (PCW3)

Low Woodland of *Casuarina pauper* over *Atriplex bunburyana, Grevillea sarissa* subsp. *bicolor*, *Lycium australa, Senna artemisioides* subsp. *filifolia,* over very open low grass *Eragrostis lanipes.*

Plains *Enneapogon* Grassland (PEG)

Open Dwarf Scrub of *Lawrencia squamata* and *Lycium australe* over *Salsola tragus* and *Sclerolaena cornishiana* herbs, *Triodia basedowii* hummock grassland and low grasses *Enneapogon caerulescens* and *Eragrostis setifolia.*

Appendix M

Vegetation Unit Matrix of Quadrats for the Lake Maitland Project

Vegetation Unit Matrix of Quadrats occurring within the Vegetation Units over the Lake Maitland project area

Vegetation Unit	SLT	SLL	KRE	PAF	PAF2	PAH	PALW	PALW2	PAOW	PAOW2	PAS	PAS2	PAW	PAW2	PCL	PCAW	PELW
LM01																	
LM02																	
LM03																	
LM04																	
LM05																	
LM06																	
LM07																	
LM08																	
LM09																	
LM10																	
LM11																	
LM12																	
LM13																	
LM14																	
LM15																	
LM16																	
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LM30																	
LM31																	
LM32																	
LM33																	
LM34																	

Vegetation Unit	SLT	SLL	KRE	PAF	PAF2	PAH	PALW	PALW2	PAOW	PAOW2	PAS	PAS2	PAW	PAW2	PCL	PCAW	PELW
LM35																	
LM36																	
LM37																	
LM38																	
LM39																	
LM40																	
LM41																	
LM42																	
LM43																	
LM44																	
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LM68																	
LM69																	
LM70																	

Vegetation Unit	SLT	SLL	KRE	PAF	PAF2	PAH	PALW	PALW2	PAOW	PAOW2	PAS	PAS2	PAW	PAW2	PCL	PCAW	PELW
LM71																	
LM72																	
LM73																	
LM75																	
LM76																	
LM77																	
LM78																	
LM79																	
LM80																	
LM81																	
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LM87																	
LM88																	
LM89																	
LM90																	
LM91																	
LM92																	
LM93																	
LM94																	

Vegetation Unit	PES	PEW	PLH	PLH2	PML	PMW	PTG	PTH	FRE	PCW	PCW2	PCW3	PEG
LM01													
LM02													
LM03													
LM04													
LM05													
LM06													
LM07													
LM08													
LM09													
LM10													
LM11													
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LM30													
LM31													
LM32													
LM33													
LM34													

Vegetation Unit	PES	PEW	PLH	PLH2	PML	PMW	PTG	PTH	FRE	PCW	PCW2	PCW3	PEG
LM35													
LM36													
LM37													
LM38													
LM39													
LM40													
LM41													
LM42													
LM43													
LM44													
LM45													
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LM66													
LM67													
LM68													
LM69													
LM70													

Vegetation Unit	PES	PEW	PLH	PLH2	PML	PMW	PTG	PTH	FRE	PCW	PCW2	PCW3	PEG
LM71													
LM72													
LM73													
LM75													
LM76													
LM77													
LM78													
LM79													
LM80													
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LM93													
LM94													

Appendix N
Vegetation Mapping

3150000mE
3200000mE
7005000mN
7000000mN
6995000mN
6990000mN
P 53/1255
P 53/1256
P 53/1257
P 53/1258
P 53/1259
P 53/1260
P 53/1261
P 53/1262
P 53/1263
L 53/152
E 53/1442
E 53/1060
E 53/947
E 53/1099
M 53/1089
E 53/1210
E 53/1441
P 53/1252
Mosaic of PAF, PAOW, PTH
Mosaic of PAW2, PML, PMW
Maireana prosthecochaeta (P3)
LM01
LM02
LM03
LM04
LM05
0
500m
Scale
MGA94 (Zone 51)

Lake Maitland Vegetation Unit Descriptions

Salt Lake (playa) Vegetation

SLT - Salt Lake Tecticornia
Low heath of *Frankenia cinerea, Maireana amoena, Tecticornia* aff. *undulata*, *Tecticornia halocnemoides* subsp. *halocnemoides,* and *Tecticornia indica* subsp. aff. *bidens,* over very open herbs of *Scaevola collaris* and open low grass of *Eragrostis lanipes*.

SLL - Salt Lake Lawrencia
Low scrubland/heath of *Atriplex nana, Lawrencia helmsii* and *Tecticornia* aff. *undulata* over very open herb of *Sclerolaena fimbriolata, Zygophyllum compressum* and open low grass of *Eragrostis lanipes*.

SPL - Saline Playa Lake
No vegetation present

Kopi Ridge Vegetation

KRE - Kopi Ridge Eucalypt
Low woodland of *Eucalyptus striaticalyx* and *Grevillea sarissa* subsp. *bicolor* over low scrub of *Lawrencia helmsii, Sclerolaena fimbriolata* and *Tecticornia* aff. *undulata.*

Plains Vegetation

PAF2 - Plains *Acacia* Low Forest 2
Low Forest of *Acacia aneura* over Atriplex bunburyana, *Eremophila jucunda* subsp. *jucunda, Maireana pyramidata, Malvaceae* sp. and *Ptilotus obovatus* over low grasses *Aristida contorta, Enneapogon caerulescens* and *Enteropogon ramosus.*

PAH - Plains *Atriplex* Heath
Dense Low Heath of *Acacia ? duriuscula*, *Atriplex amnicola, Atriplex* sp. and *Sclerolaena fimbriolata* over open herbs *Scaevola spinescens*, *Sida fibulifera* and open low grasses *Enneapogon caerulescens* and *Panicum effusum.*

PALW - Plains *Acacia* Low Woodland
Open Low Woodland of *Acacia aneura, Acacia tetragonophylla,* and *Lycium australe* over *Cratystylis subspinescens, Ptilotus obovatus*, *Sclerolaena fimbriolata* and, open low grass of *Aristida contorta, Enneapogon caerulescens and Eragrostis setifolia.*

PALW2 - Plains *Acacia* Low Woodland 2
Open Low Woodland of *Acacia aneura, Acacia aneura* var. *aneura* and *Acacia rhodophloia* over *Atriplex bunburyana, Cratystylis subspinescens*, *Eremophila falcata, Maireana pyramidata* and *Melaleuca interioris* over hummock grassland *Triodia basedowii* and low grassland *Aristida contorta* and *Enteropogon ramosus*.

PAOW2 - Plains *Acacia* Open Low Woodland 2
Open Low Woodland of *Acacia aneura* var. *aneura, A. ayersiana* and *A. ramulosa* var. *linophylla* over *Atriplex bunburyana, Triodia basedowii* and open low grasses *Aristida contorta* and *Eragrostis eriopoda.*

PAS - Plains *Acacia* Shrubland
Open shrubland of *Acacia heteroneura* var. *prolix, A. tetragonophylla, Hakea preissii* and *Lawrencia squamata* over open low grass *Enneapogon caerulescens.*

PAS2 - Plains *Atriplex* Shrubland 2
Open shrubland of *Acacia aneura* over *Atriplex bunburyana, Frankenia fecunda* and *Rhagodia drummondii*.

PAW - Plains *Acacia* Woodland
Low Woodland of *Acacia aneura, A. aneura* var. *aneura,* over *Atriplex aff. lindleyi* subsp. *inflata, Cratystylis subspinescens, Eremophila jucunda* subsp *jucunda*, *E. forrestii* subsp. *? forrestii* and *Hakea preissii* over hummock grassland *Triodia basedowii*, and very open low grasses *Enneapogon caerulescens* and *Aristida contorta*.

PCL - Plains *Cratystylis* Low Heath
Open Low heath of *Cratystylis subspinescens, Grevillea sarissa* subsp. *succinct, Lycium australa, Prostanthera* sp. and *Rhagodia drummondii* over low grass *Aristida contorta*.

PCAW - Plains *Casuarina and Acacia* Woodland
Open woodland of *Casuarina* aff. *obese* and *Acacia nyssophylla* over *Lycium australe*

PEW - Plains Eucalypt Woodland
Open Low Woodland of *Eucalyptus eremicola* subsp. *peeneri, Acacia aneura*, *A. aneura* var. *aneura, Acacia ? duriuscula, Acacia ayersiana* and *Grevillea nematophylla* and *Hakea preissii* over open herbs of *Ptilotus exaltatus* var. *exaltatus and Scaevola spinescens,* very over *Triodia basedowii* hummock grassland and open low grass of *Enneapogon caerulescens* and *Aristida contorta.*

PELW - Plains *Eremophila* Low Woodland
Open Low Woodland of *Acacia aneura,* and *Eremophila oldfieldii subsp. oldfieldii* over *Atriplex bunburyana, Eremophila maculata, Cratystylis subspinescens, Maireana pyramidata* and *Scaevola spinescens* scrub, *Triodia basedowii* hummock grassland and open low grass of *Aristida contorta* and *Enteropogon ramosus.*

PES - Plains *Eremophila* Scrub
Eremophila miniata and Acacia ayersiana over *Aristida contorta* and *Triodia basedowii* hummock grassland and open low grass of *Eragrostis eriopoda.*

PLH - Plains *Lawrencia* Heath
Open Low heath of *Atriplex bunburyana, Lawrencia squamata, Maireana amoena* and *Maireana triptera* over open low grass *Aristida contorta.*

PLH2 - Plains Lawrencia Heath 2
Open Low heath of *Frankenia fecunda*, *Lawrencia squamata*, *Lycium australe* and *Rhagodia drummondii* over very open low grass *Eragrostis lanipes.*

PTG - Plains *Triodia* Grassland
Open Low Scrub of *Hakea lorea* subsp. *lorea* and *Hakea preissii* over *Ptilotus obovatus*, *Sclerolaena parviflora,* over *Triodia basedowii and Triodia desertorum* hummock grassland and open low grass *Aristida contorta*.

FRE - Fire Regeneration Eucalyptus
Open Low Woodland of *Eucalyptus eremicola* subsp. *peeneri* over *Acacia sibina, Alyogyne pinoniana, Kennedia prorepens and Leptosema chambersii*, over very dense *Triodia basedowii* hummock grassland.

Mosaic of PAW2, PML and PMW

PAW2 - Plains *Acacia* Woodland 2
Low Woodland of *Acacia aneura* over *A. ayersiana, A. cuthbertsonii* var. *linearis, Eremophila oldfieldii* subsp. *oldfieldii* and *Senna artemisioides* subsp. *filifolia,* very open herbs *Ptilotus obovatus,* hummock grassland *Triodia basedowii* and low grass *Aristida contorta* and *Eragrostis eriopoda.*

PML - Plains Low Woodland
Low Woodland of *Acacia nyssophylla, Eucalyptus eremicola* subsp. *peeneri, Grevillea sarissa* subsp. *succinct* and *Senna artemisioides* subsp. *filifolia* over open herbs of *Scaevola spinescens, Triodia basedowii* hummock grassland and open low grass of *Aristida contorta and Eragrostis eriopoda*

PMW - Plains *Melaleuca* Low Woodland
Open Low Woodland of *Melaleuca interioris* and *Acacia ayersiana* over *A. tetragonophylla, Cratystylis subspinescens, Eremophila margarethae, Exocarpos aphyllus, Frankenia cordata, Scaevola spinescens* over *Triodia basedowii* hummock grassland over open low grass of *Enteropogon ramosus* and *Eragrostis eriopoda.*

Mosaic of PAF, PAOW, PTH

PAF - Plains *Acacia* Low Forest
Low Forest of *Acacia aneura, A. aneura* var. *fuliginea, A. ayersiana* and *Melaleuca interioris* over *Cratystylis subspinescens, Rhagodia eremaea, Scaevola spinescens* and open low grasses *Aristida contorta* and *Enteropogon ramosus*.

PAOW - Plains *Acacia* Open Low Woodland
Open Low Woodland of *Acacia aneura, A. aneura* var. *aneura* and *A. aneura* var. *argentea* over *Senna artemisioides* subsp. *filifolia, Cratystylis subspinescens*, *Eremophila forrestii* subsp. *? forrestii*, *Maireana georgei, Triodia basedowii* and open low grasses *Aristida contorta*, *Eragrostis eriopoda* and *Monachather paradoxus.*

Plains Tecticornia Heath (PTH)
Open Low heath of *Tecticornia halocnemoides, Tecticornia indica* subsp. aff. *bidens, Tecticornia ? undulata* and *Maireana oppositifolia* over open low grass *Eragrostis lanipes.*

Calcrete Vegetation

PCW - Plains *Casuarina* Low Woodland
Open Low Woodland of *Casuarina pauper* over *Acacia cuthbertsonii* var. *linearis, Acacia nyssophylla, Hakea preissii*, *Rhagodia eremaea, Salsola tragus and Sclerolaena cornishiana* over open low grass *Enneapogon caerulescens.*

PCW2 - Plains *Casuarina* Low Woodland 2
Low Woodland of *Casuarina pauper* over *Acacia burkittii, Atriplex bunburyana, Eremophila oldfieldii* subsp. *oldfieldii, Maireana eriosphaera, Ptilotus obovatus, Salsola tragus, Senna artemisioides* subsp. *filifolia* and *Sclerolaena deserticola,* and open low grass *Enneapogon caerulescens.*

PCW3 - Plains *Casuarina* Low Woodland 3
Low Woodland of *Casuarina pauper* over *Atriplex bunburyana, Grevillea sarissa* subsp. *bicolor*, *Lycium australa, Senna artemisioides* subsp. *filifolia*, over very open low grass *Eragrostis lanipes.*

PEG - Plains *Enneapogon* Grassland
Open Dwarf Scrub of *Lawrencia squamata* and *Lycium australe* over *Salsola tragus* and *Sclerolaena cornishiana* herbs, *Triodia basedowii* hummock grassland and low grasses *Enneapogon caerulescens* and *Eragrostis setifolia.*

Fauna Site (SRE)

***Maireana prosthecochaeta* (P3)**

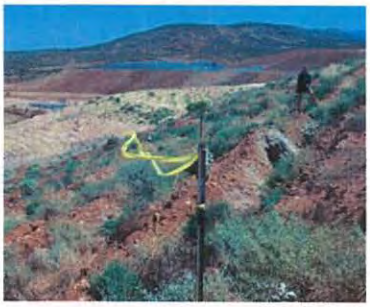
Tenement Boundary

REDPORT LIMITED
A URANIUM COMPNAY

LAKE MAITLAND PROJECT
2007 FLORA & VEGETATION SURVEY

Outback Ecology Services
1/71 Troy Tce, Jolimont WA 6014 Fax: (08) 9388 8633
Tel: (08) 9388 8799 www.outbackecology.com

Author: C. Krens	OE Ref: RLM-VS-0807		Scale: 1:25,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202			Figure: 10
CAD Ref: g1700V001.dgn	Date: July 2009	Rev: B	A1



Toro Energy Limited

Lake Way

Baseline Terrestrial Fauna Survey

May, 2008

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Lake Way Baseline Terrestrial Fauna Survey

Distribution:

Company	Copies	Contact Name
Toro Energy Limited	1	Mr Dayle Kenny

Document Control for Job Number:

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Final Draft	Paul Bolton / LC	PB	14/05/2008

Outback Ecology

Executive Summary

Toro Energy Limited (Toro Energy) is currently undertaking a Pre-feasibility Study (PFS) in respect to the development of the Wiluna Uranium Assets, which comprise the Lake Way and Centipede uranium deposits. The Lake Way and Centipede project areas are situated on the northern and western shores of Lake Way, which is a large ephemeral salt lake that forms part of an extensive chain of salt lake systems known as the Salinalands, a surface expression of the Lake Carey Palaeoriver. The town of Wiluna, the Wiluna Gold Mine, and related infrastructure such as the airport lie approximately 10 km to the north of Lake Way. The two individual project areas of Lake Way and Centipede are referred to here as the 'survey area'.

The survey area lies within the Eastern Murchison (MUR1) Bioregion which is characterised by its internal drainage, areas of red sandplains, salt lake systems associated with an occluded Palaeo-drainage system, broad plains of red-brown soils, and breakaway complexes.

Nova Energy commissioned Outback Ecology Services (OES) to commence baseline fauna surveys over the survey area during spring 2007. Fauna surveys were a component of a broader assessment undertaken concurrently by OES. Related surveys by OES also considered vegetation and flora, aquatic ecology, stygofauna, and soils.

The overall objectives of the terrestrial fauna baseline study for Lake Way were to:

- Develop an inventory of terrestrial vertebrate fauna species, and selected invertebrate fauna, identified from the survey area, or likely to be present within the survey area.
- Assess site information in the regional context by comparisons with available data from other localities within the bioregion
- Provide quantitative data that can provide a baseline against which future impacts and rehabilitation can be assessed, and the basis of a monitoring program.

This draft report provides information pertaining to the first fauna survey undertaken during October 2007.

Database searches were made prior to the field survey and a review of available literature was also undertaken to provide a list of mammals, reptiles, amphibians and birds that have the potential to occur over the survey area. Communications were undertaken with appropriate Western Australian Museum (WAM) staff to determine groups of short-range endemic invertebrates thought most likely to occur over the survey area and the sampling methodologies required, as well as the vertebrate species required for vouchering.

The focus of sampling centred upon the establishment of nine survey sites. Survey sites chosen were representative of the major habitats found over the survey area and included:

1. Melaleuca Grove
2. Mulga over Spinifex
3. Eucalypt Woodland
4. Mulga Woodland
5. Mallee over Spinifex
6. Woodland on Calcrete Flats
7. Samphire Flats
8. Claypan
9. Drainage Line and Floodplain

Major influences over site selection were: the effects of past wildfires and the impacts of cattle grazing over both Lake Way and Centipede project areas. Effects of past wildfires were particularly evident in sites dominated by spinifex. The focus of systematic censusing, including the trapping component, centred upon sites one to six.

The survey was undertaken between the 18th and 28th October, 2007, incorporating trap line establishment, inventory sampling, spotlighting sampling, targeted searches and a trapping period over six days. Pitfall traps, Elliott traps, funnel traps, cage traps and micro-pitfall traps were installed at six survey sites (sites 1 to 6), with spotlighting searches and avifauna censusing also undertaken at these sites. Inventory searches and soil sieving for invertebrates was undertaken over all nine survey sites.

Total vertebrate trapping effort over the survey period was 1,296 trap-nights, with an additional 294 trap-nights of micro-pits targeting invertebrates. Inventory searches, spotlighting searches, and avifauna censusing of survey sites totalled 3,435 minutes. Additional targeted searches were also made for significant terrestrial fauna within specified habitats including Malleefowl, Mulgara, Slender-billed Thornbill and mygalomorph spiders. Bats were sampled by the recording of echolocation calls using an ANABAT system over six nights, and opportunistic sightings of all fauna were documented over the entire survey period.

Twenty-two species of mammal were recorded over the survey area. Of these, 15 were native species, five introduced, and two domestic livestock. Fifty-five species of bird were recorded. Of these 42 were recorded from sampling sites, with a further 13 species recorded opportunistically over the survey area, or during targeted searches for other species. Thirty-two species of reptile were recorded during the survey, including nine geckos, six dragons and 12 skinks. Just one snake was recorded: this group under-represented during the survey.

The survey of invertebrates targeted potential short-range endemic groups and specimens of mygalomorph spiders, centipedes, scorpions, pseudoscorpions and molluscs were collected. Specimens were distributed to various experts for identification.

The survey, including targeted searches, recorded one vertebrate species of conservation significance; the Rainbow Bee-eater. However, an assessment of species of conservation significance known from the region and the habitats present over the survey area indicated that an additional 20 species have the potential to occur. Of these, five were assessed as likely to occur (at least intermittently), six as possibly occurring, and eight were considered unlikely to occur in the habitats present.

Along with the Rainbow Bee-eater, species considered likely to occur include the Australian Bustard, Bush Stone-curlew, Peregrine Falcon and Fork-tailed Swift. None of these species would permanently utilise habitats of the survey area.

In addition to the above, up to 20 species of waders and waterbirds listed as either migratory or marine species under Commonwealth legislation were assessed as potentially occurring over the survey area. Habitats utilised would be the Lake Way playa in times of inundation as well as claypans and creeklines draining into Lake Way.

All habitats present over the survey area are widely represented throughout the region and no critical habitat, World Heritage Properties, Ramsar Wetland Sites or Nationally Important Wetland sites are in the vicinity. However, significant habitats at the local scale include: the Uramurdah Clay Pan and associated creekline, samphire flats and adjacent saltbush communities associated with Lake Way, and Melaleuca groves along the edge of Lake Way. The Uramurdah Clay Pan, in particular, supports large eucalypts with hollows that provide sheltering and nesting sites for many species of birds and reptiles as well as many bat species. Although little information is available, after a period of inundation the clay pan is likely to be a significant breeding site for birds, including waterbirds.

Development concepts for the Toro Energy project at Lake Way are in their infancy, and impacts to fauna at this stage cannot be quantified. However, some species of conservation significance are likely to occur. Results presented in this document were obtained from a single survey only, and an additional survey is recommended. Nevertheless, impacts currently impacting the survey area are summarised and, given what is known of the proposal, potential impacts listed. General management guidelines are suggested to minimise potential impacts.

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1.0 INTRODUCTION

1.1 Project Background

Toro Energy Limited (Toro Energy) is currently undertaking a Pre-feasibility Study (PFS) for the development of the Wiluna Uranium Assets, which comprise the Lake Way and Centipede uranium deposits. Wiluna is located approximately 750 km northeast of Perth and 180 km east of Meekatharra in the East Murchison Mineral Field. The two deposits of Lake Way and Centipede are located on the northern and western edges of Lake Way, which is a large ephemeral salt lake that forms part of an extensive chain of salt lake systems known as the Salinalands, and is a surface expression of the Lake Carey Palaeoriver.

Nova Energy commissioned Outback Ecology Services (OES) to carry out baseline fauna surveys over the two project areas during 2007. The fauna survey was a component of a broader assessment undertaken concurrently by OES that also considered vegetation and flora, aquatic ecology, stygofauna, and soils.

1.2 Scope and Objectives of the Survey

This report documents the results of an initial fauna survey of the Lake Way and Centipede project areas incorporating E 53/1132 (Lake Way) and M 53/224 (Centipede). The two combined project areas are referred to here as the 'survey area'.

The survey was planned and implemented as far as practicable in accordance with the Environmental Protection Authority (EPA) Position Statement No 3. "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA, 2002), and Guidance Statement No 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA, 2004).

The overall objectives of the terrestrial fauna baseline study were to:

a) Develop an inventory of terrestrial vertebrate fauna species, and selected invertebrate fauna, identified from the survey area, or likely to be present within the survey area. This incorporated a desktop review of available information, a reconnaissance survey to verify the background information and further delineate habitat variables and detailed surveys of vertebrate terrestrial fauna at the locality, incorporating techniques appropriate to the region and scale of impact.
b) Assess site information in the regional context by comparisons with available data from other localities within the bioregion, and to provide an assessment of current and potential impacts on significant fauna populations and habitats.
c) Provide quantitative data that can serve as a baseline against which future impacts and rehabilitation can be assessed, and the basis of a monitoring program.

The study included:

- A review of:
    - Vertebrate fauna assemblages and habitats in the bioregion;
    - Fauna species of particular conservation significance potentially present over the survey area (including threatened and priority fauna, geographically restricted fauna, and short-range endemics);
    - Current impacts to fauna and habitats over the survey area; and
    - Potential impacts to terrestrial fauna from the proposed project.

- The identification of :
    - All vertebrate fauna, and targeted short-range endemic invertebrate species, that are present or likely to occur over the survey area (incorporating the results of this survey, recent published and unpublished regional records, and an assessment of habitats and likelihood of occurrence);
    - Biologically-significant fauna species at international, national, state, regional and local scales; and
    - Sensitive faunal habitats of particular conservation significance identified from the survey area.

1.3 Location of Survey Area

The two Toro Energy project areas are situated on the northern and western shores of the Lake Way playa. The town of Wiluna, the Wiluna Gold mine and related infrastructure such as the airport lie approximately 10 km to the north of Lake Way (Figure 1).

The Lake Way project area is located on the northeast shore of Lake Way and comprises a single Exploration Licence (E 53/1132) covering approximately 39.8 km^2 (Figure 1). The Centipede project area covers a portion of the western shore of Lake Way, and lies approximately 16 km diagonally south-west from the Lake Way uranium deposit and comprises a single Mining Lease (M 53/224) of approximately 840 ha (**Figure 1)** (Nova, 2007).

1.4 Land Use

1.4.1 Pastoral

Sheep stations were established in the Wiluna area in the 1920s and were once the dominant land use in the area. The Lake Way project area is located on Millbillillie pastoral lease. The Centipede project area is located on the Lake Way pastoral lease. In the past decade, many pastoral leases in the area have been purchased by mining companies and de-stocked. However, both the Millbillillie and Lake Way pastoral leases are currently stocked with cattle; Lake Way station was re-stocked in 2000.

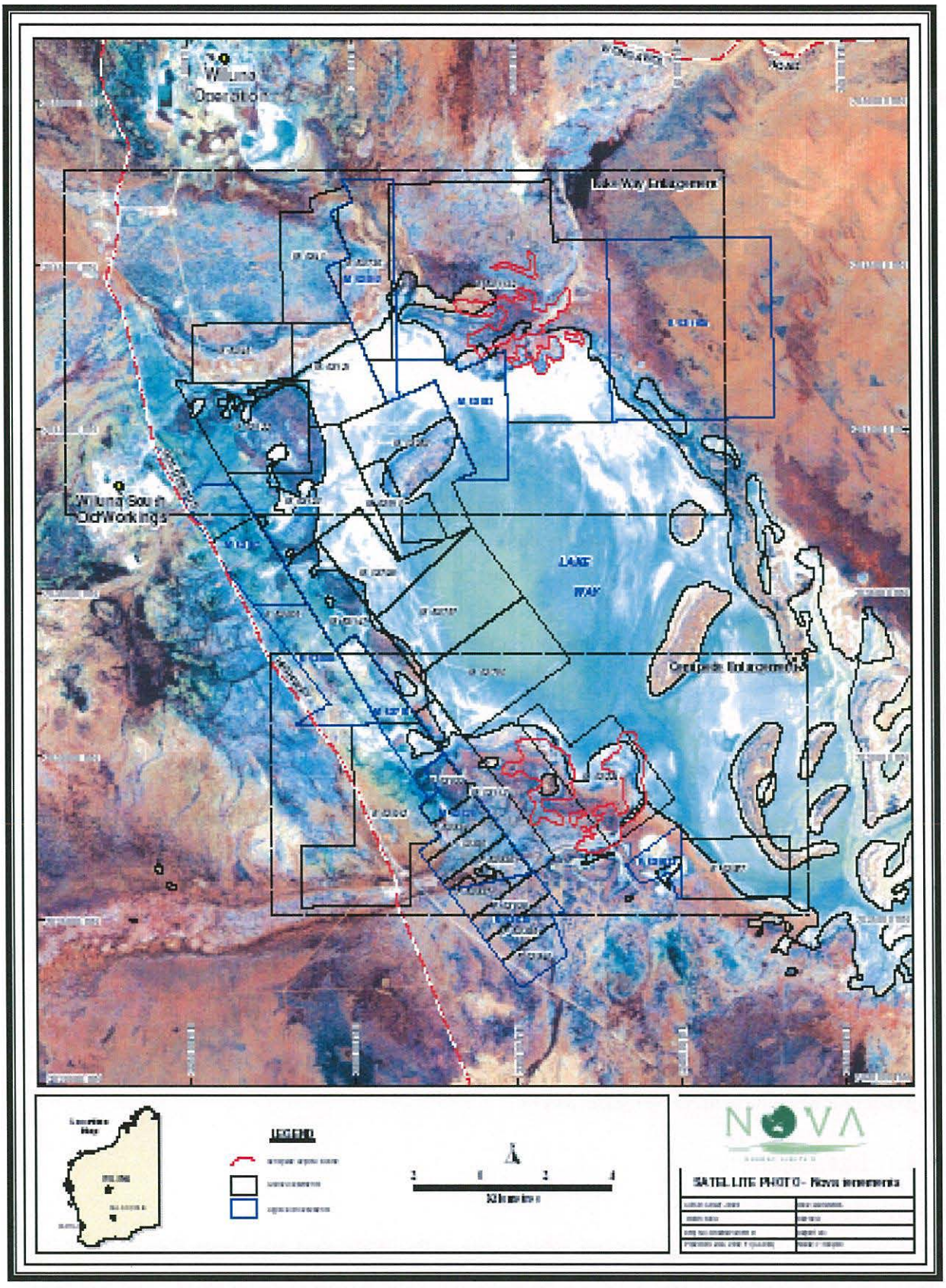

Figure 1 Locality map of the survey area

1.4.2 Mining

The first settlers in the Wiluna area were miners from Cue and Coolgardie. Gold was discovered at Wiluna in March 1896, and since then the area has produced in excess of 3 million ounces of gold (Wiluna Mine Closure Plan, 2006). Several gold mines have been worked in the area. The largest of these was the Wiluna Gold Mine, which once supported a population of around 9,000 people but ceased operation in 1948.

Three major phases of mining activity have occurred in the area. From discovery in 1896 to 1924 gold was mined from shallow underground workings in the oxidised zone. From 1931 to 1947 large underground mines were developed, and from 1984 to current times re-processing of the 1931-1947 tailings has been carried out, followed by large open pit and underground mine development.

Wiluna Gold Mine is located 4 km south of Wiluna, and the existing mine and associated operating infrastructure footprint covers a total area of approximately 1,970 ha.

Lake Way Deposit

The Delhi International Oil Corporation (Delhi) and Vam Limited Joint Venture discovered the Lake Way uranium deposit in 1972 while exploring for base metal mineralisation within the Wiluna district. Delhi completed virtually all of the exploration and feasibility work until CSR Limited acquired Delhi in December 1981. In 1983 exploration and development plans were suspended and assets were dispersed in response to the Federal Labour Government's 'Three Mines Policy' in relation to uranium mining.

Extensive exploration and evaluation has been undertaken on the Lake Way deposit involving drill holes, bulk samples, pilot plant test work, trial mining, topographic surveys, groundwater analysis, hydrologic and environmental studies. Trial mining at Lake Way involved the removal of approximately 5,000 tonnes of ore excavated for metallurgical bench-scale and pilot plant work. Estimation of mineralisation was made, and metallurgical test work and processing studies were carried out, as well as hydrological and environmental studies. Work included meteorological surveys and dispersion modelling, archaeological and anthropological surveys, surface and groundwater hydrology, vertebrate fauna studies and radiological surveys.

In April 1981 draft Environmental Impact Statements and Environmental Management Plans for the Lake Way Project were made available for public review (Lancaster and Associates, 1981), and the final documents were assessed by the Environmental Protection Authority (EPA). The EPA did not identify any 'unacceptable' potential environmental impacts preventing the proposed development from proceeding. However, the EPA did recognise that additional baseline data collection, monitoring and impact assessment work would be needed to satisfy environmental protection and management regulatory requirements.

Centipede Deposit

It is thought that the Centipede deposits were discovered around 1977 by Esso as acting manager and operator of a joint venture comprising of MIM, Inco and Seltrust. The majority of exploration was undertaken by Esso between 1977 and 1981. Rights to the Centipede project were acquired by Delhi in 1982. Exploration and development plans were suspended after the 'Three Mines Policy' was initiated in 1983.

Preliminary testing has indicated that the metallurgical behaviour of the Centipede ore is quite similar to that of Lake Way. Environmental studies are currently being undertaken over the Centipede project area.

2.0 EXISTING ENVIRONMENT

2.1 Climate

The nearest Bureau of Meteorology (BOM) weather station to Lake Way is Wiluna, and a weather station has recently been established by Toro Energy at Lake Way, as part of its baseline environmental studies. Lake Way is located in an arid climate, characterised by hot dry summers and mild dry winters. Daily temperatures range from 21°C to 38°C during summer and 5.5°C to 22°C during winter (BOM, 2007).

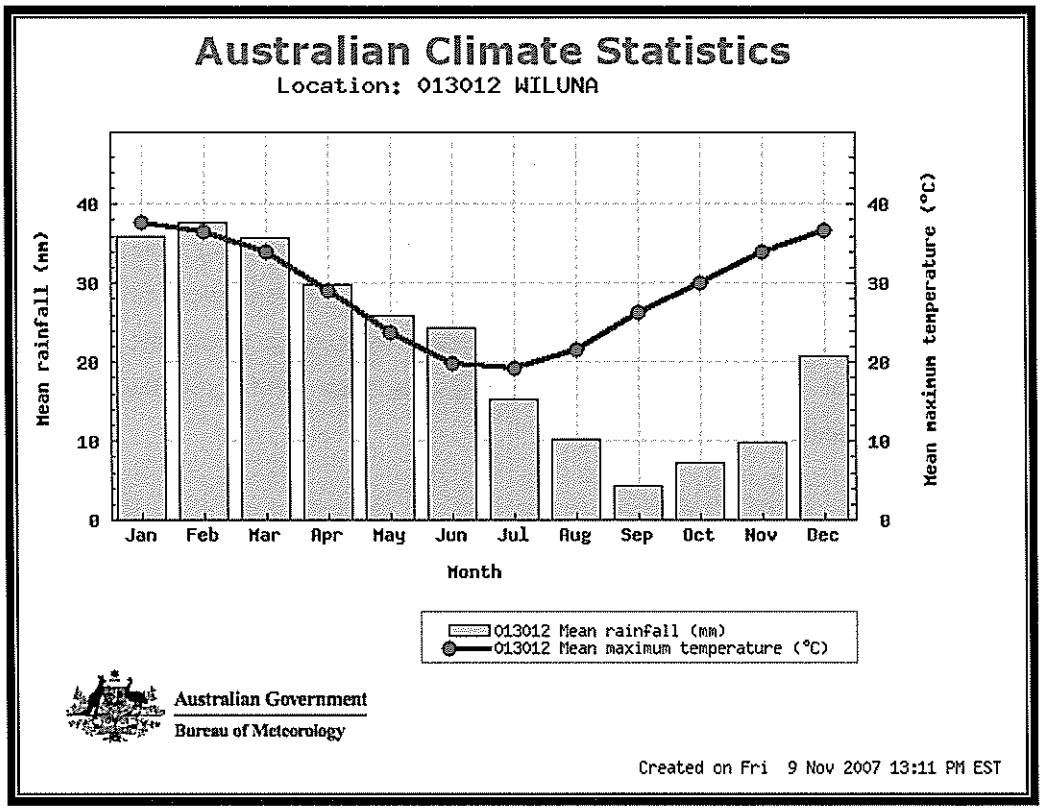

Figure 2 Climate data for Wiluna (BOM, 2007).

Rainfall within the survey area is irregular. The long-term mean annual rainfall is 257 mm, the majority of which falls during the summer and autumn months (**Figure 2**). Occasional remnant tropical depressions and more isolated storms cause Lake Way to become temporarily inundated, as happened in 2006. Winter weather patterns are directly influenced by the anticyclonic system which results in the generation of westerly winds and rain-bearing frontal systems (Gilligan 1994). Winter rains are usually heaviest around late May into July, and subside during the months of September and October as the anticyclonic conditions stabilise.

2.2 Murchison Biogeographic Region

The survey area is situated in the semi-arid to arid Eyrean Sub-region, one of three very broad sub-regions defined by Heatwole (1987) covering the entire Australian continent, with the others being the tropical Torresian sub-region and the temperate Bassian sub-regions.

Thackway and Cresswell (1995) describe a more refined system of 85 'biogeographic regions' (bioregions) covering the whole of Australia; the result of collaboration between all state conservation agencies with co-ordination by the Australian Government Department of Environment and Heritage (now the Department of Environment, Water, Heritage and the Arts). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

Lake Way is located within the Murchison Bioregion of the Interim Biogeographic Regionalisation for Australia (or IBRA) (Thackway and Cresswell, 1995). The Murchison Bioregion comprises the northern part of the Yilgarn Craton and includes two major components, or sub-regions; the Eastern Murchison (MUR1), and the Western Murchison (MUR2).

The survey area lies within the Eastern Murchison sub-region (MUR1) which is characterised by its internal drainage, areas of red sandplains, salt lake systems associated with an occluded Palaeodrainage system, broad plains of red-brown soils, and breakaway complexes (Cowan, 2001). Vegetation is dominated by mulga woodlands, hummock grasslands, saltbush shrublands and Halosarcia shrublands (NLWRA, 2002). The subregion is rich and diverse in both its flora and fauna. However, many species are wide-ranging and also occur in adjoining regions (Cowan, 2002).

Land uses of the Eastern Murchison sub-region (MUR1) include (Cowan, 2001; NLWRA, 2002):

- **Grazing.** The dominant land use of the MUR1 sub-region is grazing of stock on pastoral leases, with approximately 85.47% of the sub-region used for this purpose (Cowan, 2001).
- **Mining.** Extensive mining of nickel and gold is undertaken in the sub-region. However, most mining leases are located on pastoral lands which come under section 97 of the *Land Administration Act 1997* and are therefore still required to be stocked.

- **Unallocated Crown Land (UCL) and Crown Reserves** comprise just over 11% of the MUR1 sub-region.
- **Conservation.** The National Land and Water Resources Audit ("NLWRA"), an initiative of the National Heritage Trust, states that just 1.4% of the Murchison Bioregion is classified as conservation estate (NLWRS, 2002). In 2001, Cowan reported that 1.82% of the MUR1 sub-region was classified as conservation estate. Since that time a comprehensive land acquisition program has contributed additional land for conservation purposes and in 2004 a figure of 7.46% was reported for the bioregion (Brandis, no date). Wanjarri Nature Reserve is located approximately 65 km south of the survey area at its closest point.

2.3 Land Systems of the Survey Area

The Wiluna – Meekatharra area, within which the Project Areas are located, was surveyed in 1958 by personnel from the CSIRO Division of Land Research and Regional Survey (Mabbutt, 1963). The objective of the survey was to map and describe sections of Australia. The main descriptive unit employed during the survey was the land system, which was essentially an area within which patterns of vegetation, soil and landforms were observed. The land systems were developed to provide a means of assessing the potential of land for pastoral activities across large survey areas.

The surveys conducted by the CSIRO Division of Land Research and Regional Survey utilise the same descriptive terminologies and survey methodologies as those employed in the inventory and condition surveys subsequently undertaken by the Department of Agriculture and Food (formerly Department of Agriculture). This provides for a degree of confidence and relevance in the broad descriptions of Mabbutt *et al.* (1963) datasets, in spite of the age of the surveys. In preparing for for its fauna surveys in the Project Area, Outback Ecology disregarded those aspects of historic assessments which dealt with the condition of vegetation or soils, due to the lack of recent supporting data.

The Lake Way Project Area is located over three land systems (

Table 1). Of the land systems noted for the Lake Way Project Area, the Carnegie and Cunyu systems are the most widespread. The Centipede Project Area is located over the same two land systems (

Table 1). The comparative dominance of these two land systems within the project areas is a reflection of the location of the ore bodies in calcrete paleochannels. The Carnegie and Cunyu land systems are neither uncommon nor common within the survey area. However, the specificity of these land systems (salt lakes and fringing areas) should be taken to indicate that vegetation located on these land systems may be of some significance in a local and regional context. This consideration is discussed in detail in the results section of this report.

Table 1 Summary of Land Systems over the Lake Way and Centipede Project Areas (adapted from Mabbutt *et al.*, 1963).

Land Type (broad descriptive unit)	Land System	Description.	Total area and % of Wiluna – Meekatharra survey area*	Occurrence over Project Areas
Depositional Surfaces – Calcreted valley fills	Cunyu	The Cunyu Land System is comprised of tertiary calcrete in the form of valley fills with a mosaic of calcrete platforms and alluvial floors and plains. The Land System has a low gradient. The majority of vegetation within the Cunyu Land System is mulga or *Acacia* spp grading to fringing communities or halophytic vegetation.	1554km^2 (2.4%)	Widespread at Lake Way, small occurrence at Centipede
Depositional Surfaces – Partly saline alluvial plains	Barwidgee	The Barwidgee Land System is comprised of fine-textured saline alluvium in the form of partly saline plains, tributary plains and small clay-pans. Vegetation is variable but is dominated by halophytic shrublands with the remaining areas ranging from eucalypt and mulga communities to bare areas.	674km^2 (1%)	Lake Way Project Area.
Depositional Surfaces – Mainly non-saline alluvial plains	Mitchell	The Mitchell Land System is comprised of quarternary alluvium and aeolian sands in the form of non-saline alluvial sandy plains grading to saline alluvial flats in lower areas. Vegetation ranges from mulga on sand plains and groves to halophytic shrublands on saline plains and intergroves and wanderrie flats.	466km^2 (0.7%)	Restricted to a small area on the northern edge of Lake Way Project Area.
Depositional Surfaces – Sand plain and dunes	Bullimore	The Bullimore Land System is comprised of quarternary aeolian sand in the forms of depositional sand plains and dunes and occasional breakaways. Vegetation is predominately spinifex with a canopy of mallee or mulga grading to spinifex and forbs. A small percentage of the Land System is host to mulga with mallee over mixed grasses and forbs.	13985km^2 (21.6%)	Lake Way Project Area
Depositional Surfaces – Salt lakes and dunes	Carnegie	The Carnegie Land System is comprised of quarternary lacustrine saline clay and sand, saline alluvium and aeolian sand in the form of salt lakes and fringing dunes, with kopi banks to the south and east of lakes. Vegetation ranges from samphire or halophytic shrublands to fringing communities of *Melaleuca* spp or mulga to mulga over chenopods to mainly bare.	3625km^2 (5.6%)	Main Land System at Centipede, widespread at Lake Way

* area converted from square miles – conversion factor of 2.5899 used to derive area in square kilometres

3.0 SURVEY METHODOLOGY

3.1 Sources of Information

3.1.1 Vertebrates

Database searches were made prior to the field survey. The search areas were defined by polygons that were centred on the survey area and covered at least 250 km by 250 km. Database searches of these areas were made using the following databases and internet tools:

- The Western Australian Museum (WAM) FaunaBase database to identify potential vertebrate fauna within the study area. The bounding coordinates used were:
    - 25.10° S, 118.77° E
    - 28.19° S, 121.83° E
- Threatened and Priority Fauna Database held by the Department of Environment and Conservation (DEC) to facilitate the identification of species of conservation significance within the study area. The bounding coordinates used were:
    - 25.03° S, 118.87° E
    - 28.31° S, 122.07° E
- The Protected Matters and Environmental Reporting Tools of the Australian Government Department of Environment and Water Resources to identify fauna species of national environmental significance that are protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* potentially occurring within the area. The bounding coordinates used were:
    - 25.19° S, 118.82° E
    - 28.22° S, 121.73° E
- The Environmental Reporting tool of the Australian Government Department of Environment and Water Resources to identify fauna species of national environmental significance. The bounding coordinates used were:
    - 25.07° S, 118.81° E
    - 28.23° S, 121.78° E
- The Birds Australia database to identify avifauna potentially occurring over the study area.
- The Australian Natural Resources Atlas of the National Land and Water Resources Audit to gain information on significant fauna and fauna habitats within the Murchison Bioregion.
- The Australian Wetlands Database of the Australian Government Department of Environment and Water Resources to ascertain regionally significant wetland habitats occurring over the search area.

A review of literature was also undertaken to provide a list of mammals, reptiles, amphibians and birds that have potential to occur over the study area. The vertebrate fauna of the region has been the subject of a number of studies, predominantly as part of other mining projects in the region including; Bancroft and Bamford (2004), Dunlop (1990), HGM (1997), HGM (1999), Lancaster and Associates (1981), Ninox, (1989), Ninox (1993), OES (2002), OES (2004), OES (2005a), OES (2005b), OES (2006a), OES (2006b), and OES (2008a).

Lancaster and Associates (1981) quote regional fauna studies undertaken by the CSIRO Division of Wildlife Research during 1977 and 1978, as well as a study of vertebrate fauna on Yeelirrie Station for Western Mining Corporation (Tingay and Tingay, 1978).

A baseline fauna survey of the Lake Way area was undertaken by Outback Ecology in 2002 for Wiluna Gold operations (OES, 2002) that included a desktop assessment and systematic trapping at a site 15 km south of Wiluna on the western shore of Lake Way. Data from a baseline study of the Lake Maitland area, approximately 100 km to the south-east, are also available (OES, 2008a).

Two short reports focussing on avian fauna usage of Lake Way have been conducted for Agincourt Wiluna Gold Mine: A review by Bamford Consulting Ecologists (Bancroft and Bamford 2004), and Waterbird Management Guidelines prepared by Outback Ecology (OES, 2005b). Opportunistic sightings of waterbirds have also been recorded (OES, 2004; OES, 2005a; and OES 2005b).

The Western Australian Museum (WAM) has undertaken intensive surveys over the Eastern Goldfields, including the vicinity of the survey area (How and Dell, 1992; Hall, *et al.* 1994), and surveys have also been conducted within Wanjarri Nature Reserve (CALM, 1996; Moriarty, 1972).

Communications were undertaken with appropriate WAM staff to determine which vertebrate species captured during the present survey may be required for collection and lodging with WAM. These included the reptiles *Eremiascincus richardsonii* (Broad-banded Sand-swimmer), *Tympanocryptis cephalus* (Pebble Dragon), and *Diporiphora* sp, as well as the frog *Pseudophryne occidentalis* (Orange-Crowned (Western) Toadlet.

Information from the sources outlined above was augmented with additional information relating to species' likelihood of occurrence based upon the experience of Outback Ecology's scientists and their understanding of general patterns of fauna distribution and known habitat preferences. Many of the species present on regional lists have specific habitat requirements that may be present in the general area, but not in the specific habitats of the survey area. Some species, therefore, will be included in lists but are unlikely to be present in the actual survey area.

Relevant texts from which information on general patterns of distribution was obtained included:

Mammals:	Churchill (1998); Menkhorst and Knight (2001); Strahan (2002).
Birds:	The Handbook of Australian, New Zealand and Antarctic Birds (Birds Australia, various editors and dates); Johnstone and Storr (1998 and 2004); Barrett *et al.* 2003; Blakers *et al.* (1984).
Amphibians:	Tyler *et al.* (2000).
Reptiles:	Storr *et al.* (1983, 1990, 1999 and 2002); Wilson and Swan (2003).

Fish: Allen *et al.* (2002); Morgan and Gill (2004).

Comprehensive vegetation mapping over the survey area is being undertaken by a concurrent study (2008b). Information from the OES study was utilised to facilitate the description and delineation of fauna habitats in this study.

3.1.2 Potential Short-range Endemic Invertebrates

Communications with Dr Mark Harvey of the Western Australian Museum (WAM) resulted in the identification of five groups of short-range endemic invertebrates thought most likely to occur over the survey area. The identification of invertebrate species requires the skills of specialists. Internationally-recognised experts from the Western Australian Museum (WAM) and from the University of Western Australia (UWA) were engaged to verify and refine methodology and to supervise identifications of any target taxa collected during the survey.

Table 2 Target SRE groups and associated staff consulted by OES

Target SRE Group	Staff	
Terrestrial molluscs	Ms. Shirley Slack-Smith	WAM
Scorpions	Dr. Mark Harvey	WAM
Pseudoscorpions	Dr. Mark Harvey	WAM
Myriopods (particularly millipedes)	Dr. Mark Harvey	WAM
Mygalomorph spiders	Prof. Barbara York Main	UWA

3.2 Taxonomy and Nomenclature

In this report nomenclature and taxonomy of vertebrate species follows that of the Western Australian Museum provided in the Checklist of the Vertebrates of Western Australia for amphibians, reptiles and mammals (WAM, 2002), and for birds the Birds Australia Draft Working List of Birds of Australia and Australian Territories, 2003 based on Christidis and Boles (1994). Invertebrate taxonomy is based on nomenclature provided by the WA Museum and University of Western Australia.

3.3 Survey Timing and Weather

The survey was undertaken between the 18th and 28th October 2007. Field surveys incorporated trap line establishment, inventory sampling, spotlighting sampling, targeted searches and a trapping period over six days between the 22rd and 28th October 2007. Weather during the survey was warm to hot, with maximum temperatures ranging between 26° and 36° and minima between 12° and 20°. Light rainfall of 2.2 mm fell during trapline establishment on 19th and 20th October, immediately prior to the trapping component (

Table 3).

Table 3 Temperature and rainfall recorded in Wiluna (BOM, 2007) during the time of the October 2007 survey (trapping component shaded)

Date	Day	Min	Max	Rain
17	We	15.0	38.0	0
18	Th	19.0	27.0	0
19	Fr	17.0	36.0	2.0
20	Sa	19.0	34.5	0.2
21	Su	15.0	28.0	0
22	Mo	14.5	26.0	0
23	Tu	12.0	27.0	0
24	We	12.0	30.0	0
25	Th	12.0	34.5	0
26	Fr	20.0	34.0	0
27	Sa	15.0	Unavailable	0

3.4 Outline of Sampling Methods

The methods adopted for the survey were formulated as far as practicable in accordance with the Environmental Protection Authority (EPA) Position Statement No 3. "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA, 2002), and Guidance Statement No 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA, 2004).

The inventory of fauna involved a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling was that collected over a fixed time period in a discrete vegetation community type, using an equal or standardised sampling effort. Opportunistic sampling includes data collected non-systematically within and outside of fixed sampling sites. Survey design was targeted at the local scale but employed a methodology that was consistent with regional surveys. The focus of systematic censusing centred upon the establishment of survey sites representative of the major habitats found over the survey area.

3.4.1 Site Selection, Locations and Descriptions

A desktop review of habitats present at the site was conducted prior to the survey. Aerial photography, contour mapping, land systems mapping, and Beard (1975) mapping were used to determine preliminary site selection, which was based upon the dominant landform and vegetation type.

Ground-truthing was undertaken to verify the desktop study and to further delineate habitats, particularly in regard to topography, wildfire, vegetation condition, patchiness and variability amongst vegetation associations, as well as to determine any local refugia. Data and condition assessment from a concurrent vegetation survey (2008b) and communications with an OES botanist undertaking fine-scale vegetation mapping during the same period also informed habitat delineations.

Major influences over site selection were: the effects of past wildfires and the impacts of cattle grazing over the two project areas. Effects of past wildfires were particularly evident in sites dominated by spinifex.

Site selection was further influenced by the proposed development; consideration was given to the likely zone of direct impacts, zone of indirect impacts and zone of wider interest. Following the reconnaissance survey, sampling sites were chosen as being:

i) Representative of the major fauna habitats present
ii) Representative of areas of environmental impact potentially arising from the proposal
iii) Areas of ecological sensitivity or discrete habitats

The locations and number of sites surveyed are summarised in **Table 4** with the "Criteria for Selection" referring to those criteria listed above. Fauna survey sites were also distributed to encompass a broad cross section of the survey area. Sites do not cover all differentiated habitats available to the wide range of vertebrate present in the region at a small scale, however, they are representative of the major habitats present and provide a useful grouping as a sampling strategy, and within which to discuss species occurrence.

Table 4 Survey site locations

Site Name		Location	Criteria for Selection	Co-ordinates (GDA 94)
LW01	Melaleuca Grove	Centipede	i), ii)	51 J 237847 / 7028276
LW02	Mulga over Spinifex	Centipede	i), ii)	51 J 237830 / 7028112
LW03	Eucalypt Woodland	Lake Way	i)	51 J 232643 / 7045345
LW04	Mulga Woodland	Lake Way	i), ii)	51 J 233276 / 7045360
LW05	Mallee over Spinifex	Lake Way	i), ii)	51 J 234900 / 7043846
LW06	Woodland on Calcrete Flats	Lake Way	i), ii)	51 J 235516 / 7045409
LW07	Samphire Flats	Centipede	i), ii)	51 J 238165 / 7028067
LW08	Claypan	Lake Way	iii)	51 J 235159 / 7047492
LW09	Drainage Line and Floodplain	Lake Way	i), ii), iii)	51 J 236566 / 7044342

Sites LW01 to LW06 were established to sample vertebrate fauna with a combination of trapping, inventory searching, and bird censusing conducted at these sites. Sites LW01 to LW07 also incorporated systematic sampling for invertebrates.

Vertebrate trapping was not undertaken over Samphire Flats habitat (Site LW07) because past experience has shown that this habitat type is relatively unproductive. Amphibians are absent due to the salinity, and apart from the Salt Lake Dragon (*Ctenophorus salinarum*), reptiles and small ground mammals targeted by this methodology are largely absent, probably due to a combination of salinity, regular flooding, and lack of structural complexity in the habitat.

Sampling at Sites LW08 and LW09 was restricted to inventory searching and spotlighting only, due to cultural sensitivities to ground disturbance within these areas at the time of the survey. Survey site descriptions, with photographs, are summarised as follows:

Plate 1 Site LW01: Melaleuca Grove

The Melaleuca Grove Site (LW01 - **Plate 1**) consisted of a low closed to open forest of *Melaleuca xerophila* on sandy soils. This habitat occurs as fringing vegetation, particularly on inflow areas, between the samphire flats of Lake Way and upslope vegetation units.

Plate 2 Site LW02: Mulga over Spinifex

The Mulga over Spinifex site (LW02 - **Plate 2**) consisted of Mulga *(Acacia aneura* var *aneura)* low open woodland over a hummock grassland of *Triodia melvillei* (spinifex) with a scattered shrub layer on sandy soils. Over the survey area this community ranges in structure from hummock grassland with a few scattered emergents through to a low woodland with a 10% to 30% upper storey tree cover.

Plate 3 Site LW03: Eucalypt Woodland

The Eucalypt Woodland site (LW03 - **Plate 3**) consisted of a low open woodland of *Eucalyptus striaticalyx* subsp. *striaticalyx* over a low sparse to dense shrubland of *Pittosporum phylliraeoides*

("weeping pittosporum"), Eremophila spp., and *Senna artemisioides* subsp. *Filifolia* ("punty bush") on loamy soils with deep leaf litter, logs and branches present.

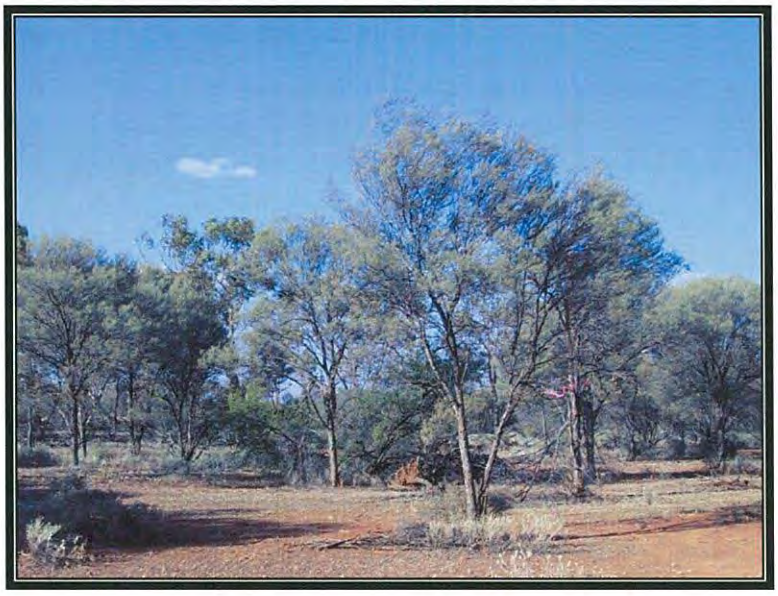

Plate 4 Site LW04: Mulga Woodland

The Mulga Woodland site (LW04 - **Plate 4**) supported a low woodland of Mulga *(Acacia aneura* var *aneura)* over a low scrub of *Senna artemisioides* subsp *filifolia* and *Eremophila* spp. with *an* open low grass of *Aristida contorta* ("bunched kerosene grass") and *Enteropogon ramosus* ("curly windmill grass") on loamy soils with leaf litter, logs and branches present.

Plate 5 Site LW05: Mallee over Spinifex

The Mallee over Spinifex site (LW05 - **Plate 5**) consisted of a coppicing low open woodland of *Eucalyptus eremicola* subsp. *peeneri* over a hummock grassland of *Triodia sp*, with a scattered shrub layer of *Grevillea sarissa* subsp. *succincta Acacia* spp. and *Eremophila* spp on sandy soils.

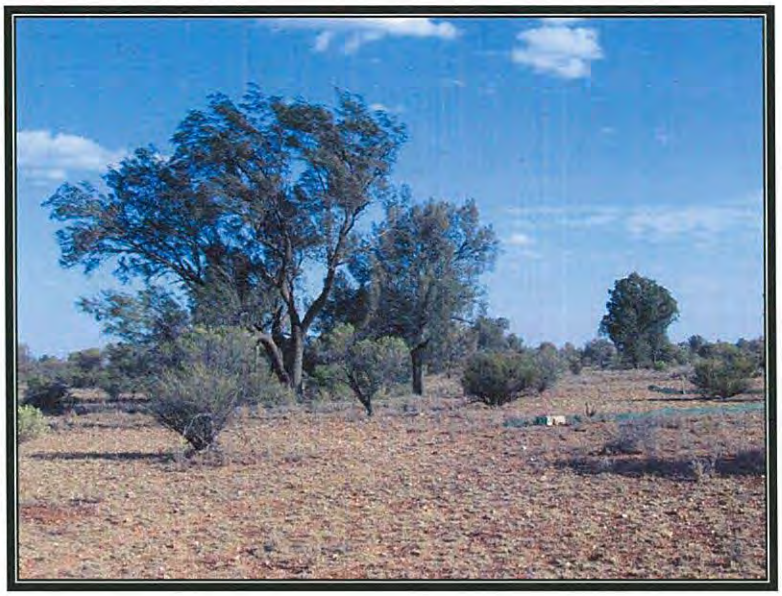

Plate 6 Site LW06: Woodland on Calcrete Flats

The Woodland on Calcrete Flats site (LW06 - **Plate 6**) consisted of scatterred *Casuarina pauper* over a low open scrub of *Acacia tetragonophylla* ("dead-finish" or "kurara") and *A.* victoriae ("elegant wattle") over very open herbs *Sclerolaena bicornis* ("goathead burr") over very open low grass of *Enneapogon caerulescens.*

Plate 7 Site LW07 Samphire Flats

The Samphire Flats site (LW07 - **Plate 7**) supported a low heath of *Halosarcia* spp. over a scattered low grassland of *Eragrostis* spp.

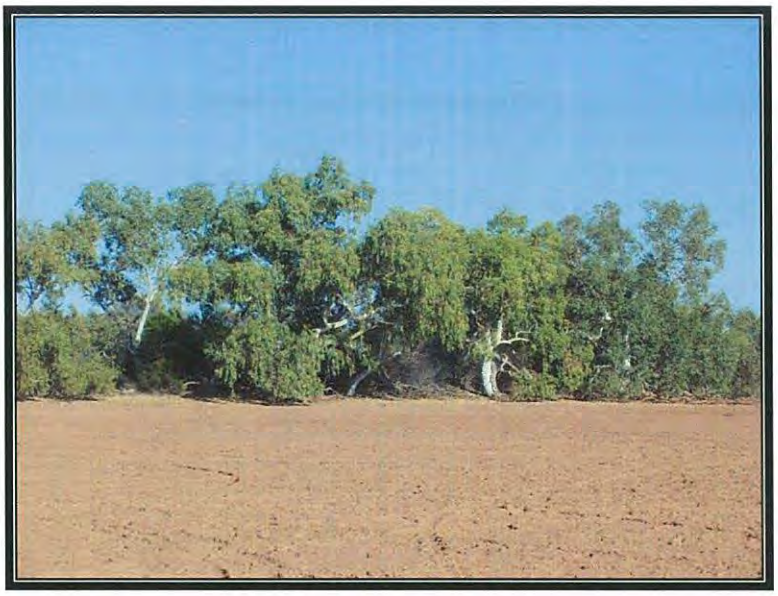

Plate 8 Site LW08: Claypan

The Claypan site (LW08 - **Plate 8**) consisted of a bare claypan that is intermittently inundated, surrounded by a thin zonation (<20m) of fringing vegetation consisting of *Eucalyptus camaldulensis* ("red gum") over a dense mixed shrub layer over a dense cover of grasses. At ground level leaf litter, logs and branches were present.

Plate 9 Site LW09: Drainage Line and Floodplain

The Drainage Line site (LW09 - **Plate 9**) consisted of a narrow drainage channel with an associated floodplain comprised of a dense mixed shrubland of *Acacia* spp., *Olearia stuartii* ("rock daisy-bush" or "Stuart's daisy-bush"), *Senna* spp, and *Grevillea sarissa* subsp. *succincta*.

3.4.2 Systematic Censusing

The focus of systematic censusing centred upon the establishment of survey sites measuring 1 ha in size. Within sites LW01 to LW06 a standard trapping grid was established that incorporated pit traps (2 types), Elliott box traps, Sheffield cage traps, funnel traps and micro pit traps (for invertebrates). A representation of the trapping grid is shown in **Figure 3** below, and

Table 5 summarises the trapping that occurred at each site. Two different sized pit-traps were incorporated into the design; that is 20L buckets and 150mm diameter 'pipes', as each pit-trap has features thought to favour particular species.

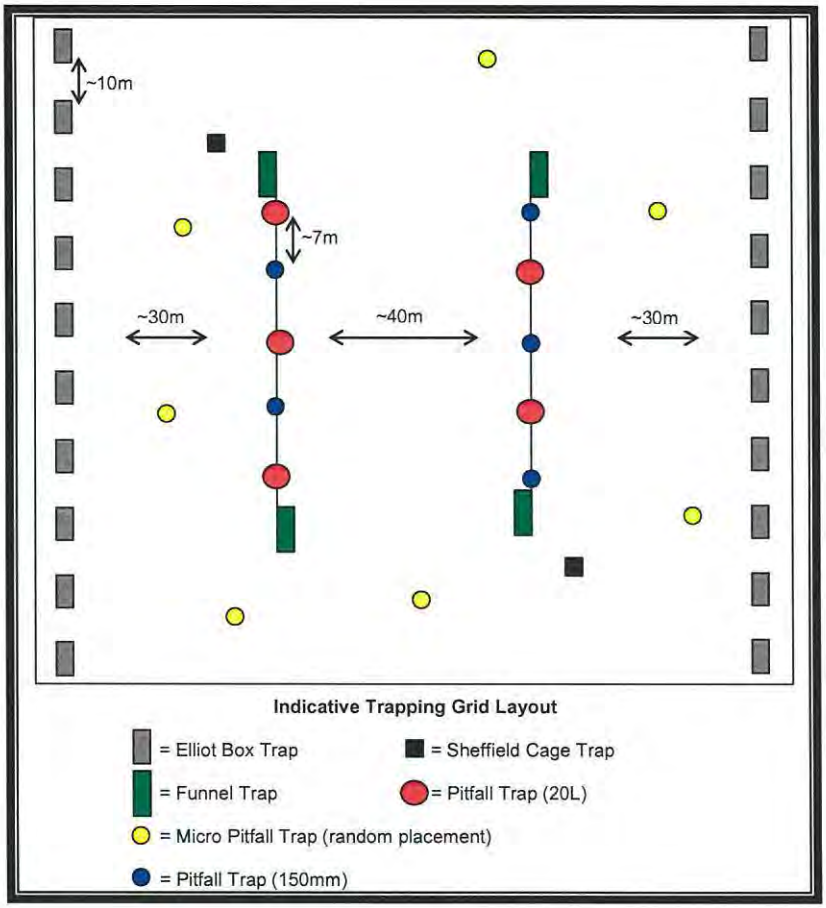

Figure 3 Representative grid layout

Following is a summary of systematic sampling undertaken at survey sites:

1. Pitfall traps and drift fence: Ten pit traps were positioned in each grid. Two types of pit traps were incorporated into the design: PVC pipe 150 mm in diameter and 400 mm deep, as well as standard 20 litre PVC buckets. Pit traps were set flush with the surface of the ground, with two lines of five established at seven metre spacings. Each line of five pits was joined by a single driftline 20 cm high, set into the substrate. Pit traps were checked daily for targeted invertebrates as well as vertebrate fauna.

2. Elliot box traps: Two lines of ten medium sized Elliot traps (9 cm x 9 cm x 32 cm) were placed within the grid in sheltered areas, and baited with a mixture of rolled oats, peanut butter and sardines.

3. Sheffield cage traps: Two cage traps were placed within the grid in sheltered areas and baited as above.

4. Funnel traps: Five funnel traps measuring 75 cm x 18 cm x 18 cm were placed along driftline fences shared with the pit traps.

5. Micro-pits: Seven micropits were installed at each site at least 1.5 m apart. Traps consisted of plastic containers of 80 mm in diameter and 125 mm deep sitting flush with the soil surface, and containing approx 200 ml of a mixture of ethylene glycol and water at a ratio of 30:70.

6. Inventory Searches: Survey sites were hand-searched for cryptic species of vertebrates and targeted invertebrate groups for specific periods of time. Techniques included identification of active animals, raking leaf and bark litter, overturning logs and stones, searching beneath the bark of dead trees, investigating burrows and recording tracks, diggings, scats, and other sign. Bird records were also made during inventory searches. Specific searches were made for the permanent burrows of mygalomorph spiders and these were dug up and specimens collected. Lids of mygalomorph burrows were also collected for subsequent identification. Searches were made for snail shells at the base of shrubs and hummock grasses.

7. Soil Sieving: Species of terrestrial molluscs may be found within the top 0.2 cm to 1.0 cm of soil. Samples of this soil layer were collected for subsequent inspection in the laboratory. Sieved samples of approximately 500 cc were collected from all sites. Samples were sieved on site, and the < 0.1 cm and > 1 cm fraction returned to where it was collected. Collected samples were transported from site to the OES laboratory in Perth in Esky's.

8. Spotlight Searches: Sites were searched at night using head torches and spotlights for nocturnal species, such as geckos, snakes nocturnal birds and invertebrates. Records of species observed between sites were also made.

9. Avifauna Censusing: Censuses were used to survey the avifauna present within each habitat. The duration of each census was 20 minutes, undertaken during trap clearance, with the number of individuals of each species observed and/or heard was recorded. The surveys were carried out in the mornings between 0600 hr and 1200 hr. To obtain sufficient data bird censusing was un-bounded. That is, observations were not confined to survey site boundaries but all records were made in the vicinity of survey sites and within the habitat represented during the allocated time.

Table 5 Summary of trapping undertaken at each site

	Site No	Description	Pits: 20L bucket	Pits: 150mm poly	Elliott Traps	Cage Traps	Funnel Traps	Micro-pits
Systematic Sampling Vertebrates and SREs	LW01	Melaleuca Grove	5	5	20	2	4	7
	LW02	Mulga over Spinifex	5	5	20	2	4	7
	LW03	Eucalypt Woodland	5	5	20	2	4	7
	LW04	Mulga Woodland	5	5	20	2	4	7
	LW05	Mallee over Spinifex	5	5	20	2	4	7
	LW06	Woodland on Calcrete Flats	5	5	20	2	4	7
	LW07	Samphire Flats						7
Totals			30	30	120	12	24	49
Inventory searching and soil sieving	LW08	Claypana						
	LW09	Drainage Line - Floodplain						

Systematic Survey Effort

Three Outback Ecology staff members undertook trapline establishment and the spring fauna survey over ten days, with vertebrate trapping undertaken over a six day period. One of the three staff members was dedicated to the invertebrate component of the survey. Trapping effort displayed as 'trap-nights' is shown in **Table 6**. One trap-night is the equivalent of one trap open for one night. Note that standard pit traps were checked for targeted invertebrates as well as vertebrate fauna. No fish traps were used during the survey as there was no surface water present over the survey area at the time. A total of 1,296 trap-nights was undertaken over the survey area, excluding micro-pits (**Table 6**).

Table 6 Total trapping effort

Site No.		Pit Trap-nights	Elliot Trap-nights	Funnel Trap-nights	Cage Trap-nights	Total	Micro Pit Trap-nights
LW01	Melaleuca Grove	60	120	24	12	216	42
LW02	Mulga over Spinifex	60	120	24	12	216	42
LW03	Eucalypt Woodland	60	120	24	12	216	42
LW04	Mulga Woodland	60	120	24	12	216	42
LW05	Mallee over Spinifex	60	120	24	12	216	42
LW06	Woodland on Calcrete Flats	60	120	24	12	216	42
LW07	Samphire Flats	-	-	-	-	-	42
LW08	Claypan	-	-	-	-	-	-
LW09	Drainage Line - Floodplain	-	-	-	-	-	-
		360	720	144	72	**1,296**	294

A total of 3,435 minutes was spent on systematic surveys within representative sites, with 600 minutes spent undertaking surveys of avifauna (**Table 7**). Opportunistic sightings around the greater survey area also contributed significantly to the number of species recorded. Systematic inventory and spotlighting searches totalled 2,430 minutes and 405 minutes respectively. One staff member undertook bird census and spotlighting surveys, whereas three staff members undertook the inventory (or hand-searching) component, with one staff member focussing on invertebrates.

Table 7 Total bird census, inventory, and spotlighting effort

Site No.		Bird Census (Minutes)	Inventory (Minutes)	Spotlighting (Minutes)	Total (Minutes)
LW01	Melaleuca Grove	100	90 (x3)	45	415
LW02	Mulga over Spinifex	100	90 (x3)	45	415
LW03	Eucalypt Woodland	100	90 (x3)	45	415
LW04	Mulga Woodland	100	90 (x3)	45	415
LW05	Mallee over Spinifex	100	90 (x3)	45	415
LW06	Woodland on Calcrete Flats	100	90 (x3)	45	415
LW07	Samphire Flats		90 (x3)	45	415
LW08	Claypan		90 (x3)	45	315
LW09	Drainage Line - Floodplain		90 (x3)	45	315
Total		600	2,430	405	**3,435**

3.4.3 Non-systematic Sampling

To supplement the systematic sampling, the presence of all vertebrate species was recorded wherever, and whenever, possible during the survey. Non-systematic sampling included:

1. Opportunistic sightings: The presence of all vertebrate and invertebrate species encountered was recorded while working and travelling within the survey area during the day and night, including during trap line establishment. Opportunistic sampling included data collected non-systematically within and outside of fixed sampling sites.
2. Secondary evidence: Tracks, diggings, scats, burrows and nests were recorded wherever and whenever possible, including invertebrates (particularly mygalomorph burrows).
3. Spotlighting (nocturnal road surveys): Tracks were traversed in a vehicle at low speeds at night time, with any fauna detected within headlights recorded. Over 100 minutes of nocturnal road surveys were undertaken over the survey period.

3.4.4 Targeted Searches

Bat Fauna

Bats were sampled via echolocation call detection through electronic detectors. No typical bat habitat such as rocky outcrops or cave systems occurs over the survey area. However, the Uramurdah Clay Pan (**Plate 10**) that is located on the northern boundary of the Lake Way project area supports large eucalypts, which may provide roosting sites for bats. Although dry at the time of the survey, the clay pan is intermittently inundated with water. At the time of the survey the only surface water occurring was that associated with Abercrombie stock well, located approximately 3 km to the west of the Centipede project area. Bats often drink at surface water, after emerging from shelter at dusk, and sampling was undertaken at Abercrombie stock well over four nights (**Plate 10**). Bats also forage for insects around flowering vegetation or under artificial light and one nights sampling was undertaken at Uramurdah Clay Pan (Site LW08), where eucalypts were flowering, as well as under the lights at Wiluna Minesite (**Table 8**).

Table 8 Bat call detection locations

Date	Site	Location	Co-ordinates	Technique	Habitat
23/10/07	Abercrombie Well	Centipede Region	51 J 233029 7027618	Anabat onto Minidisk	Artificial water at stock bore
24/10/07	Abercrombie Well	Centipede Region	51 J 233029 7027618	Anabat onto Minidisk	Artificial water at stock bore
25/10/07	Abercrombie Well	Centipede Region	51 J 233029 7027618	Anabat onto ZCAIM	Artificial water at stock bore
26/10/07	Abercrombie Creek	Centipede Region	51 J 232855 7027404	Anabat onto ZCAIM	Large Eucalypts along creekline
27/10/07	Uramurdah Clay Pan	Lake Way project area	51 J 235159 7047492	Anabat onto Minidisk	Dry clay pan with flowering eucalypts
28/10/07	Wiluna Mine Camp	Wiluna	51 J 227907 7050645	Anabat onto Minidisk	Under artificial lights at minesite

The echolocation call detection system consisted of an Anabat detector (Titley Electronics, Ballina, NSW) that was able to transform ultrasonic bat echolocation calls for analysis. Techniques employed included Anabat detector through ZCAIM (Zero-Crossings Analysis Interface Module), as well as Anabat detector directly onto minidisk (that is, in real time). Interpretation of results obtained was made by Mr Robert Bullen who has experience in the region, including work interpreting bat calls for the Department of Environment and Conservation (DEC).

Plate 10 Bat call detection sites: Abercrombie Creek in the vicinity of Abercrombie Well (left) and Uramurdah Clay Pan (right)

Other Targeted Searches

From the desktop study, literature review and field survey, habitats were identified with the potential to support significant fauna species known from the region. Targeted searches were made for specific or significant terrestrial fauna within specified habitats. Targeted searches included:

1. Samphire/Saltbush habitats of the Centipede project area. A targeted search by one person of approximately 180 minutes was made for Slender-billed Thornbill in particular, but also, Bush Stone-curlew, and Australian Bustard.
2. Acacia/Mulga habitats over the Centipede project area. Dedicated transects were traversed by three people for 210 minutes within suitable habitat to search for distinctive signs, or sightings, of Malleefowl in particular but also Mulgara, Greater Bilby, Striated Grasswren, and Great Desert Skink. Searches for Malleefowl mounds were also undertaken during all travelling through the overall survey area and surrounds during the survey period.
3. Mygalomorph spiders and other invertebrates. Littered areas surrounding the salt lake as well as under shrubs, mallee and mulga were searched for the typical lidded trapdoors of mygalomorph (trapdoor spider) burrows as well as the open burrows of Teyl species. Aerial soil tubes of Aname species were searched for in spinifex grassland.

3.4.5 Sorting and Identification of Invertebrate Specimens

All invertebrate specimens collected from survey sites were sorted in the field into major taxonomic groups. Any specimens of millipedes, scorpions, and pseudoscorpions collected by hand-searching were placed into 70% ethanol immediately upon capture. Spiders were placed in 100% ethanol upon capture due to their softer body parts.

All vials were sealed and labelled before transportation to the OES Perth laboratory. Within the laboratory all specimens, including those collected opportunistically, were grouped and labelled by

OES staff into categories suitable for delivery to WAM and UWA. Standard identification keys were used to group specimens (eg. Brunet, 1997; CSIRO, 1970; DEW, 2007; Harvey and Yen, 1989; Raven *et al.* 2002), typically to the level of Order. Spiders were also sorted by OES staff to differentiate potential mygalomorph species. Potential mygalomorph spiders were delivered to Professor Barbara York Main of UWA for subsequent identification, and potential millipede, scorpions and centipede specimens were delivered to Dr Mark Harvey of WAM.

The sieved soil samples collected from the survey sites were inspected for terrestrial mollusc specimens in the OES Laboratory in Perth. A thin layer of soil was placed into a gridded petri dish and inspected under magnification. Mollusc specimens collected were subsequently wrapped in tissue, placed in labelled vials and delivered to Ms Shirley Slack-Smith of WAM.

4.0 VERTEBRATE FAUNA

4.1 Sampling Adequacy

Standard species accumulation curves were produced for the different vertebrate groups recorded during the survey period as a basic aid to assessing sampling adequacy. Data are inclusive of all sampling methods and are presented as the number of species recorded over time.

From the species accumulation curves (**Figure 4**) it can be seen that reptile numbers increased quickly from day two to four. Reptile and native mammal records indicate a point of diminishing returns towards the end of the survey period, with just four additional species recorded over the last two days and no additional species recorded on the last day.

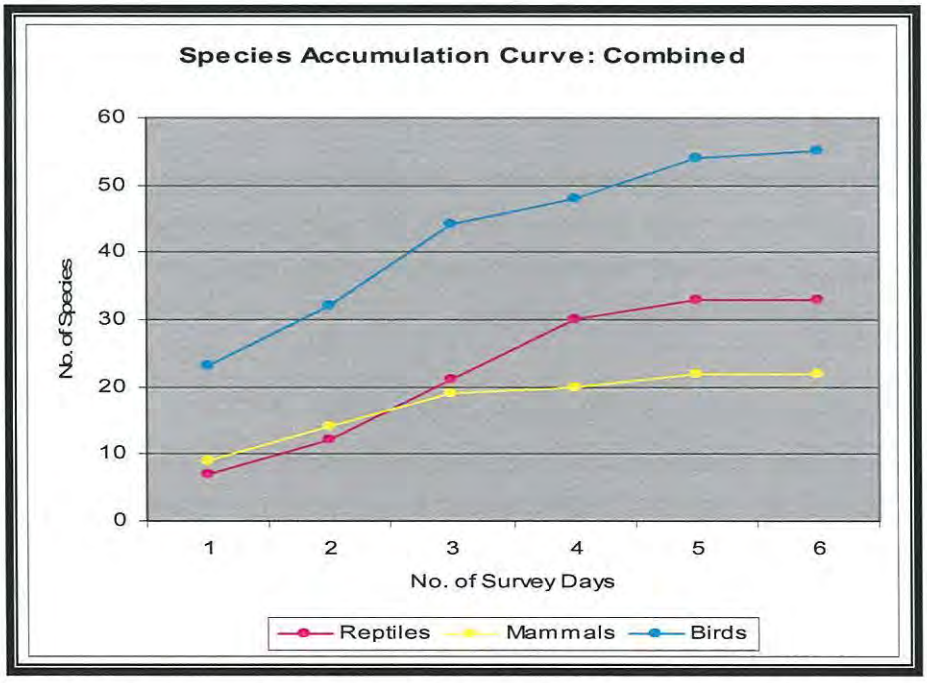

Figure 4 Species accumulation curves for vertebrate fauna during the 2007 survey

The number of bird species recorded increased quickly from day one to three during the survey before slowing tapering off. However, additional bird species were still being recorded at the end of the survey with seven additional species recorded over the last two days.

The survey results suggest that sampling was adequate for the particular season sampled, and over 190 trapping captures were recorded. However sampling during a different season is likely to increase numbers of species found in all groups for the site.

4.2 Vertebrate Fauna Habitats

Sites selected for systematic surveying represented fauna habitats that are characteristic of the survey area, and are generally consistent with classifications used elsewhere in biodiversity assessments. Fauna habitats identified were:

- Melaleuca Grove (Site LW01)
- Mulga over Spinifex (Site LW02)
- Eucalypt Woodland (Site LW03)
- Mulga Woodland (Site LW04)
- Mallee over Spinifex (Site LW05)
- Woodland on Calcrete Flats (Site LW06)
- Samphire Flats (Site LW07)
- Claypan (Site LW08)
- Drainage Line / Floodplain (Site LW09)

Spinifex and shrubland habitats over the survey area are currently significantly impacted by frequent fire and all habitats, but particularly those adjacent to Lake Way, are heavily grazed by cattle. Selection of survey sites was heavily biased towards areas of unburnt vegetation, and areas less impacted by grazing. Trapping at sites LW07 to LW09 was not undertaken (see Section 3.4.1).

Table 9 shows the number of species recorded at individual sites. Introduced mammal species have been omitted. It can be seen from the table that sites with a ground cover of spinifex (LW02 and LW05) recorded more native mammal species than other sites, and that sites incorporating eucalypts (LW03 and LW05) recorded more bird species. Reptile species richness was highest at sites with a ground cover of spinifex (LW02 and LW05), as well as the Mulga Woodland site (LW04).

Table 9 Number of species recorded at sites (excluding exotics)

Group	LW01 Melaleuca Grove	LW02 Mulga over Spinifex	LW03 Eucalypt Woodland	LW04 Mulga Woodland	LW05 Mallee over Spinifex	LW06 Woodland on Calcrete Flats
Mammals	2	7	1	4	5	2
Birds	4	11	16	7	15	10
Reptiles	6	10	6	9	10	6
Amphibians	-	-	-	-	-	-
Total	**12**	**28**	**23**	**20**	**30**	**18**

Spinifex hummock grasslands are recognised as supporting a high diversity of reptiles and small mammals (Kendrick and McKenzie, 2001), and spinifex communities recorded higher species richness during this survey. Furthermore, abundances also reflected this trend (**Table 10**). Along with the shelter provided by spinifex clumps, the sandy substrates that support these communities provide a suitable medium both for fossorial reptiles as well as burrowing mammals.

By contrast, bird species richness is more likely to be positively influenced by the structural complexity of eucalypt woodland habitats. Although not included in **Table 9** (because daily bird censusing was not conducted), a one-off inventory search for birds at the Claypan site (Site LW08) that is surrounded by large eucalypts recorded 22 bird species; more than any other site.

Table 10 Abundances recorded at sites based on trapping and bird censusing data

Group	LW01 Melaleuca Grove	LW02 Mulga over Spinifex	LW03 Eucalypt Woodland	LW04 Mulga Woodland	LW05 Mallee over Spinifex	LW06 Woodland on Calcrete Flats
Mammals	2	16	3	5	11	4
Birds	5	28	53	7	45	12
Reptiles	5	20	31	17	44	25
Amphibians	-	-	-	-	-	-
Total	**12**	**64**	**87**	**29**	**100**	**25**

The Melaleuca Grove (Site LW01) recorded very few species, and extremely low abundances. Although a conspicuous discrete habitat, it lacked ground cover, had a low number plant species, and was also heavily disturbed by the grazing of cattle, as well as by kangaroos and rabbits; all of which also sheltered in the cover provided by this habitat.

4.3 Vertebrate Fauna Recorded within the Survey Area

Results of data-base searches are presented in Appendices A to H. Species lists have been prepared for the survey area based on a search of the available literature, information obtained from the WA Museum fauna database, published and unpublished information relevant to the area, and records of the survey combined with knowledge of habitat preferences and the habitats that actually occur over the survey area. These lists are included as Appendix I. Records of species identified from the survey area during the spring 2007 survey are detailed below.

4.3.1 Mammals

Twenty-two species of mammal representing 13 families were recorded over the survey area during the survey (

Table 11). Of these, 15 were native species, five introduced, and two domestic stock.

Fifteen native mammals were also recorded by How and Dell (1992) over three comprehensive survey periods at Banjawarn in the Duketon-Sir Samuel block of the biological survey of the Eastern Goldfields, and 18 mammals recorded by OES (2008a) over two survey periods at Lake Maitland. How and Dell (1992) recorded more Dasyurid species while this study recorded more bats. The rodents, and all but two bats, recorded by How and Dell (1992) were also recorded during this study. Along with the species recorded during this survey, OES (2008a) also recorded the Desert Mouse *(Pseudomys desertor),* Stripe-faced Dunnart *(Sminthopsis macroura),* and Mulgara *(Dasycercus cristicauda).* The seven species of bats recorded by OES at Lake Maitland (in prep1) were the same seven species recorded during this survey.

There are 47 mammal species known from the entire Murchison bioregion (NLWA, 2002), and WAM searches over an area of approximately 250 km by 250 km (Appendix B) centred on Lake Way list 37 species. Many of these are bats and exotic species, and/or species restricted to habitats not represented over the Lake Way survey area, particularly dunefields, rocky ranges and hills, and granite tors. Furthermore, NLWA (2002) considers that 20 mammal species no longer occur in the Bioregion and are now either extinct (e.g. Lesser Stick-nest Rat, Pig-footed Bandicoot, Crescent Nailtail Wallaby, Long-tailed Hopping-mouse and Short-tailed Hopping-mouse) or regionally extinct (e.g., Greater Stick-nest Rat, Chuditch, Black-flanked Rock-wallaby and Greater Bilby). Apart from the hopping-mice, all these species are critical weight range (CWR) mammals with weights between 35 g and 5,500 g that have been most affected by environmental changes following European settlement, predominantly due to fox and cat predation (Burbidge and McKenzie, 1998). The bioregion, therefore, has very high 'faunal attrition' and 'faunal contraction' indices at 0.45 and 0.4 respectively (NLWA, 2002).

Table 11 **Mammals recorded during the October 2007 survey**

Species	Sites						Bat recording sites		
	LW01	LW02	LW03	LW04	LW05	LW06	Aber-crombie Well	Uramur-dah Clay Pan	Wiluna Mine Camp
Echidna *Tachyglossus aculeatus*		x			x	x			
Wongai Ningaui *Ningaui ridei*		x			x				
Ooldea Dunnart *Sminthopsis ooldea*		x		x					
Euro *Macropus robustus*	x	x		x					
Red Kangaroo *Macropus rufus*	x	x		x	x	x		x	
Spinifex Hopping-mouse *Notomys alexis*		x	x	x	x				
Sandy Inland Mouse *Pseudomys hermannsburgensis*		x			x				
*House Mouse *Mus domesticus*	x		x	x		x			
Hill's Sheathtail Bat *Taphozous hilli*							x		
Gould's Wattled Bat *Chalinolobus gouldii*							x	x	x
Lesser longeared Bat *Nyctophilus geoffroyi*							x		x
Inland Broadnosed Bat *Scotorepens balstoni*							x	x	
Finlayson's Cave Bat *Vespadelus finlaysoni*								x	
Southern Freetail Bat *Mormopterus planiceps ('sp. 3')*							x	x	x
White-striped Freetail Bat *Tadarida australis*							x		
Dingo / Wild Dog *Canis lupus dingo*				x					
*Red Fox *Vulpes vulpes*								x	
*Feral Cat *Felis catus*								x	
*European Rabbit *Oryctolagus cuniculus*	x	x	x	x	x	x		x	
*Horse *Equus caballus*				x					
*European Cattle *Bos taurus*	x	x	x	x	x	x		x	
*Dromedary Camel *Camelus dromedarius*								x	

* Introduced species

All native mammals recorded during the survey were either trapped, or recorded through inventory, spotlight searches and ANABAT recordings. In addition, evidence of all native mammals was recorded within established survey sites, with the Red Fox, Feral Cat and Dromedary Camel recorded outside of survey sites. Cattle appear to have open access across both project areas.

Of the five mammal species captured through the trapping program, four were recorded in similar abundances. That is; the Wongai Ningaui *(Ningaui ridei),* Spinifex Hopping-mouse *(Notomys alexis),* Sandy Inland Mouse *(Pseudomys hermannsburgensis)* and House Mouse *(Mus musculus).* Conversely, the Ooldea Dunnart *(Sminthopsis ooldea)* was captured on just two occasions.

The Red Kangaroo *(Macropus rufus)* was abundant in the chenopod flats and calcrete flats covering and surrounding Lake Way and the Euro *(Macropus robustus erubescens)* was more common in shrubland and Mulga Woodland.

Seven bat species were recorded during the survey. Six species were consistently recorded at Abercrombie Well, with an additional species *(Vespadelus finlaysoni)* recorded at the Uramurdah Clay Pan only. Given the habitats present seven species is considered a satisfactory result for the site. *Taphozous hilli* and *Vespadelus finlaysoni* roost in cave systems and are therefore not likely to roost over the survey area due to a lack of habitat. The other five species are known to use hollows in trees as roost sites and are therefore likely to roost over the survey area in woodland habitats. *Tadarida australis* is thought to migrate (Churchill, 1998), and the October record is likely to be a straggler heading south for the summer (B. Bullen *pers comm*). Of the bat species recorded, none are considered of conservation significance.

4.3.2 Birds

Fifty-five species of bird were observed during the survey (
Table 12). Of these, 42 were recorded from established survey sites, with a further 13 species recorded opportunistically over the survey area, or during targeted searches for other species. This compares with 22 recorded previously by OES at Lake Way (OES, 2002), 50 recorded by Ninox (1993) at the Bronzewing Gold Project, 60 by OES (2008a) over two surveys, 70 by How and Dell (1992) in the Duketon-Sir Samuel block over three surveys, 111 at Wanjarri Nature Reserve (Moriarty, 1972), and 210 by Birds Australia in the Murchison Bioregion (Blakers *et al.* 1984; Barrett, *et al.* 2003). Differences in numbers are due to differences in survey scale and survey intensity. Scale refers to the size of area surveyed and variability of habitats covered. Survey intensity includes the length of the survey period as well as timing of surveys. For example, Birds Australia data was accumulated over many years over the entire bioregion within numerous habitats. Similarly, Moriarty (1972) data were accumulated over many years, and within additional habitats that do not occur over the survey area (CALM, 1996). Moriarty (1972), How and Dell (1992), and Birds Australia data also include surveys of habitats not present over the survey area, particularly those habitats associated with rocky ranges and hills, and are therefore likely to include species not present at Lake Way.

Table 12 Bird species recorded during the survey

Species		Sites									
		LW 01	LW 02	LW 03	LW 04	LW 05	LW 06	LW 07	LW 08	LW 09	Opp
Emu	*Dromaius novaehollandiae*					x			x	x	
Black-breasted Buzzard	*Hamirostra melanosternon*										o
Black Kite	*Milvus migrans*										o
Whistling Kite	*Haliastur sphenurus*								x		
Collared Sparrowhawk	*Accipiter cirrhocephalus*										o
Wedge-tailed Eagle	*Aquila audax*										o
Little Eagle	*Hieraaetus morphnoides*										o
Brown Falcon	*Falco berigora*								x		
Australian Hobby	*Falco longipennis*										o
Nankeen Kestrel	*Falco cenchroides*						x				
Common Bronzewing	*Phaps chalcoptera*		x			x			x	x	
Crested Pigeon	*Ocyphaps lophotes*	x	x	x	x		x			x	
Galah	*Eolophus roseicapillus*		x	x						x	
Australian Ringneck	*Barnardius zonarius*		x	x	x	x			x		
Mulga Parrot	*Psephotus varius*		x	x		x					
Southern Boobook	*Ninox novaeseelandiae*										o
Tawny Frogmouth	*Podargus strigoides*			x							
Spotted Nightjar	*Eurostopodus argus*										o
Australian Owlet-nightjar	*Aegotheles cristatus*										o
Rainbow Bee-eater	*Merops ornatus*								x		
Splendid Fairy-wren	*Malurus splendens*									x	
Variegated Fairy-wren	*Malurus lamberti*	x				x					
White-winged Fairy-wren	*Malurus leucopterus*									x	
Redthroat	*Pyrrholaemus brunneus*										o
Weebill	*Smicrornis brevirostris*		x	x		x			x		
Inland Thornbill	*Acanthiza apicalis*			x					x		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		x	x	x						
Slaty-backed Thornbill	*Acanthiza robustirostris*					x					
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*								x		
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*					x	x				
Yellow-throated Miner	*Manorina flavigula*			x	x	x	x		x		
Singing Honeyeater	*Lichenostomus virescens*	x		x	x	x	x		x		
White-eared Honeyeater	*Lichenostomus leucotis*			x					x		
Grey-headed Honeyeater	*Lichenostomus keartlandi*								x		
Yellow-plumed Honeyeater	*Lichenostomus ornatus*								x		
White-plumed Honeyeater	*Lichenostomus penicillatus*		x			x			x		
Brown Honeyeater	*Lichmera indistincta*								x	x	
Grey-crowned Babbler	*Pomatostomus temporalis*										o
Chiming Wedgebill	*Psophodes occidentalis*					x					
Rufous Whistler	*Pachycephala rufiventris*			x					x		
Grey Shrike-thrush	*Colluricincla harmonica*		x	x					x		
Magpie-lark	*Grallina cyanoleuca*								x		
Willie Wagtail	*Rhipidura leucophrys*					x			x		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				x		x				

Species		Sites									
		LW 01	LW 02	LW 03	LW 04	LW 05	LW 06	LW 07	LW 08	LW 09	Opp
Black-faced Woodswallow	*Artamus cinereus*		x				x				
Grey Butcherbird	*Cracticus torquatus*			x							
Pied Butcherbird	*Cracticus nigrogularis*						x				
Australian Magpie	*Gymnorhina tibicen*			x							
Grey Currawong	*Strepera versicolor*										o
Little Crow	*Corvus bennetti*	x	x	x	x		x	x			
Western Bowerbird	*Chlamydera guttata*					x					
Australian Pipit	*Anthus novaeseelandiae*						x	x			
Zebra Finch	*Taeniopygia guttata*										o
Welcome Swallow	*Hirundo neoxena*								x		
Tree Martin	*Hirundo nigricans*					x			x		

The timing of the survey meant that some migratory, nomadic or irruptive species, such as particular honeyeater species and passerines such as the Grey Fantail and Western Gerygone, were not present. Migratory birds are those with regular seasonal movements and several species move into the Murchison during winter-spring period, with some returning to the southwest during summer-autumn, and others moving to northern Australia during this period. Irruptive and nomadic species are those that occur in an area occasionally due to a response to temporary favourable conditions (either on-site or elsewhere). Appendix I includes those migratory, nomadic, or irruptive[1] species likely to occur over the survey area over particular seasons or favourable climatic conditions.

There have been few records of waterbirds directly using Lake Way, and none were recorded during this survey. Bancroft and Bamford (2004) reviewed wetland avifauna use of the lake and concluded that in periods of flood Lake Way has the potential to support up to 47 species of waterbird, including up to 18 species listed as migratory and/or marine species under the EPBC Act. These species are included in Appendix I.

Although targeted searches did not record species of conservation significance, the Rainbow Bee-eater was recorded at site LW08 (see Section 7.2).

4.3.3 Reptiles

The Murchison Bioregion is rich in reptiles and over 80 species are known. However, the number present in the survey is likely to be significantly lower than elsewhere in the bioregion due to the lack of habitats over the survey area that are represented elsewhere in the bioregion. Thirty-two species of reptile were recorded during the survey (Table 13) including nine geckos, six dragons and 12 skinks. Nine species were recorded by OES (2002), 39 species by OES (2008a) over two surveys, and 46 by How and Dell (1992) over three survey periods in the Duketon-Sir Samuel block of the biological

[1] Species that migrate irregularly, possibly in response to resource shortages.

survey of the Eastern Goldfields. Just one snake was recorded: this group was under-represented during the survey.

Table 13 Reptile species recorded during the survey

Species		Sites						Other
		LW01	LW02	LW03	LW04	LW05	LW06	
Central Military Dragon	*Ctenophorus isolepis*					x		
Central Netted Dragon	*Ctenophorus nuchalis*		x					
Claypan Dragon	*Ctenophorus salinarum*							LW07
	Lophognathus longirostris							LW08
Thorny Devil	*Moloch horridus*					x		
Bearded Dragon	*Pogona minor minor*				x			
Fat-tailed Gecko	*Diplodactylus conspicillatus*				x	x		
Sandplain Gecko	*Diplodactylus stenodactylus*							Spot
	Gehyra purpurascens	x						
Variegated Gecko	*Gehyra variegata*		x	x	x		x	
Bynoe's Gecko	*Heteronotia binoei*	x						
Smooth Knob-tailed Gecko	*Nephrurus laevissimus*	x						
Banded Knob-tailed Gecko	*Nephrurus wheeleri wheeleri*							Camp
Beaked Gecko	*Rhynchoedura ornata*		x		x	x	x	
Spiny-tailed Gecko	*Strophurus strophurus?*	x						
Butler's Delma	*Delma butleri*		x					
Hooded Scaly-foot	*Pygopus nigriceps*					x		
	Cryptoblepharus carnabyi			x				
Fence Skink	*Cryptoblepharus plagiocephalus*				x			
Southern Mallee Skink	*Ctenotus atlas*					x		
	Ctenotus leonhardii		x					
Leopard Ctenotus	*Ctenotus pantherinus ocellifer*						x	
	Ctenotus quattuordecimlineatus					x		
	Ctenotus schomburgkii		x		x	x	x	
	Lerista bipes		x	x		x		
	Lerista desertorum			x				
	Lerista muelleri	x	x	x	x		x	
Common Dwarf Skink	*Menetia greyii*		x	x	x	x	x	
	Morethia butleri				x			
Gould's Sand Monitor	*Varanus gouldii*	x						
Yellow-spotted Monitor	*Varanus panoptes rubidus*							Opp
	Ramphotyphlops hamatus		x					
Steindachner's Turtle	*Chelodina steindachneri*							LW08

Although habitat preferences for reptiles are not completely understood, dunefields, rocky ranges and hills, and granite tors are all habitats that typically support a large number of species, but which are not represented over the survey area. For example, the Perentie (*Varanus giganteus*), *Ctenophorus ornatus* and *Ctenophorus caudicinctus* prefer rocky areas and are unlikely to be present in the survey area due to a lack of habitat.

Numerous old shells of Steindachner's Turtle *(Chelodina steindachneri)* were found along the edge of Uramurdah Clay Pan (Site LW08). This species is common in semi-arid areas and undertakes extended aestivation during times of drought. The Spiny-tailed gecko recorded was not captured but is likely to be *Strophurus strophurus* due to morphology, habitat, and distribution patterns.

4.3.4 Amphibians

Although no amphibians were recorded over the survey area, WAM lists 11 species that could potentially occur in the region. Five species were recorded by How and Dell (1992) in the Duketon-Sir Samuel block of the biological survey of the Eastern Goldfields. All have aquatic larval stages and all except the Desert Tree Frog burrow to avoid desiccation through heat. Salt levels are likely to be too high within Lake Way itself to support frogs and if present they are more likely to be present in intermittent freshwater pools surrounding the lake, including the Uramurdah Clay Pan and associated creekline. The Desert Tree Frog *(Littoria rubella)* usually favours eucalypts surrounding creeklines, or man-made habitats, and if present is likely to occur at the Uramurdah Clay Pan.

4.3.5 Fish

The only fish listed by WAM for the region is *Tragulichthys jaculiferus*. This is the marine Longspine Porcupinefish that inhabits coastal marine waters and the record is clearly an anomaly. In such an arid environment the only species of fish with the potential to occur is the Spangled Perch *(Leiopotherapon unicolor)*. This species can occur in arid areas including the Murchison, Gascoyne, Pilbara and Kimberley. It is a very drought tolerant species that survives long periods between rainfall events probably by aestivating in wet mud or litter. If present, it is most likely to be found at the Uramurdah Clay Pan (Site LW08) and associated creekline.

4.3.6 Introduced Species

Introduced exotic species that occur in the Murchison bioregion are listed in **Table 14**. Apart from species recorded, the Feral Goat and Sheep are also all likely to be present over the survey area at certain times dependent upon pastoral management.

Table 14 Introduced exotic species possibly occurring over the survey area (NLWA, 2002)

Group	Common Name	Scientific Name
Mammals	*House Mouse	*Mus domesticus*
	*Dingo / Wild Dog	*Canis lupus dingo*
	*Red Fox	*Vulpes vulpes*
	*Cat	*Felis catus*
	*European Rabbit	*Oryctolagus cuniculus*
	*Brumby / Horse	*Equus caballus*
	Donkey	*Equus asinus*
	*Dromedary Camel	*Camelus dromedarius*
	*European Cattle	*Bos taurus*
	Goat	*Capra hircus*
	Sheep	*Ovis aries*
Birds	Rock Dove	*Columba livia*

	Laughing Turtle-Dove	*Streptopelia senegalensis*
	Spotted Turtle-Dove	*Streptopelia chinensis*

* Recorded during the survey

The introduced birds listed in Table 14 are largely restricted to the modified environments of major towns to the south of the survey area and are unlikely to occur over the project area.

5.0 SHORT-RANGE ENDEMIC INVERTEBRATES

Invertebrate specimens were sorted into targeted groups by OES staff and delivered to various specialists during December 2007 and January 2008.

- Mygalomorph spiders were delivered to Professor Barbara York Main of UWA for subsequent identification (Appendix J).
- Potential scorpion, pseudoscorpion and centipede specimens were delivered to the WA Museum (att: Dr Mark Harvey) for subsequent identification (Appendix J).
- Mollusc specimens collected were wrapped in tissue, placed in labelled vials and delivered to the WA Museum (att: Shirley Slack-Smith) for subsequent identification (Appendix J).

5.1 Mygalomorph Spiders

The Mygalomorphae, or trapdoor and funnelweb spiders, are represented by 10 families in Australia, eight of which occur in Western Australia. The family Migidae is confined to the moist forested and topographically elevated areas of the southwest, and the Theraphosidae are a predominantly tropical family (Main 2005), and are therefore unlikely to occur over the survey area.

The remaining six families potentially occur within the survey area of Lake Way. These families include the Actinopodidae, Barychelidae, Ctenizidae, Dipluridae, Idiopidae and Nemesiidae (Raven *et al.* 2002). Mygalomorph genera of interest to the survey area included *Aganippe*, *Anidiops*, *Gaius*, *Arbanitis*, *Eucyrtops*, *Aname*, *Teyl*, *Cethegus*, and *Selenocosmia* (B. Y. Main, *pers. Comm.*).

A Threatened and Priority Fauna Database search of the survey area by the Department of Environment and Conservation found that the Priority 2 mygalomorph spider *Kwonkan moriartii* (Main, 1983) was collected in the past from Kathleen Valley, approximately 100 km south of the survey area. Little is known about this species except that the single record is represented by the halotype specimen collected in 1962. This species was not recorded during the survey at Lake Way.

Table 15 Mygalomorph spiders identified from Lake Way (December 2007)

Site	Sex	Family	Genus/species
LW01	Juvenile	Nemesiidae	*Aname* sp.
	Penultimate male	Idiopidae	*Eucyrtops* sp.
LW02	Female	Nemesiidae	Aname sp. "armigera sp. Group" ("wish bone spider")
	Female	Barychelidae	Idiommata sp. (?)
LW04	Juvenile	Idiopidae	*Aganippe* sp. (?) damaged specimen
	Male	Barychelidae	nec *Idiommata**
	Female	Idiopidae	*Eucyrtops* sp.
LW05	Female	Nemesiidae	Aname sp. (?) "armigera" sp. Group
	Female	Barychelidae	nec *Idiommata**
	Female	Idiopidae	*Aganippe sp. A*
LW09	Female	Idiopidae	*Aganippe sp. A. "occidentalis sp. Group"*

In taxonomy, where placing species can be complicated, the abbreviate 'nec' can be used to mean 'not'. In the above example, 'nec *Idiommata*' refers to individuals that belong to the family Barychelidae that are not from the common and wide-spread genus *Idiommata*.

Plate 11 Burrow, left, and associated Mygalomorph spider, right. This spider is from the family Barychelidae, probably *Idiommata* sp.

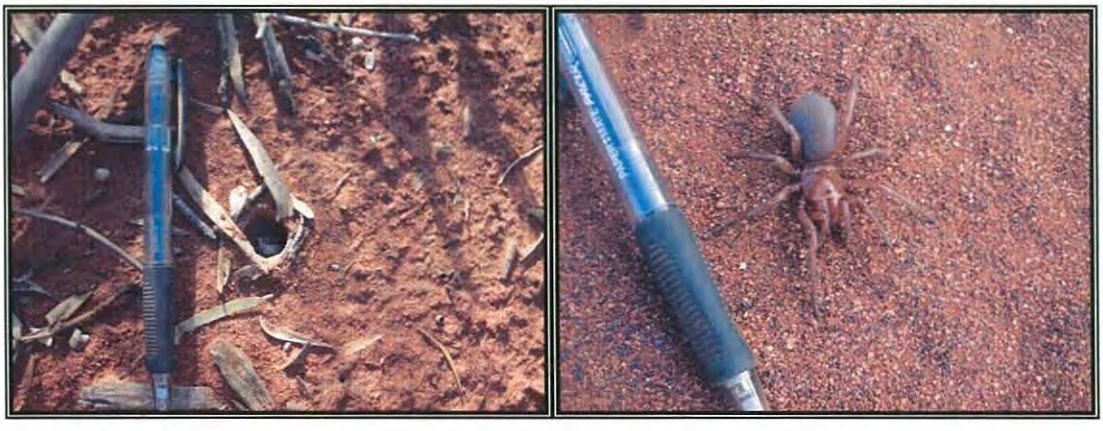

Plate 12 Burrow, left, and associated Mygalomorph spider, right. This spider is from the family Nemesiidae, *Aname* sp. from the armigera sp. group.

Twelve Mygalomorph specimens were collected during the Lake Way survey (Appendix J). These spiders were from three families of mygalmorphidae represented by five genera and six species. These were Barychelidae (*Idiommata* sp. (**Plate 11**) and an unidentified genus sp.), Idiopidae (*Eucyrtops* sp. and two *Aganippe* species) and Nemesiidae (*Aname* sp. an unnamed species in "armigera species group" (**Plate 12**)) (**Table 15**). The taxonomic status of the genera is currently inadequate to place species more precisely. However, general conclusions that can be made regarding the taxonomy are:

- the Barychelid, *Idiommata* sp. (?) may be a named species,
- the Aname species is almost certainly widespread, and
- the *Aganippe* species and the *Eucyrtops* species from the Idiopidae family may tend to be restricted in their distribution (Main, 2008).

The full report by Barbara York Main is included in Appendix L.

5.2 Scorpions, Centipedes and Millipedes

Scorpions were collected from Sites LW01, LW02, LW03, LW05, and LW06. Pseudoscorpions were collected from Sites LW02, LW03, LW04, LW05, and LW06. Centipedes were collected from Sites LW02, LW03, and LW06 (Appendix J).

From a total of 27 specimens collected during the survey. Three species of pseudoscorpions, five species of scorpions and four species of centipedes (Scolopendridae) were identified (

Table 16). None of the specimens collected could be regarded as short-range endemic, with most being widely distributed in the semi-arid zone of Western Australia (Harvey, pers comm., 2008). The only exceptions may be the two scorpion species from the genus *Urodacus*, which are currently listed as the type species 'Lakeway 1' from LW05 and 'Lakeway 2' from LW02 and LW05. This genus is currently under review by Erich Volschenk (Ecologia Enviroment). The taxonomy of this group has proven to be problematic, with numerous unnamed species and variable morphologies.

Table 16 Identifications of pseudoscorpions, scorpions and centipedes collected at Lake Way (December 2007).

Site	Class	Order	Family	Genus	Species	Authority
LW 01	Arachnida	Scorpiones	Buthidae	*Lychas*	*`adonis`*	
LW 02	Arachnida	Pseudoscorpiones	Atemnidae	*Oratemnus*	*distinctus*	(Beier, 1954)
	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	*`sp. 8/3`*	
	Arachnida	Scorpiones	Buthidae	*Lychas*	*`adonis`*	
	Arachnida	Scorpiones	Urodacidae	*Urodacus*	***`lakeway2`***	
	Chilopoda	Scolopendrida	Scolopendridae	*Scolopendra*	*laeta*	Haase, 1887
LW 03	Arachnida	Pseudoscorpiones	Atemnidae	*Oratemnus*	*distinctus*	(Beier, 1954)
	Arachnida	Scorpiones	Buthidae	*Lychas*	*`adonis`*	
	Chilopoda	Scolopendrida	Scolopendridae	*Cormocephalus*	*turneri*	Pocock, 1901
LW 04	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	*`sp.`*	
LW 05	Arachnida	Pseudoscorpiones	Atemnidae	*Oratemnus*	*distinctus*	(Beier, 1954)
	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	*`sp. 8/3`*	
	Arachnida	Scorpiones	Buthidae	*Lychas*	*`adonis`*	
	Arachnida	Scorpiones	Buthidae	*Lychas*	*annulatus*	Glauert, 1925
	Arachnida	Scorpiones	Urodacidae	*Urodacus*	***`lakeway1`***	
	Arachnida	Scorpiones	Urodacidae	*Urodacus*	***`lakeway2`***	
	Chilopoda	Scolopendrida	Scolopendridae	*Cormocephalus*	*aurantiipes*	(Newport, 1844)
LW 06	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	*`sp. 8/3`*	
	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	*`sp.`*	
	Arachnida	Scorpiones	Buthidae	*Isometroides*	*`sp.`*	
	Chilopoda	Scolopendrida	Scolopendridae	*Cormocephalus*	*turneri*	Pocock, 1901
	Chilopoda	Scolopendrida	Scolopendridae	*Scolopendra*	*laeta*	Haase, 1887
	Chilopoda	Scolopendrida	Scolopendridae	*Scolopendra*	*morsitans*	Linnaeus, 1758

5.3 Terrestrial Snails

Specimens of molluscs were collected from Sites LW01, LW03, LW04, LW05, LW06, LW07, LW08 and LW09. Two families were represented by the specimens collected; the non-marine, aquatic family Planorbidae represented by *Glyphophysa (Glyptophysa)* sp. at LW08 and the terrestrial family Pupillidae represented by three species (**Table 17**).

Table 17 Species of aquatic and terrestrial snails collected at Lake Way (December 2007).

Site	Identification	Authority
LW 01	Pupoides ?adelaidae	(Adams & Angas, 1864)
	Pupoides ?myoporinae	(Tate, 1880)
LW 03	Pupoides ?adelaidae	(Adams & Angas, 1864)
	Pupoides ?myoporinae	(Tate, 1880)
LW 04	Pupoides ?adelaidae	(Adams & Angas, 1864)
LW 05	Pupoides ?adelaidae	(Adams & Angas, 1864)
LW 06	Pupoides ?adelaidae	(Adams & Angas, 1864)
LW 07	Pupoides ?adelaidae	(Adams & Angas, 1864)
LW 08	Glyptophysa (Glyptophysa) sp.	
	Gastrocopta ?larapinta	(Tate, 1896)
LW 09	Pupoides ?adelaidae	(Adams & Angas, 1864)

The aquatic species *Glyptophysa (Glyptophysa)* sp. is a member of the world-wide sinistrally coiled freshwater gastropods of the family Planorbidae. Species of this family are thought to be widespread particularly in inland areas of Australia (Walker 1988; Smith 1992). This family has had very little taxonomic attention at the species level, with most work on the Australian taxa having been at the generic level (Slack-Smith & Wisson, 2008).

The species *Pupoides ?myoporinae* is reported to have a wide but apparently disjunct range in Victoria/southern South Australia and in the south eastern area of Western Australia (Solem 1986). The specimens from Lake Way are tentatively identified as the species *Pupoides myoporinea* since this species exists to the east and west of Lake Way, despite some apparently minor morphological differences (Slack-Smith & Wisson, 2008).

Pupoides ?adelaidae is a dextrally coiled species that has a wide geographic distribution from Victoria to the eastern wheatbelt of Western Australia (Solem, 1986). There are not any published records of this species occurring at Lake Way, however there are records to the east and west of the area (Slack-Smith & Wisson, 2008).

The species *Gastrocopta ?larapinta* is a minute dextrally-coiled species that has a wide but patchy distribution in central Australia (southern part of the Northern Territory), with a few records from the north-west and the east coast of Queensland. Slack-Smith & Wisson (2008) have found the apertural teeth of the Lake Way specimens to be similar to that of *G. larapinta* and different to other species of *Gastrocopta* that may have distributional ranges extending into the Lake Way region. However,

because this record would indicate a substantial range extension southwards for *G. larapinta*, Slack-Smith & Wisson (2008) have only tentatively identified the specimens as belonging to the species.

In summary, Slack-Smith & Wisson (2008) conclude that there is no reason to believe that, at the species level, any of these four molluscan taxa exhibit any degree of short range endemicity, as all are believed to belong to species that occupy wide geographical ranges. The full report is included in Appendix M

6.0 SURVEY LIMITATIONS AND CONSTRAINTS

The EPA (2004) lists a number of possible limitations and constraints that can impinge on the adequacy of fauna surveys. These are reproduced in **Table 18** with an assessment relating to the current survey undertaken by Outback Ecology. A number of factors can influence the design and intensity of a fauna survey. All fauna surveys are limited to some degree by time and seasonal factors, and ideally a number of surveys would be undertaken over a number of years and within a number of different seasons. Nevertheless, all the factors identified by the EPA (2004) were considered in the design of the survey. It is anticipated that this initial survey will be augmented with further sampling in future to provide multi-seasonal data.

No specific formal guidance is available for the survey of terrestrial short-range endemic invertebrates. Moreover, prescriptive survey guidelines, including standard methodologies, have not been established by regulating authorities.

Terrestrial invertebrate sampling of the survey area focussed on mesic (moist) habitats presumed more likely to support short range endemic invertebrate taxa, and the survey used a variety of sampling techniques. Sampling was targeted at very specific invertebrate groups known to display short-range endemism. Results presented in this document were obtained from a single survey only, and an additional survey is likely to be required. In consideration of the target taxa of interest, mygalomorph spiders in particular are known from the region, are typically sedentary, with movement from fixed burrows restricted to specific temperature and humidity conditions. Opportunities for sampling through pit-trapping are therefore restricted. Targeted searches for mygalomorph burrows were undertaken to overcome this constraint.

Table 18 Summary of potential fauna survey constraints

Aspect	Constraint?	Comment Regarding Current Survey
Competency/experience of consultants	No	All members of the survey team were fauna specialists employed by OES, and have many years experience undertaking fauna surveys of this kind in Western Australia. All potential SRE invertebrates will be identified by appropriate experts.
Scope	Limited	All terrestrial vertebrate fauna groups were sampled using well-known and standardised techniques. However, little is known of invertebrate short range endemics and their habitats, and standardised methodologies are not available.
Proportion of fauna identified	Limited	Species area curves suggest further survey intensity during the current survey would not be productive. However, further survey in different seasons would likely increase numbers of species identified. Systematic sampling of the Uramurdah Creekline and Clay Pan was not undertaken.
Information sources (eg historic or recent)	No	Relatively well surveyed bioregion due predominantly to regional surveys and those undertaken for mining operations. Recent work undertaken in relatively close proximity to the survey site.
Further work which might be needed	Limited	Further work in different seasons would record a more accurate picture of the vertebrate fauna assemblage. However, the regional vertebrate fauna is relatively well known. Systematic sampling of the Uramurdah Creekline and Clay Pan is likely to add additional reptile species using these habitats. Waterbird use of the Uramurdah Clay Pan after flooding has not been documented.
Timing / weather / season / cycle	Limited	Timing and season was planned with advice from relevant experts. Temperatures during the first half of the trapping component were below averages expected for the time of year. However, maximum temperatures during the second half of the trapping component exceeded averages, with temperatures of over 34° C. Amphibians were not recorded, probably due to a lack of significant rainfall prior to the survey.
Disturbances	Limited	Cattle grazing, and to a lesser extent kangaroo and rabbit grazing, has impacted the survey area considerably. Frequent fire has also impacted habitats. However, survey results are a reflection of current land management practices.
Intensity	No	1,296 trap-nights and 3,435 minutes of census, inventory, and spotlighting searching is adequate intensity for a first local baseline survey of this type within this IBRA subregion.
Completeness	Limited	Systematic sampling was not undertaken of a large claypan (Uramurdah Clay Pan) and drainage line (Uramurdah Creekline) due to cultural sensitivities regarding ground disturbance. Although inventory sampling was undertaken in these areas systematic sampling would enhance results.
Resources	No	Resources were adequate to carry out the survey satisfactorily. Survey participants were competent in identification of species present. Target SRE invertebrates were collected and identified by specialists.
Remoteness / access problems	No	All representative areas sampled were accessible by 4WD vehicle.
Availability of contextual information	No	Information is available for the IBRA subregion including WAM Faunabase, DEC lists, National Land and Water Resources Audit, as well as other regional fauna surveys.

7.0 CONSERVATION SIGNIFICANCE

7.1 Framework for conservation significance

Fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under Commonwealth and state legislation. At the national level, fauna are protected under the *Environmental Protection and Biodiversity Conservation Act, 1999* (EPBC Act). Within Western Australia fauna can be listed under various Schedules under the *Western Australian Wildlife Conservation Act, 1950.* Definitions of conservation significance are presented in Appendix K.

The International Union for the Conservation of Nature (IUCN) reviews conservation status and lists fauna under various categories (the IUCN Red List). Categories for fauna and their conservation status used under the EPBC Act are those recommended by the IUCN. The *Western Australian Conservation Act*, 1950 uses a set of 'Schedules', but the DEC also classifies species using IUCN categories.

International agreements that Australia has entered into include: the Japan-Australia Migratory Bird Agreement (JAMBA); the China-Australia Migratory Bird Agreement (CAMBA), that coverz migratory species of avifauna, particularly trans-equatorial waders; and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals).

The EPBC Act has lists of migratory species that are recognised under these international treaties. Particular species listed in JAMBA are also protected under Schedule 3 of the Western Australian *Wildlife Conservation Act*, 1950.

The Department of Environment and Conservation (DEC) also recognises species not listed under the Western Australian *Wildlife Conservation Act*, but for which there is some concern, and has produced a supplementary list of 'Priority' fauna. These species as well as those listed in various government-endorsed Action Plans (eg. Duncan, *et al.* 1999; Garnett and Crowley, 2000) are also of recognised significance. Other species of conservation significance include endemics, those with restricted of fragmented ranges, or those that are at the extreme limits of their distribution. Short-range endemic fauna are those with naturally restricted distributional ranges.

The conservation significance of terrestrial vertebrate fauna potentially occurring over the survey area can be assessed at four spatial scales:

- International – National: Species listed under the EPBC Act, IUCN, and International Treaties
- State: Species listed under the Western Australian *Wildlife Conservation Act, 1950*
- Regional: DEC listed Priority Species and species listed in Action Plans
- Local: Species not listed under any Acts or relevant publications, but considered to be of conservation significance due to patterns of distribution.

7.2 Vertebrate species of conservation significance

7.2.1 International, National, State and Regional Significance

The search of the DEC Threatened and Priority Fauna Database identified a number of vertebrate species of conservation significance recorded from the region (*Kwonkan moriartii*, a mygalomorph or trapdoor spider, was also recorded, but is considered in Section 5). Vertebrates identified were:

- Boodie (or Burrowing Bettong) *(Bettongia lesueur)*
- Banded Hare-wallaby *(Lagostrophus fasciatus)*
- Mulgara (*Dasycercus cristicauda)*
- Ghost Bat *(Macroderma gigas)*
- Malleefowl *(Leipoa ocellata)*
- Night Parrot *(Pezoporus occidentalis)*
- Major Mitchell's Cockatoo *(Cacatua leadbeateri)*
- Princess Parrot *(Polytelis alexandrae)*
- Masked Owl *(Tyto novaehollandiae)*
- Australian Bustard *(Ardeotis australis)*
- Bush Stone-curlew *(Burhinus grallarius)*
- Peregrine Falcon *(Falco peregrinus)*
- Striated Grasswren *(Amytornis striatus striatus)*
- Thick-billed Grasswren *(Amytornis textilis textilis)*
- White-browed Babbler (western wheatbelt) *(Pomatostomus superciliosus ashbyi)*
- Giant Desert Skink *(Egernia kintorei)*

Information from the DEC Threatened and Priority Fauna Database was augmented with additional information relating to the likelihood of occurrence of species of conservation significance, based upon other database searches and texts, as well as personal experience of the OES scientists and general patterns of distribution and known habitat preferences. A list was prepared of species of conservation significance with the potential to occur over the survey area (**Table 19**). Table 16 includes several additional species to those identified from the DEC Threatened and Priority Fauna Database. Likelihood of occurrence is then discussed on an individual species basis.

A number of species identified from the DEC Threatened and Priority Fauna Database have not been included in Table 16. Furthermore, species considered regionally extinct, outside their range, or restricted to habitats not present at the survey site, have also been excluded. This includes the Greater Stick-nest Rat, Lesser Stick-nest Rat, Pig-footed Bandicoot, Long-tailed Hopping-mouse, and

Short-tailed Hopping-mouse. In consideration of the DEC Threatened and Priority Fauna Database, other species excluded from Table 16 are:

- Schedule 1: Boodie or Burrowing Bettong *(Bettongia lesueur)*

  A recent record of the Boodie from Wiluna, in 2006, appears on the DEC Database search (Appendix A). Although this species once occurred in the bioregion it is now extinct on the mainland, occurring only on offshore islands. This record appears to be either an anomaly, refers to historical evidence prior to its extinction on the mainland, or refers to warrens or mounds made by this burrowing species that remain visible for many years.

- Schedule 1: Banded Hare-wallaby *(Lagostrophus fasciatus)*

  A record of the Banded Hare-wallaby appears on the DEC Database search (Appendix A) from Peak Hill. This species is now extinct on the mainland, occurring naturally on just two offshore islands at Shark Bay (with an introduction to a third island). Although no date is supplied, this record probably refers to historical evidence prior to the species extinction on the mainland.

- Priority 4: Ghost Bat (*Macroderma gigas)*

  The only record of the Ghost Bat from the DEC Database search is a 'day sighting' from 1961 at Lake Carnegie (Appendix A). The Ghost Bat is known from northern Australia, including the Pilbara and the Kimberley, and it is unlikely that it occurs in the Murchison Bioregion (Churchill, 1998).

- Priority 4: Thick-billed Grasswren (western subspecies) *(Amytornis textilis textilis)*.

  Although identified from the DEC Database search (Appendix A), this species has suffered major reductions in distribution and no longer occurs in the region, with the closest population now located at Shark Bay (Higgins *et al.* 2001). The WA Museum record refers to historical data from 1974.

- Priority 4: White-browed Babbler (western wheatbelt) (*Pomatostomus superciliosus ashbyi)*.

  This DEC Database listing (Appendix A) refers to the population in the southwest of WA (Garnett and Crowley, 2000). Although White-browed Babblers may be present, the survey area is not in the western wheatbelt region that the priority rating refers to, and the species is relatively common in the Murchison Bioregion.

Table 19 Species of International, National, State or Regional conservation significance potentially occurring over the survey area

Group	Name		National	State	Regional	Likelihood of occurrence
Mammals	Mulgara	*Dasycercus cristicauda*	VU	S1		P
	Long-tailed Dunnart	*Long-tailed Dunnart*			P4	U
	Greater Bilby	*Macrotis lagotis*	VU	S1		U
	Southern Marsupial Mole	*Notoryctes typhlops*	VU	S1		U
Birds	Night Parrot	*Pezoporus occidentalis*	EN	S1		U
	Malleefowl	*Leipoa ocellata*	VU	S1		P
	Slender-billed Thornbill	*Acanthiza iredalei iredalei*	VU			P
	Princess Parrot	*Polytelis alexandrae*	VU		P4	U
	Striated Grasswren	*Amytornis striatus striatus*			P4	P
	Australian Bustard	*Ardeotis australis*			P4	L
	Bush Stone-curlew	*Burhinus grallarius*			P4	L
	Major Mitchell's Cockatoo	*Cacatua leadbeateri*		SP		P
	Peregrine Falcon	*Falco peregrinus*		SP		L
	Grey Falcon	*Falco hypoleucos*			P4	P
	Masked Owl	*Tyto novaehollandiae*			P3	U
	Rainbow Bee-eater	*Merops ornatus*	Mig			R
	Fork-tailed Swift	*Apus pacificus*	Mig			L
	Migratory Waders/waterbirds	Various	Mig			L
Reptiles	Great Desert Skink	*Egernia kintorei*	VU	S1		U
	Woma	*Aspidites ramsayi*		SP		U

EN Endangered
VU Vulnerable
S1 Schedule 1

SP Specially Protected
Mig Migratory Species
P# Priority Fauna

R Recorded
L Likely
U Unlikely
P Possible

A targeted search was undertaken over the Centipede project area for Malleefowl in particular but also Mulgara, Greater Bilby, Striated Grasswren, Great Desert Skink or any other species of conservation significance. Dedicated transects were traversed by three people for 210 minutes within suitable habitat (**Figure 5**). Habitat included Mulga Woodland (LW04) and Mulga over Spinifex (LW02). All diggings, tracks, scats and other sign potentially attributed to these species was inspected. Opportunistic searches for Malleefowl mounds were also made during all travelling through the project areas and surrounds during the survey period.

Figure 5 Transects traversed during targeted searches for species of conservation significance over the Centipede project area

A targeted search by one person of approximately 180 minutes was also made for Slender-billed Thornbill in particular, but also, Bush Stone-curlew, and Australian Bustard over the Samphire/Saltbush habitats (LW07) of the Centipede project area. Spotlighting over all sites also focused on nocturnal species of conservation significance.

Apart from the Rainbow Bee-eater no other evidence of species of conservation significance was recorded during targeted searches, inventory searches, spotlighting or other opportunistic sampling.

Mammals

Mammals of conservation significance are known from the bioregion, with the potential to occur over the survey area.

The Mulgara inhabits sandplains dominated by *Triodia sp,* where it burrows between low sand dunes. The Mulgara was not recorded during the survey. It is infrequently recorded, in part due to boom-bust cycles, contracting to core habitat areas in lean times, and expanding rapidly after favourable conditions prevail (Gibson and McKenzie, 2005). The Threatened and Priority Fauna Database contains records of Mulgara from Kumarina, Jundee Minesite, Wanjarri Nature Reserve, Barwidgee Station, Mt Keith Mine Site, and Honeymoon Well (Appendix A). Most of these sites are within 100 km of the survey area, with the closest within 25 km (Honeymoon Well). The area immediately to the

east and south of the survey area incorporating the Pastoral Leases of Barwidgee, Jundee, and Mt Keith are known to support Mulgara. Recent records have been made, (including OES, 2008a), and on-going monitoring and management of populations is undertaken (Pearson, *et al.* 2005).

The Mulgara was not recorded during the survey. Although spinifex habitat is present, it predominantly occurs as an understorey of Mulga and/or Mallee (Sites LW02 and LW05); not the almost pure stands of spinifex with little overstorey apparently preferred by this species (Gibson and Cole,1992; Maxwell *et al.* 1996; HGM, 1997). Additionally, the degraded nature of spinifex habitats in terms of frequent fire and cattle grazing is not conducive to supporting this species. Nevertheless, although core habitat does not occur for this species over the survey area, given that populations are known to occur in the vicinity it is possible that this species may disperse through the survey area from time to time.

The Long-tailed Dunnart has been collected intermittently in various locations primarily to the north and east of the survey area (FaunaBase, 2007). It occurs in rocky habitats (Strahan, 2002) and may be rarely captured due to the difficulties of installing pit traps in these areas. Suitable habitat is not present over the survey area and this species is unlikely to occur.

The Greater Bilby once occurred in the region and a WA Museum record exists for the species north of Wiluna in 1985. However, in WA it now only occurs in areas of the Gibson and Great Sandy Deserts south to Warburton, the Pilbara and Dampierland Bioregions, as well as the Kimberley (FaunaBase, 2007; Pavey, 2006). It is unlikely that the Bilby still survives in the East Murchison sub-region and it is unlikely to be present over the survey area as it is well outside of its known distribution.

The Southern Marsupial Mole was identified by NLWRA (2002) (Appendix E) as occurring in the East Murchison sub-region. This species occupies arid areas immediately east and north of the survey area, living underground in sand dunes, inter-dunal flats and sandy soils along river flats. The Southern Marsupial Mole is unlikely to occur over the survey area due to the site being outside of its known distribution, and lack of suitable habitat.

Birds

Birds of conservation significance are known from the bioregion, with the potential to occur over the survey area.

The Night Parrot is only very rarely recorded. Although it has been associated with hummock grasslands in the past, particularly dense clumps of mature spinifex, its preferred habitat appears to be samphire flats and saltbush associated with salt lake systems (Blakers *et al.* 1984; Higgins, 1999), or a juxtaposition of mature spinifex and chenopod habitats (FMG, 2005). No large, mature, spinifex occurs over the survey due to regular burning, and spinifex/saltbush/samphire communities have

been heavily grazed. A record from the Little Sandy Desert over 200 km to the northeast of the survey area is included in the DEC database search (Appendix A). However, the majority, and more recent, records for the Night Parrot are from the Pilbara and the species is not expected to occur over the survey area.

The Malleefowl is a ground-dwelling bird that builds large and distinctive mounds of soil and litter within which its eggs are incubated. The Malleefowl's distribution includes the survey area (Blakers *et al.* 1984; Barrett, *et al.* 2003), which is close to the historical northern limit of its range, but its current range is now predominantly to the south and west (Marchant and Higgins, 1993). Nevertheless, relatively recent regional records have been made since 1990 (Appendix A) including at Wiluna, as well as from Lake Carnegie and Earaheedy to the east, Wanjarri Nature Reserve, Yandal Station, and Mt Keith to the south and Yeelirrie and Atley to the southwest. This rare species could still occur in the habitats present, particularly Mulga communities, and if so would be close to the edge of its current distribution.

No Malleefowl, or their distinctive mounds, were recorded during the survey, including during targeted searches (Figure 4), and it appears that this bird no longer occurs over the survey area. The Malleefowl favours long unburnt shrubland habitat and frequent fire and heavy grazing by cattle are likely to have compromised habitat suitability for this species. Nevertheless, it is possible that if regional abatement of threatening processes was implemented (relating to fire management, grazing control and feral predator control) this bird may re-colonise the survey area.

The Slender-billed Thornbill's preferred habitat is saltbush communities and samphire flats associated with salt lake systems. Habitat occurs over the survey area and although targeted searches failed to record this species, it is possible that the Slender-billed Thornbill still occurs. The survey area is on the northeast distributional boundary for this species (Higgins and Peter, 2002), and although in a degraded condition habitat is present. Although listed Federally, as well as in South Australia and the Northern Territory, this species is not listed in under Western Australian legislation and it is thought that populations in northern South Australia and east of the Flinders Ranges, and possibly those that occur north-west of Lake Gairdner, are most likely to be in decline (DEW-SPRAT, 2007).

The Princess Parrot is an inhabitant of lightly wooded country of desert areas to the east of the survey area; from the Great Sandy Desert, through the Gibson Desert and into the Great Victoria Desert. A record from Kumarina close to the western edge of the Little Sandy Desert, over 220 km to the north of the survey area, is included in the DEC database search (Appendix A). A single record also exists for Wanjarri Nature Reserve in 1964 (Higgins, 1999). However, the survey area is outside the core range of this species, suitable habitat of swales between sand dunes or savannah woodland is not present, and the species is unlikely to occur.

The Striated Grasswren occurs in spinifex communities, with or without an overstorey of shrubs, on sandy or loamy plains. The species once occurred in the vicinity of the survey area and two relatively old records from 1979 and 1987 are contained within the Threatened and Priority Fauna Database from Wanjarri Nature Reserve, as well as two from the Little Sandy Desert (Appendix A), where it now occurs as scattered but widespread populations (Higgins, *et al.* 2001). Although this species was not recorded during the survey, habitat occurs over the survey area (LW02, LW05). If the species were to occur it would be at the southern and western edge of its primary range.

The Australian Bustard and Bush Stone-curlew occur on plains in the region. The DEC Threatened and Priority Fauna Database contains 15 records of the Australian Bustard, including from Wiluna and Lake Violet and one record of the Bush Stone-curlew from Mt Keith (Appendix A). Both these species have wide distributions across Australia and habitat occurs over the survey area. Introduced predators impact on recruitment of these ground-nesting birds, and changed fire regimes influence availability of food sources. Although neither species was recorded during the survey, the survey area is within the distribution of both species, suitable habitat occurs, and both birds are likely to be present, at least intermittently.

The Major Mitchell Cockatoo's distribution is both patchy and disjunct. Although the survey area lies outside the species distribution as identified by Johnstone and Storr, (1998), Higgins (1999) shows the survey area on the edge of its range and a DEC threatened fauna database record exists from just east of Wiluna in 1967 (Appendix A). It may be possible that this species occurs over the survey area from time-to-time. Its preferred habitat of open woodland is not widespread over the survey area, however, eucalypts associated with claypan, drainage line and eucalypt woodland offer the structural elements required.

The Peregrine Falcon is widespread in Australia, but requires specific nesting sites. It does not build a nest and requires cliffs, rocky outcrops, or large tree hollows. The species is highly mobile and is likely to occur over the survey area from time-to-time. Large eucalypts occur over the survey area surrounding Uramurdah Clay Pan (LW08), offering potential breeding habitat.

Similarly, the Grey Falcon has a very broad but scattered distribution across northern and eastern Australia and prefers larger creeklines supporting River Red Gums and often nests in eucalypts along watercourses. The southern distribution of the Grey Falcon is immediately to the north and east of the survey area in the vicinity of Lake Carnegie (Johnstone, 1998; Marchant and Higgins, 1993). However, the species is highly mobile and may occur over the survey area from time-to-time.

Athough the Masked Owl in Western Australia is primarily found in the southwest, scattered records have been made in the arid zone including at Yandil Station, 50 km northwest of the survey area (Higgins, 1999), as well as unconfirmed sightings from Wanjarri Nature Reserve (Higgins, 1999). A record of the Masked Owl also occurs on the DEC Database from the Canning Stock Route in 1942

(Appendix A). The reliability of records has been compromised due to confusion with the more common Barn Owl. Given that the survey area is far from this species' core distribution, the few and scattered regional records, and the lack of suitable woodland habitat over the survey area it is unlikely that this species is present. Similarly, although the Barking Owl was recorded by Birds Australia in the Murchison Bioregion, this is outside of its usual range (Johnstone and Storr, 1998).

The Rainbow Bee-eater and Fork-tailed Swift are federally-listed migratory species likely to occur over the habitats of the survey area. The Rainbow Bee-eater was recorded during the survey at Site LW08. It occupies numerous habitats, including open woodlands with sandy loamy soil, sandridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Pizzey and Knight, 1998). The Fork-tailed Swift is an aerial species that would overfly the survey area without specifically utilising the habitats present.

There have been few records of waders and waterbirds directly using Lake Way, and none were recorded during this survey. Commonwealth database searches (Appendices C and D) identified the Oriental Plover and Great Egret as listed as either migratory and/or marine under the EPBC Act and potentially occurring over the search area. However, many more are likely (Jaensch and Vervest, 1990). The Birds Australia database (Appendix F) lists at least 14 species, predominantly from the genera *Calidris* and *Tringa* that, although having a 'low' reporting status in the bioregion, potentially occur intermittently. The majority of members from these genera are migratory waders that breed in northern latitudes. Most are coastal, but some species will also utilise inland waters. It is the latter group of species that potentially occurs over the survey area. It appears that no waterbird species of conservation significance permanently inhabits Lake Way (Bancroft and Bamford, 2004). Migratory waders arrive during the summer and depart during the winter to breed in northern latitudes. Significant summer rainfall, or persistent surface water during this time, is likely to attract these species to Lake Way. Few data are available, but after the passage of cyclone Ilona in 1988, Red-necked Avocets, Silver Gulls and Gull-billed Terns were confirmed breeding (Bancroft and Bamford, 2004) in the area.

Bancroft and Bamford (2004) and OES (2005b) reviewed wetland avifauna use of the lake and concluded that in periods of flood Lake Way has the potential to support up to 47 species of waterbird, including up to 18 species listed as either migratory and/or marine under the EPBC Act. **Table 20** summarises EPBC Act listed species with the potential to occur over the survey area after periods of inundation.

Table 20 Waterbirds and waders listed under the EPBC Act as either migratory or marine potentially utilising habitats of the survey area

Species					Migratory Listed	Marine Listed
	Musk Duck	*Biziura lobata*				x
	Nankeen Night Heron	*Nycticorax caledonicus*				x
	Great Egret	*Ardea alba*			x	x
	Straw-necked Ibis	*Threskiornis spinicollis*				x
	Buff-banded Rail	*Gallirallus philippensis*				x
	Baillon's Crake	*Porzana pusilla*				x
*	Common Greenshank	*Tringa nebularia*			x	x
*	Wood Sandpiper	*Tringa glareola*			x	x
*	Common Sandpiper	*Actitis hypoleucos*			x	x
*	Red-necked Stint	*Calidris ruficollis*			x	x
*	Sharp-tailed Sandpiper	*Calidris acuminata*			x	x
*	Curlew Sandpiper	*Calidris ferruginea*			x	x
	Black-winged Stilt	*Himantopus himantopus*	#			x
	Red-necked Avocet	*Recurvirostra novaehollandiae*	#	B		x
	Red-capped Plover	*Charadrius ruficapillus*	#	B		x
*	Oriental Plover	*Charadrius veredus*			x	x
	Australian Pratincole	*Stiltia isabella*				x
	Silver Gull	*Larus novaehollandiae*	#	B		x
	Gull-billed Tern	*Sterna nilotica*	#	B		x
	Whiskered Tern	*Chlidonias hybridus*	#			x

* Non-breeding migrants
\# Recorded from site
B Breeding record

Reptiles

Reptiles of conservation significance are known from the bioregion, with the potential to occur over the survey area.

The Great Desert Skink occurs on red sandplains and sand ridges supporting spinifex predominantly to the east of the survey area (Pearson *et al.* 2001). Nationally, current strongholds for the Great Desert Skink appear to be the Tanami Desert, Uluru and an area of the Gibson Desert north of Warburton. Although the precise distribution of this species is likely to remain uncertain, three main populations appear to occur in WA; at Patjarr (240 km northwest of Warburton), the vicinity of Lake MacKay, and Rudall River National Park. In the past, the species has been collected from Kathleen Valley, approximately 100 km south of the survey area. Evidence of this species was not obtained during the survey, including during targeted searches, and given the lack of suitable habitat and the survey area being outside of the species current core distribution, it is unlikely that the Great Desert Skink occurs.

The Woma occurs throughout arid zones of Australia with a disjunct south-west population in Western Australia that is now very rare (and may be taxonomically differentiated from the desert 'form'). In the more arid zones, the Woma favours open myrtaceous heath on sandplains, and dunefields dominated by spinifex. In the south-west it also appears to favour sandplain habitats (Storr *et al.* 2002), though few records exist. The survey area is situated outside of the northern limit of the south-west distribution and it is unlikely that this species occurs.

7.2.2 Local Significance

Although not a threatened species, the Spotted Mulga Snake (*Pseudechis butleri)* is listed by the NLWA (2002) as endemic to the bioregion and, although not recorded, has the potential to occur over the survey area within Mulga Woodland. Reptile species complexes within which taxonomy is unresolved include the genera *Heteronotia, Cryptoblepharus*, and *Menetia.*

7.3 Short-range Endemic Invertebrates

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale (Allen *et al.* 2002). Factors affecting endemism through influencing distribution, speciation and differentiation appear to be: the taxon's life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions and historical environmental conditions (Allen *et al.* 2002; EPA, 2004; Ponder and Colgan, 2002; Harvey, 2002).

'Short-range endemism' refers to taxa with naturally restricted distributional ranges. The definition of what constitutes 'restricted ranges' varies from species to species, however the definition proposed by Harvey (2002) is of an area less than 10,000 km². These taxa are also characterised by poor dispersal, reliance on discontinuous habitats, low growth rates, often seasonally influenced activity in wetter months, and often exhibit low fecundity (Harvey, 2002). The restriction of a taxon's distribution to a specific area is often most greatly influenced by a prominent physical barrier preventing migration between adjacent populations of the same taxon.

Short-range endemic (SRE) fauna in Australia are dominated by invertebrate species, which have undergone little investigation to date. Terrestrial invertebrate groups that possess attributes associated with short-range endemism include: terrestrial molluscs, mygalomorph spiders, myriopods, scorpions and pseudoscorpions.

While species' habitat preferences vary, there are several common habitat factors favoured by the targeted groups. Primarily, more mesic areas are preferred, as they offer protection from heat, desiccation and predators, and provide a source of moisture. Examples of such habitats at a broad scale include gorges, rocky ranges and ridges (particularly those that face south or southeast and/or near water supplies), as well as rivers and creeklines. Such areas are more likely to provide the habitat attributes required for these species. Over the survey area the mesic qualities of the

Uramurdah Clay Pan and Uramurdah Creekline at the Lake Way project area are more likely to offer the habitat attributes required at the local scale than other habitats present.

Some better-known invertebrate species, not necessarily with short-range endemic attributes, have been listed as threatened under state or Commonwealth legislation. The DEC threatened and priority species database search (Appendix A) includes the Priority 2 mygalomorph spider *Kwonkan moriartii* (Main 1983) that was collected from Kathleen Valley, approximately 100 km south of the survey area. However, this species was not found at Lake Way during the December 2008 survey.

Since short range endemic invertebrates have attracted little attention to date, there is a considerable level of uncertainty in regard to their taxonomy and identification. For Mygalomorph spiders Main (2008) was able to place many of the spiders found during the recent surveys into their appropriate genera and some could be placed into groups within those genera e.g. *Aname* and *Aganippe*. However, it is not possible to be more certain in regard to their detailed taxonomy. In regard to short range endemism, Main (2008) concludes that the *Aganippe* species and the *Eucyrtops* species from the Idiopidae family may not be widespread in their distribution (Main 2008).

Dr Mark Harvey identified specimens of pseudoscorpions, scorpions and centipedes. Harvey (2008) comments on their distribution were that none of the specimens collected could be considered as short range endemic, with most being widely distributed in the semi-arid zone of Western Australia. This is with the exception of two scorpion species form the genus *Urodacus* which are currently listed as the type specimens 'Lakeway 1' and 'Lakeway 2'. This genus is currently under review by Erich Volschenk (Ecologia Environmental) and the taxonomy is uncertain.

Specimens of molluscs collected during the survey were found to belong to four species. These species were tentatively identified as *Glyptophysa (Glyptophysa)* sp., *Pupoides ?myoporinae, Pupoides ?adelaidae* and *Gastrocopta ?larapinta*. Slack-Smith & Wisson (2008) concluded that there is no reason to believe that, at the species level, any of these four molluscan taxa exhibit any degree of short range endemicity, as all are believed to belong to species that occupy wide geographical ranges.

7.4 Significant Habitats

State and National Significance

Habitats which are site- or type-specific and possess high ecological value are of state significance. Habitats which exhibit such a level of significance may contain either specific habitat-dependent fauna or high biodiversity and are poorly represented elsewhere. If a habitat is poorly represented in conservation reserves, its conservation significance is increased.

Habitat that is considered critical to the survival of a Federally-listed threatened species or threatened ecological community can be entered by the Australian Government Minister for Environment and

Water Resources onto a register of critical habitat. Habitat listed in the register in relation to a species or ecological community is critical habitat for the species or ecological community.

No critical habitat is located over the survey area, and no World Heritage Properties, Ramsar Wetland Sites or Nationally Important Wetland sites are in the vicinity (Appendices C and D). However the Murchison bioregion includes many important salt lake wetlands such as the Lake Carnegie System, Lake Barlee, Lake Ballard and Lake Marmion, all of which have been listed by the Commonwealth Government Department of the Environment, Water, Heritage and the Arts (DEWHA) in the Directory of Important Wetlands in Australia. In addition, Wooleen Lake, Lake Barlee, and Aneen Lake also qualify as refugia in semi-arid Australia (Morton, *et al.* 1995) (Appendix H). Recognised values of these wetlands include the importance to waterbirds. For example, Lake Barlee is an intermittent salt lake where up to 200,000 pairs of Banded Stilt *(Cladorhynchus leucocephalus)* may breed when the lake is in flood (Burbidge and Fuller 1982).

The closest wetland of significance to Lake Way is the Lake Carnegie System, approximately 70 km west of the survey area, which is listed in the Directory of Important Wetlands in Australia.

Local Significance and Sensitive Habitats

All of the broad terrestrial fauna habitat types identified over the survey area are represented elsewhere in the bioregion, and none are considered of regional significance.

The landscape within which the survey area is situated is subject to frequent burning and cattle grazing. Inappropriate fire regimes have been recognised as a major threatening process in the Bioregion (NLWRA, 2002). Habitats that provide refuge against frequent fire are important for the maintenance of biodiversity in such a landscape. For example, short-range endemic species including invertebrates are more likely to be associated with more mesic areas, as they offer protection from heat, desiccation and predators, and provide a source of moisture.

The Uramurdah Clay Pan and Uramurdah Creekline at the Lake Way project area offer important habitat attributes at the local scale. The Uramurdah Clay Pan supports large eucalypts (**Plate 13**) with hollows that provide sheltering and nesting sites for many species of birds and reptiles, as well as many bat species. Although little information is available, after a period of inundation the Uramurdah Clay Pan is likely to be a significant breeding site for birds, including waterbirds. The linear configuration of drainage lines and their more mesic characteristics support dual roles as both fire refuges and routes for immigration and emigration in a landscape subject to frequent fire. Uramurdah Creekline provides such a corridor entering Lake Way. Claypan and creekline habitats provide mesic qualities that are important to a wide range of fauna. Although not permanently saturated, the underlying soil of these habitats is likely to possess higher moisture content than surrounding areas, and provide the conditions that burrowing fauna such as Leptodactylid frogs and the Flat-shelled Turtle *(Chelodina steindachneri)* require to survive drought. More persistent moisture also promotes denser and more diverse vegetation that provides shelter and food for a range of fauna.

Plate 13 Large eucalypts surrounding Uramurdah Clay Pan (left) and the associated Uramurdah Creekline and floodplain (right)

Melaleuca groves along the edge of Lake Way (**Plate 14**) are disjunct at the local scale and offer shelter and breeding sites for a range of vertebrate fauna. This habitat recorded very low species

richness and abundance during the survey, probably due to its degraded state from continual use as a shelter and feeding site by kangaroos, livestock, and rabbits. The dense nature of the canopy, structural niches of hollows and crevices, and linear configuration offer important shelter requirements for fauna in an arid environment, including breeding sites for birds. Although degraded, the use of this habitat by feral and native animals demonstrates its important shelter attributes.

Plate 14 Melaleuca groves at the Centipede project area (left) and an example shelter and structural niches of hollows and crevices (right)

Samphire flats and adjacent saltbush communities associated with the Lake Way (**Plate 15**) are disjunct at the regional scale and provide intermittent habitat for waterbirds, and are therefore considered at least locally significant. This includes Abercrombie Creek over the Centipede project area, which possesses attributes similar to the Lake Way samphire flats, and from a habitat perspective could be considered an extension of that system. (Conversely, Uramurdah Creekline and floodplain at the Lake Way project area is a discrete habitat over the survey area.) Samphire flats and saltbush communities support other fauna of conservation significance such as the Slender-billed Thornbill, Bush Stone-curlew, and Australian Bustard, and are particularly prone to impacts from grazing pressures, due to the palatability of the vegetation.

Plate 15 Samphire habitat over the Abercrombie Creekline at the Centipede project area (left) and the same habitat on the edge of Lake Way (right)

8.0 IMPACTS TO FAUNA POPULATIONS

8.1 Current Impacts and Habitat Condition

Threatening impacts have been analysed for the Murchison Bioregion by the National Land and Water Audit (NLWA, 2002). Ecosystems and species at risk are currently subject to a large number of threatening processes, and the trend is not known in many cases. Impacts identified in the bioregion by the audit include: changed fire regimes, grazing pressure, feral animals, weeds and vegetation clearing. These factors are deemed to be causing a general loss of soil fertility and vegetation cover in the bioregion, with a consequent loss of native species.

Terrestrial vertebrate species at risk within the bioregion have also been identified (Appendix E) and specific threats to viability described by the audit (**Table 21**).

Table 21 Vertebrate species 'at risk' by NLWA (2002) within the MUR1 subregion, and their threatening processes

Species name	Threatening processes	Threatening processes notes
Great Desert Skink *Egernia kintorei*	Changed fire regimes	No data
	Feral animals	Foxes and cats
Western Slender-billed Thornbill *Acanthiza iredalei iredalei*	Changed fire regimes	No data
Princess Parrot *Polytelis alexandrae*	Grazing pressure	No data
Malleefowl *Leipoa ocellata*	Feral animals	Foxes and cats
	Firewood collection	No data
	Grazing pressure	No data
Mulgara *Dasycercus cristicauda*	Changed fire regimes	No data
	Feral animals	Foxes and cats
Greater Bilby *Macrotis lagotis*	Changed fire regimes	No data
	Feral animals	Foxes
Southern Marsupial Mole *Notoryctes typhlops*	Changed fire regimes	No data
	Feral animals	Foxes and cats

Specific threats to terrestrial vertebrates in general identified in the bioregion (NLWA, 2002) include:

- Feral predators (cats and foxes);
- Changed fire regimes; and
- Vegetation fragmentation.

Although vegetation clearing is not significant in the region, vegetation and habitat fragmentation can occur through degradation of habitats, for example through the effects of over-grazing. Habitats over the survey area are currently in poor condition. The survey area is currently being used for pastoral purposes and the effects of stock grazing combined with drought are evident across all habitats. The

impacts of weeds on fauna habitats appear to be minimal, however, to be properly assessed a survey would need to be undertaken after significant rainfall.

Inappropriate fire regimes for biodiversity outcomes are currently affecting the survey area. Although no recent fires have occurred, vegetation structure is indicative of frequent widespread fire. This is manifest in even-aged spinifex communities, lacking large hummocks, and recent coppicing of mallee communities. Inappropriate fire regimes, and frequent broadscale fires in particular, can simplify vegetation communities and lead to reduced heterogeneity of the landscape. Reduced shelter from frequent burns also leads to greater impacts on ground fauna from introduced predators.

8.2 Potential Impacts of Proposal and General Management Guidelines

Species of conservation significance are likely to occur over the survey area, at least intermittently. However, development concepts for the Toro Energy project over Lake Way are in their infancy, and impacts to vertebrate fauna at this stage cannot be fully quantified.

For short range endemic invertebrates, the level of uncertainty in regard to taxonomy and identification has made it difficult to evaluate the potential impact of the mining development. However, from identifications made to date, it does not appear that any of the specimens collected belonged to species unique to the Lake Way and Centipede tenements. Additionally, there does not appear to be any relictual or fragmented habitat that would have potential for the formation of localised endemism. Any uncertainty in taxonomy and species distributions is more likely a result of the lack of surveys conducted on the taxa sampled and the lack of taxonomic reviews.

Resource deposits at Lake Way and Centipede are located on the edge of the Lake Way playa and clearing within this fringing vegetation habitat will be required. Some clearing within Mulga communities will also be required for infrastructure. Potential adverse impacts on fauna or the habitats that support fauna may arise from the aspects of the Lake Way uranium mining project:

- Development of shallow open pits required to access the ore body
- Dewatering of pit areas prior to mining below the local water table
- Diversions to Uramurdah and Abercrombie Creeklines
- Development of a mining camp
- Associated mine plant and infrastructure
- Linear infrastructure, such as roads and service corridors
- Effects of noise and dust
- Potential to introduce weeds and increase populations of exotic species
- Secondary impacts, such as off-road vehicles, increased access, and increased risk of fire

General Management Guidelines

The management guidelines below are general in nature and are suggested to minimise potential impacts to the terrestrial vertebrate fauna of the survey area:

- Reduce vegetation clearance to an absolute minimum.
- Minimise alterations to surface hydrology by avoiding drainage features wherever possible. Avoid primary and/or secondary impacts to Uramurdah Clay Pan in particular. Assess surface water and groundwater impacts to this feature and mitigate if required.
- Progressively rehabilitate pits to an appropriate standard. Ensure Uramurdah and Abercrombie Creeklines are restored to a standard that can replicate fauna habitat attributes.
- Assess the likely impact of dewatering and any groundwater drawdown on vegetation.
- Discourage the establishment of any artificial water supplies and assess the likely impact of the mine dewatering program and any groundwater drawdown on waterbirds and migratory waders.
- Implement dust suppression methods across the survey area, particularly during construction but also during operation, to reduce impacts of dust on surrounding vegetation.
- Prevent the establishment of new weed species, and the further spread of existing weed species.
- Develop strategies to reduce the likelihood of increased populations of feral animals, such as appropriate refuse management.
- Consider the preparation and implementation of a succinct Fire Management Plan, not only to reduce the risk of unplanned fire emanating from the survey area, but also to mitigate against wildfire from off-site ignition sources.

9.0 STUDY TEAM

The Lake Way Fauna Survey was conducted by:

Mr Andre Schmitz	B.App.Sc. Env. Man.	Senior Environmental Scientist
Ms Brooke Hay	B.Sc. Zool.	Biologist
Mr Paul Bolton	B. Sc (Hons)	Biologist (Short-range Endemics)

The Lake Way Fauna Survey (vertebrates and invertebrates) was conducted under the following Licence issued by DEC:

- Licence to Take Fauna for Scientific Purposes (Regulation 17) – Licence No: SF006066
  - Date of issue: 24/09/2007
  - Date of expiry: 30/11/2007
  - Valid from: 24/09/2007

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Appendix A

Search Results of the Threatened Fauna Database held by the Department of Environment and Conservation

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

Schedule 1 - Fauna that is rare or is likely to become extinct

* Date	Certainty	Seen	Location Name	Method
Bettongia lesueur lesueur			**Boodie (Shark Bay)**	*1 records*
This species is the only macropod that lives on a regular basis in burrows of its own construction.				
2006	1	0	Wiluna	Diggings
Dasycercus cristicauda			**Mulgara**	*201 records*
This small carnivorous marsupial lives in burrows and occurs in arid sandy regions from the eastern Pilbara to central Australia.				
1993	1	20	Kumarina	
1993	1	1	Kumarina	Caught or trapped
1993	1	8	Kumarina	Caught or trapped
1993	1	2	Kumarina	Caught or trapped
1993	1	7	Kumarina	Caught or trapped
1994	1	4	Kumarina	Caught or trapped
1994	1	2	Kumarina	Caught or trapped
1994	1	5	Kumarina	Caught or trapped
1994	1	7	Kumarina	Caught or trapped
1994	1	1	Kumarina	Caught or trapped
1994	1	6	Kumarina	Caught or trapped
1994	1	6	Kumarina	Caught or trapped
1995	1	2	Jundee Mine Site	Caught or trapped
1996	1	1	Jundee Mine Site	Caught or trapped
1996	1	1	WANJARRI NATURE RESERVE	Caught or trapped
1997	1	2	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	7	Mt Keith	Caught or trapped
1997	1	6	Mt Keith	
1997	1	1	Mt Keith	Caught or trapped
1997	1	1	Mt Keith	Caught or trapped
1997		2	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1998	1	1	Mount Keith Mine Site	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Day sighting
1998	1	1	Barwidgee	Caught or trapped
2002	1	1	Kumarina	Caught or trapped
2002	1	1	Kumarina	Caught or trapped
2002	1	1	Kumarina	Caught or trapped
2002	1	1	Kumarina	Caught or trapped

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2002	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
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	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method
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	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2003	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Kumarina	Caught or trapped
	2004	2	0	Kumarina	Diggings
	2004	1	1	Kumarina	Caught or trapped
	2004	1	1	Sir Samuel	Caught or trapped
	2004	1	1	Sir Samuel	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2005	1	1	Kumarina	Caught or trapped
	2006	1	0	Kumarina	Definite signs
	2006	1	1	Kumarina	Caught or trapped
	2006	1	1	Kumarina	Caught or trapped
	2006	1	2	Kumarina	Caught or trapped
	2006	1	1	Kumarina	Caught or trapped
	2006	1	2	Honeymoon Well	Night sighting
	2006	1	1	Honeymoon Well	Caught or trapped
	2006	1	1	Honeymoon Well	Caught or trapped
	2006	1	1	Honeymoon Well	Night sighting
	2006	1	1	Honeymoon Well	Caught or trapped
	2006	1	1	Honeymoon Well	Caught or trapped
	2007	1	1	Honeymoon Well	Caught or trapped
	2007	1	1	Honeymoon Well	Caught or trapped
	2007	1	1	Honeymoon Well	Caught or trapped
	2007	1	1	Honeymoon Well	Caught or trapped

Lagostrophus fasciatus fasciatus **Banded Hare-wallaby** *1 records*

This small macropod occurs in low shrubland and extant populations occur on Bernier and Dorre islands in Shark Bay. An attempted reintroduction to Peron Peninsula showed that the species is highly vulnerable to predation from cats as well as foxes.

*	Date	Certainty	Seen	Location Name	Method
		2		Peak Hill	Day sighting

Leipoa ocellata **Malleefowl** *10 records*

This species was once widely distributed across southern Australia. It prefers woodland or shrubland with an abundant litter layer that provides essential material for the construction of its nest mound.

*	Date	Certainty	Seen	Location Name	Method
	1974	1	1	Little Sandy Desert	Day sighting
	1984	2		Yeelirrie	
	1995	1	1	Atley	

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method
	1997	1	1	WANJARRI NATURE RESERVE	Tracks
	1997	1	1	WANJARRI NATURE RESERVE	Tracks
	1998	1	1	Earaheedy station	Day sighting
	1998	1	1	Lake Carnegie	Day sighting
	1998	1	1	Mount Keith	Day sighting
	2001	1	2	Yandal Station	Day sighting
	2006	1	0	Wiluna	Tracks

Pezoporus occidentalis — Night Parrot — *1 records*

This nocturnal species is known to inhabit treeless or sparsely wooded spinifex (Triodia spp) near water.

1979	2	1	Little Sandy Desert	

Egernia kintorei — Giant Desert Skink — *1 records*

A burrowing species of skink found in a variety of desert habitats on sandy, clay and loamy soils.

1964	1	1	Kathleen	Caught or trapped

Schedule 4 - Other specially protected fauna

Falco peregrinus — Peregrine Falcon — *4 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

1974	1	1	Poison Creek	Day sighting
1998	1	2	Little Sandy Desert	Day sighting
1999	1	2	Little Sandy Desert	Day sighting
2001	1	1	Little Sandy Desert	Day sighting

Cacatua leadbeateri — Major Mitchell's Cockatoo — *1 records*

This species is sporadically distributed through arid and semi-arid Australia and may occur in sparsely timbered grasslands and shrublands and rocky outcrops.

1967	2		Millrose	Day sighting

Priority Two: Taxa with few, poorly known populations on conservation lands

Kwonkan moriartii — Kwonkan moriartii — *2 records*

There is very little information for this species except that the single record in the search area represents the holotype specimen collected in 1962.

1962	1	1	Kathleen	
1962	1	1	Kathleen	

Priority Three: Taxa with several, poorly known populations, some on conservation lands

Tyto novaehollandiae novaehollandiae — Masked Owl (SW ssp) — *1 records*

This species is an inhabitant of forests and woodlands, nests in tree hollows and has declined in the south-west. Its large talons are adapted for preying on small to medium sized mammals.

1942	2	1	Canning Stock Route	Night sighting

Priority Four: Taxa in need of monitoring

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	Date	Certainty	Seen	Location Name	Method

Macroderma gigas — Ghost Bat — *1 records*

This species is Australia's only carnivorous bat and has a patchy distribution across northern Australia. It shelters in caves, mine shafts and deep rock fissures and is sensitive to disturbance.

1961	1	1	Lake Carnegie	Day sighting

Ardeotis australis — Australian Bustard — *15 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

1974	1	4	Lake Violet	Day sighting
1974	1	2	Sandstone	Day sighting
1982	1	4	Wiluna	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	2	Wanjarri Nature Reserve	Day sighting
1985	1	2	Wanjarri Nature Reserve	Day sighting
1985	1	1	Wanjarri Nature Reserve	Day sighting
1987	1	2	Wanjarri Nature Reserve	Day sighting
1998	1	1	Little Sandy Desert	Day sighting
1999	1	1	Little Sandy Desert	Dead
1999	1	1	Little Sandy Desert	Day sighting
2000	1	3	Little Sandy Desert	Day sighting
2001	1	1	Little Sandy Desert	Day sighting

Burhinus grallarius — Bush Stonecurlew — *1 records*

A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.

1985	1	10	Mt Keith	

Polytelis alexandrae — Princess Parrot — *1 records*

Little is known about this species as its occurrence is sporadic through the arid interior. Occurs on red desert sandplains and dunes and along tree-lined watercourses.

1919	2	2	Kumarina	Day sighting

Amytornis striatus striatus — Striated Grasswren — *4 records*

This subspecies of Striated Grasswren inhabits spinifex on sandhills and rocky hillslopes and may occur in the area in question.

1979	1	1	Wanjarri Nature Reserve	Caught or trapped
1987	1	1	Wanjarri Nature Reserve	Day sighting
1990	1	1	Little Sandy Desert	Day sighting
1991	1	1	Little Sandy Desert	Day sighting

Amytornis textilis textilis — Thick-billed Grass-wren (western ssp) — *1 records*

This species inhabits shrubland, preferring the denser vegetation along drainage depressions.

1974	1	5	Wiluna	Day sighting

Pomatostomus superciliosus ashbyi — White-browed Babbler (western wheatbe — *1 records*

This species of bird lives in eucalypt forests and woodlands, and forages on or near the ground for insects and seeds.

25.034 °S 118.871 °E / 28.3067 °S 122.069 °E Lake Way area, Wiluna

*	*Date*	*Certainty*	*Seen*	*Location Name*	*Method*
	1978	1		Millbillillie	Day sighting

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Appendix B

Search Results of the Western Australian Museum's Faunabase

Amphibia collected between -25.1047, 118.7776 and -28.1929, 121.832

Hylidae
Cyclorana maini
Cyclorana platycephala
Litoria rubella

Myobatrachidae
Limnodynastes spenceri
Neobatrachus aquilonius
Neobatrachus centralis
Neobatrachus kunapalari
Neobatrachus sutor
Neobatrachus wilsmorei
Notaden nichollsi
Pseudophryne occidentalis

Reptiles collected between -25.1047, 118.7776 and -28.1929, 121.832

Agamidae
Caimanops amphiboluroides
Ctenophorus caudicinctus
Ctenophorus caudicinctus infans
Ctenophorus caudicinctus mensarum
Ctenophorus fordi
Ctenophorus isolepis gularis
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus ornatus
Ctenophorus reticulatus
Ctenophorus salinarum
Ctenophorus scutulatus
Diporiphora winneckei
Lophognathus longirostris
Moloch horridus
Pogona minor minor
Tympanocryptis cephala

Boidae
Antaresia perthensis
Antaresia stimsoni stimsoni

Cheluidae
Chelodina steindachneri

Elapidae
Acanthophis pyrrhus
Brachyurophis approximans
Brachyurophis fasciolata fasciolata
Brachyurophis semifasciata
Demansia psammophis cupreiceps
Furina ornata
Parasuta monachus
Pseudechis australis
Pseudechis butleri
Pseudonaja modesta
Pseudonaja nuchalis
Simoselaps bertholdi
Suta fasciata

Gekkonidae
Diplodactylus conspicillatus
Diplodactylus elderi
Diplodactylus granariensis rex
Diplodactylus pulcher
Diplodactylus squarrosus
Diplodactylus stenodactylus
Gehyra punctata
Gehyra purpurascens
Gehyra variegata
Heteronotia binoei

Nephrurus laevissimus
Nephrurus levis levis
Nephrurus sheai
Nephrurus vertebralis
Nephrurus wheeleri
Nephrurus wheeleri wheeleri
Oedura marmorata
Rhynchoedura ornata
Strophurus assimilis
Strophurus elderi
Strophurus strophurus
Strophurus wellingtonae
Underwoodisaurus milii

Pygopodidae
Delma butleri
Delma fraseri petersoni
Delma nasuta
Lialis burtonis
Pygopus nigriceps

Scincidae
Cryptoblepharus plagiocephalus
Ctenotus ariadnae
Ctenotus calurus
Ctenotus dux
Ctenotus grandis grandis
Ctenotus helenae
Ctenotus leonhardii
Ctenotus pantherinus ocellifer
Ctenotus quattuordecimlineatus
Ctenotus saxatilis
Ctenotus schomburgkii
Ctenotus severus
Ctenotus uber uber
Cyclodomorphus melanops melanops
Egernia depressa
Egernia formosa
Egernia inornata
Egernia kintorei
Egernia striata
Eremiascincus richardsonii
Lerista bipes
Lerista desertorum
Lerista macropisthopus fusciceps
Lerista muelleri
Menetia greyii
Morethia butleri
Morethia ruficauda ruficauda
Tiliqua multifasciata
Tiliqua occipitalis

Typhlopidae
Ramphotyphlops hamatus
Ramphotyphlops waitii

Varanidae
Varanus acanthurus
Varanus brevicauda
Varanus caudolineatus
Varanus eremius
Varanus giganteus
Varanus gouldii
Varanus panoptes rubidus
Varanus tristis tristis

Birds collected between -25.1047, 118.7776 and -28.1929, 121.832

Acanthizidae
Acanthiza apicalis
Acanthiza chrysorrhoa
Acanthiza robustirostris
Acanthiza uropygialis
Aphelocephala leucopsis castaneiventris
Calamanthus campestris
Gerygone fusca
Gerygone fusca fusca
Gerygone fusca mungi
Pyrrholaemus brunneus
Sericornis frontalis maculatus
Smicrornis brevirostris

Accipitridae
Accipiter cirrocephalus cirrocephalus
Aquila audax
Circus assimilis
Haliastur sphenurus
Hamirostra isura
Milvus migrans affinis

Aegothelidae
Aegotheles cristatus cristatus

Anatidae
Cygnus atratus

Ardeidae
Ardea novaehollandiae
Ardea pacifica

Artamidae
Artamus personatus

Campephagidae
Coracina novaehollandiae
Coracina novaehollandiae novaehollandiae
Coracina novaehollandiae subpallida
Lalage tricolor

Caprimulgidae
Eurostopodus argus

Casuariidae
Dromaius novaehollandiae

Charadriidae
Charadrius melanops

Cinclosomatidae
Cinclosoma castaneothorax marginatum

Climacteridae
Climacteris affinis superciliosa

Columbidae
Geopelia cuneata
Geopelia striata placida
Ocyphaps lophotes
Phaps chalcoptera

Corvidae
Corvus bennetti
Corvus orru
Corvus orru cecilae

Cracticidae
Cracticus nigrogularis
Cracticus tibicen
Strepera versicolor
Strepera versicolor plumbea

Cuculidae
Chrysococcyx basalis
Cuculus pallidus

Dicruridae
Grallina cyanoleuca
Rhipidura fuliginosa preissi
Rhipidura leucophrys
Rhipidura leucophrys leucophrys

Falconidae
Falco berigora berigora
Falco cenchroides
Falco cenchroides cenchroides
Falco longipennis longipennis

Halcyonidae
Todiramphus pyrrhopygia

Hirundinidae
Cheramoeca leucosternus

Maluridae
Amytornis striatus striatus
Amytornis textilis
Malurus lamberti assimilis
Malurus leucopterus
Malurus leucopterus leuconotus
Malurus splendens
Malurus splendens splendens
Stipiturus ruficeps ruficeps

Megapodiidae
Leipoa ocellata

Meliphagidae
Acanthagenys rufogularis
Certhionyx variegatus
Epthianura aurifrons
Lichenostomus keartlandi
Lichenostomus penicillatus
Lichenostomus plumulus
Lichenostomus virescens
Manorina flavigula
Phylidonyris albifrons

Otididae
Ardeotis australis

Pachycephalidae
Colluricincla harmonica
Pachycephala rufiventris rufiventris

Pardalotidae
Pardalotus rubricatus
Pardalotus striatus murchisoni
Pardalotus striatus westraliensis
Pardalotus striatus westraliensisxmurchisoni

Passeridae
Lonchura castaneothorax
Taeniopygia guttata castanotis

Petroicidae
Petroica cucullata
Petroica goodenovii

Podargidae
Podargus strigoides brachypterus

Podicipedidae
Poliocephalus poliocephalus
Tachybaptus novaehollandiae novaehollandiae

Pomatostomidae
Pomatostomus superciliosus
Pomatostomus temporalis rubeculus

Psittacidae
Cacatua roseicapilla assimilis
Melopsittacus undulatus
Neophema bourkii
Neophema elegans
Neophema splendida
Nymphicus hollandicus
Platycercus varius
Platycercus zonarius
Platycercus zonarius zonarius
Polytelis alexandrae
Polytelis anthopeplus anthopeplus

Ptilonorhynchidae
Ptilonorhynchus maculatus guttatus

Rallidae
Gallinula tenebrosa tenebrosa
Porzana pusilla palustris

Strigidae
Ninox novaeseelandiae

Sylviidae
Cincloramphus mathewsi
Cisticola exilis
Cisticola juncidis
Megalurus timoriensis

Mammals collected between -25.1047, 118.7776 and -28.1929, 121.832

Canidae
Canis lupus dingo
Vulpes vulpes

Dasyuridae
Antechinomys laniger
Dasycercus cristicauda
Ningaui ridei
Pseudantechinus woolleyae
Sminthopsis crassicaudata
Sminthopsis dolichura
Sminthopsis hirtipes
Sminthopsis longicaudata
Sminthopsis macroura
Sminthopsis ooldea
Sminthopsis youngsoni

Emballonuridae
Saccolaimus flaviventris
Taphozous georgianus
Taphozous hilli

Macropodidae
Macropus robustus erubescens
Macropus rufus

Molossidae
Mormopterus beccarii
Tadarida australis

Muridae
Mus musculus
Notomys alexis
Pseudomys albocinereus
Pseudomys bolami
Pseudomys desertor
Pseudomys hermannsburgensis
Zyzomys argurus

Tachyglossidae
Tachyglossus aculeatus

Thylacomyidae
Macrotis lagotis

Vespertilionidae
Chalinolobus gouldii
Nyctophilus geoffroyi
Scotorepens balstoni
Scotorepens greyii
Vespadelus baverstocki
Vespadelus finlaysoni
Vespadelus regulus

Appendix C

Search Results of the Federal Government Environment Protection and Biodiversity Conservation Act Protected Matters Database

24 September 2007 12:20

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Area

Buffer: 0 km

Coordinates: -25.190,118.829, -28.220,118.829, -28.220,121.725, -25.19,121.725

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	8
Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	9
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None

Regional Forest Agreements: None

Details

Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information] (Ramsar Sites)	
EIGHTY MILE BEACH	Within same catchment as Ramsar site

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
*Acanthiza iredalei iredalei** Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata * Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae * Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasycercus cristicauda * Mulgara	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus * Karkarratul, Northern Marsupial Mole	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) * Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Egernia kintorei * Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis * Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		

Leipoa ocellata * Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus * Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus * Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Commonwealth Lands [Dataset Information]		
Unknown		

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Indigenous

Kanatukul Mythological and Art Site WA

Nyingan Mythological and Art Site WA

Warritin Mythological and Art Site WA

Weebo Protected Area WA

Yeelirrie Pool Mythological and Occupation Site WA

Yeelirrie Station Mythological Site WA

Natural

Carnarvon Range Proposed Reserve WA

Wanjarri Nature Reserve WA

Windich Spring Proposed Reserve WA

Extra Information

State and Territory Reserves [Dataset Information]

Wanjarri Nature Reserve, WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria

- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated:

Department of the Environment and Water Resources
GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

Appendix D

Search Results of the Department of Environment and Water's Environmental Reporting Tool

Environmental Reporting Tool

Database Report

28 November 2007 16:11

This report includes places of national environmental significance that are registered in the Department of the Environment and Water Resources' databases, for the selected area. The information presented here has been provided by a range of groups across Australia, and the accuracy and resolution varies.

Search Type:	Area
Buffer:	0 km
Coordinates:	-25.071,118.814, -28.233,118.814, -28.233,121.783, -25.07,121.783

Report Contents: Summary >> Details >> Caveat >> Acknowledgment

Biodiversity

Threatened Species:	8
Migratory Species:	6
Listed Marine Species:	4
Invasive Species:	7
Whales and Other Cetaceans:	None
Threatened Ecological Communities:	None

Heritage

World Heritage Properties:	None
Australian Heritage Sites:	10

Wetlands

Ramsar sites: (Internationally important)	1
Nationally Important Wetlands:	1

National Pollutant Inventory

Reporting Facilities:	27
Airsheds:	None
Catchments:	None

Protected Areas

Reserves and Conservation Areas:	1
Regional Forest Agreements:	None

Biodiversity

Threatened Species Dataset Information	Status	Comments
Birds		
Acanthiza iredalei iredalei Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus Karkarratul, Northern Marsupial Mole	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Egernia kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Dataset Information]	Status	Comments
Migratory Terrestrial Species		
Birds		

Leipoa ocellata Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Listed Marine Species [Dataset Information]	Status	Comments
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Invasive Species [Dataset Information]	Status	Comments
Selected Invasive Species: Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.		

Mammals

Capra hircus Goat	Feral	Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat	Feral	Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit	Feral	Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox	Feral	Species or species habitat likely to occur within area

Plants

Carrichtera annua Ward's Weed	Invasive	Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass	Invasive	Species or species habitat likely to occur within area
Prosopis spp. Mesquite	WoNS	Species or species habitat may occur within area

Heritage

Australian Heritage Sites [Dataset Information]
Note that not all Indigenous sites may be listed.

Indigenous

Kanatukul Mythological and Art Site WA

Katjara Mythological and Art Site WA

Nyingan Mythological and Art Site WA

Warritin Mythological and Art Site WA

Weebo Protected Area WA

Yeelirrie Pool Mythological and Occupation Site WA

Yeelirrie Station Mythological Site WA

Natural

Carnarvon Range Proposed Reserve WA

Wanjarri Nature Reserve WA

Windich Spring Proposed Reserve WA

Wetlands

Wetlands of International Importance (Ramsar sites) [Dataset Information]

EIGHTY MILE BEACH	Within same catchment as Ramsar site

Nationally Important Wetland Sites [Dataset Information]

Windich Springs, WA

National Pollutant Inventory

NPI Location Report

Reporting Facility [Dataset Information]	Top Substance	Source
Substance emissions are ranked on a scale of 1-100: 1=lowest; 100=highest. Rankings are shown as: =0-25; =26-50; =51-75; =76-100.		
AGINCOURT RESOURCES LTD (Wiluna Gold Mine, WILUNA WA)	Antimony & compounds [Low]	Gold ore mining by underground and open cut methods, processed using bacterial oxidation treatment and cyanidation processes
AGNEW GOLD MINING CO P/L (Agnew Gold Mine, LEINSTER WA)	Chromium (III) compounds [Low]	Mining and processing of gold ore
BARRICK GOLD OF AUST LTD (PLUTONIC, MEEKATHARRA WA)	Cyanide (inorganic) compounds [Low]	Mineral Ore Mining and Processing
BP AUST LTD (AIR BP LEINSTER, LEINSTER WA)	Total Volatile Organic Compounds [Low]	Bulk petroleum storage facility
ENERGY GENERATION P/L (Wiluna Power Station, WILUNA WA)	Oxides of Nitrogen [Low]	DIESEL POWER STATION SUPPLYING POWER TO WILUNA
Forsayth NL (Lawlers Gold Mine, Agnew WA)	Particulate Matter 10.0 um [Low]	Gold ore mining and processing
LEGEND MINING LIMITED (Gidgee Gold Mine, SANDSTONE WA)	Particulate Matter 10.0 um [Low]	Underground Mining and Gold Processing (on care and maintenance from 31/3/05)
LIONORE AUSTRALIA (WILDARA) NL (Thunderbox Operations, LEINSTER WA)	Arsenic & compounds [Low]	Gold Mining and Processing Operation
Magellan Metals Pty Ltd (Magellan	Carbon	Lead Mining and Processing

Operations, WILUNA WA)	disulfide [Medium]	
NEWMONT YANDAL OPERATIONS P/L (Jundee Operations, Wiluna WA)	Cyanide (inorganic) compounds [Low]	Mining, Mineral Processing
ORICA AUST P/L (Leinster Explosives Plant, Leinster WA)	Total Volatile Organic Compounds [Low]	Dangerous good storage depot for ammonium nitrate, ammonium nitrate emulsion and diesel to support bulk explosives delivery to mines.
ORICA AUST P/L (MT KEITH PLANT, Sandstone WA)	Total Volatile Organic Compounds [Low]	Dangerous goods storage depot for storage of ammonium nitrate, ammonium nitrate emulsson & diesel to support bulk explosive delivery to mine.
PLUTONIC OPERATIONS LIMITED (BARRA / ORIENT, MEEKATHARRA WA)	Particulate Matter 10.0 um [Low]	MINERAL ORE MINING AND PROCESSING
PLUTONIC OPERATIONS LIMITED (MARYMIA, MEEKATHARRA WA)	Particulate Matter 10.0 um [Low]	MINERAL ORE MINING AND PROCESSING
PLUTONIC OPERATIONS LIMITED (REDFIN-SALMON, MEEKATHARRA WA)	Particulate Matter 10.0 um [Low]	GOLD ORE MINING
SEPT PTY LTD (Bulchina Mine Power House, SANDSTONE WA)	Oxides of Nitrogen [Low]	Power Generation
SIR SAMUEL MINES NL (Cosmos Nickel Project, Leinster WA)	Nickel & compounds [Low]	Mining and processing of nickel ores
Sundowner Minerals NL (Darlot Gold Mine, Lake Darlot WA)	Cyanide (inorganic) compounds [Low]	Underground mine operations. The stoping method used is predominantly longhole open stoping. Ore processing capacity by milling and CIP leaching exceeds 750,000 tonnes per year.

TEC DESERT PTY LTD (Leinster Nickel Operations, LEINSTER WA)	Oxides of Nitrogen [Low]	Electricity Generation
TEC DESERT PTY LTD (Mt Keith Nickel Operations, LEINSTER WA)	Oxides of Nitrogen [Low]	Electricity Generation
TROY RESOURCES NL (Bulchina Mine, SANDSTONE WA)	Chromium (III) compounds [Low]	Excavate Gold Ore and Waste. Process Gold Ore and ship dore.
TROY RESOURCES NL (Lords Operations, Sandstone WA)	Chromium (III) compounds [Low]	Gold Ore Mining
TROY RESOURCES NL (Sandstone Operations, Sandstone WA)	Cyanide (inorganic) compounds [Low]	Gold Ore Processing , Power generation
VIEW RESOURCES LTD (BRONZEWING GOLD MINE, Leinster WA)	Particulate Matter 10.0 um [Low]	BRONZEWING IS ON CARE AND MAINTENANCE - FUEL BURNING ACTIVITY ONLY
WESTERN POWER CORP (Wiluna Power Station, WILUNA WA)	Oxides of Nitrogen [Low]	Electricity generation and distribution
WMC Resources Ltd (Leinster Nickel Operation, Leinster WA)	Carbon disulfide [Medium]	Nickel mining and concentrating
WMC Resources Ltd (Mt Keith Nickel Operation, Wiluna WA)	Carbon disulfide [High]	Nickel ore mining from a single open pit using conventional methods. Nickel concentrator incorporates desliming, flotation, thickening and tailings disposal. Concentrate is trucked to Leonora and Leinster.

Other

Reserves and Conservation Areas [Dataset Information]

Wanjarri Nature Reserve, WA

Caveat

The information presented here has been drawn from a range of sources, compiled for a variety of purposes. Details of the coverage of each dataset are included in the metadata [Dataset Information] links above.

Acknowledgment

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
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- Tasmanian Herbarium
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- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

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Department of the Environment and Water Resources
GPO Box 787 Canberra ACT 2601 Australia
Telephone: (02) 6274 1111

Appendix E

Species Identified as 'At Risk' by the National Lands and Water Resources Audit (MUR1)

Murchison (MUR1)

Table: Species at risk in each subregion: their status, trend and subregional distribution. The reliability of the assessment of trend is indicated and whether recovery plans have been prepared.

Species Group	Species name	EPBC listing	State listing	Trend	Recommended rank	Existing recovery plans (yes/no)	Subregional occurrence
MUR1							
Birds	*Acanthiza iredalei iredalei* (Slender-billed Thornbill (western))	Vulnerable	NT (E) SA (V)	Unknown	Qualitative	No	AW1; AW2; COO1; COO2; COO3; CR1; EYB2; EYB3; EYB5; FLB4; FLB5; GAS2; GAS3; GAW1; GAW2; GAW4; GAW5; GD1; GS1; GS2; GVD2; GVD5; GVD6; HAM; KAN2; LSD2; MAL1; MAL2; MUR1; MUR2; NCP1; NCP3; NCP4; NUL1; NUL2; NUL3; YAL
Birds	*Leipoa ocellata* (Malleefowl)	Vulnerable	NSW (E) NT (E) SA (V) VIC (E) WA (V)	Unknown	Quantitative and qualitative	No	AW1; AW2; BBS23; BBS24; BBS25; CAR2; COO1; COO2; COO3; CP2; CP3; CP4; CP5; CR1; DRP10; DRP5; DRP9; ESP1; ESP2; EYB1; EYB3; EYB4; EYB5; GD1; GS1; GS2; GS3; GVD1; GVD2; GVD4; GVD6; HAM; MAL1; MAL2; MDD1; MDD2; MDD3; MDD4; MDD5; MDD6; MUR1; MUR2; NCP1; NCP2;
Birds	*Pezoporus occidentalis* (Night Parrot)	Endangered	SA (E) VIC (X) WA (E)	Extinction	No data	No	AW1; CAR1; CHC2; DL1; GD1; GD2; GS1; GS2; GS3; GSD1; GSD2; GSD5; LSD1; LSD2; MDD2; MDD4; MGD4; MUL10; MUL8; MUR1; MUR2; PIL1; PIL2; PIL3; PIL4; YAL

Birds	*Polytelis alexandrae* (Princess Parrot, Alexandra's Parrot)	Vulnerable	NT (V)	Unknown	Quantitative and qualitative	No	CHC3; CR1; FIN1; FIN2; FIN3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GSD4; GVD1; GVD3; LSD2; MAC1; MAC2; MAC3; MUR1; NUL1; NUL2; MII3; PIL1; SEQ1; TAN1
Mammals	*Dasycercus cristicauda* (Mulgara)	Vulnerable	NSW (X) NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; BRT2; BRT3; CAR1; CAR2; CHC1; CHC2; COO3; CR1; DMR1; DMR3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GVD1; GVD2; HAM; LSD1; LSD2; MAC1; MAC3; MUR1; MUR2; NUL1; NUL2; PIL1; SSD1; SSD2; TAN1
Mammals	*Leporillus apicalis* (Lesser Stick-nest Rat)	Extinct	NT (X) VIC (X) WA (X)	Extinction	No data	No	AW1; CAR2; CR1; GAS3; GD1; GS1; GVD1; GVD2; HAM; LSD2; MAL1; MDD2; MUR1; NUL2; PIL3; YAL
Mammals	*Leporillus conditor* (Wopilkara, Greater Stick-nest Rat)	Vulnerable	SA (V) VIC (X) WA (V)	Extinction	No data	No	BBS24; BHC1; CAR2; DRP10; GS1; HAM; MDD1; MUR1; NUL2; YAL
Mammals	*Macrotis lagotis* (Greater Bilby)	Vulnerable	NT (V) QLD (E) SA (E) WA (V)	Extinction	Quantitative and qualitative	No	AW1; AW2; BBS22; BBS24; BHC1; CAR2; CHC2; CHC3; CHC4; COO2; COO3; CP2; CP3; CR1; DL2; DMR3; DRP8; GAS1; GAS3; GD1; GD2; GSD1; GSD2; JF1; JF2; LSD1; LSD2; MAL2; MDD1; MDD6; MGD4; MGD7; MUR1; MUR2; NSS1; NSS2; NUL2; OVP1; OVP2; OVP4; PIL1; PIL2; PIL4; SSD6;

Mammals	*Notomys amplus* (Short-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	CAR2; GD1; MUR1; YAL
Mammals	*Notomys longicaudatus* (Long-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW2; BHC1; BHC2; CR1; GD1; MUR1; YAL
Mammals	*Notoryctes typhlops* (Yitjarritjarri, Southern Marsupial Mole)	Endangered	NT (V) SA (E) WA (E)	Unknown	Qualitative	No	COO3; CR1; CR2; FIN1; FIN2; FIN3; GAW2; GD1; GSD2; GSD5; GVD1; GVD2; GVD3; GVD4; LSD2; MAC2; MUR1; NUL1; NUL2; TAN1; TAN2
Mammals	*Onychogalea lunata* (Crescent Nail-tail Wallaby)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW1; COO3; CR1; GD1; MAL2; MUR1; NUL2
Reptiles	*Egernia kintorei* (Great Desert Skink)	Vulnerable	NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; CR1; DMR1; FIN2; GAS2; GD1; GSD1; GSD2; GSD4; LSD1; MAC1; MAC2; MUR1; TAN1

Murchison (MUR1)

Table: Species at risk in each subregion: their threatening processes.

Species name	Threatening processes	Threatening processes notes
Acanthiza iredalei iredalei (Slender-billed Thornbill (western))	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Feral animals	Foxes and cats
Egernia kintorei (Great Desert Skink)	Changed fire regimes	No data
Egernia kintorei (Great Desert Skink)	Feral animals	Foxes and cats
Eucalyptus articulata (Ponton Creek Mallee)	Changed fire regimes	No data
Leipoa ocellata (Malleefowl)	Feral animals	Foxes and cats
Leipoa ocellata (Malleefowl)	Firewood collection	No data
Leipoa ocellata (Malleefowl)	Grazing pressure	No data
Macrotis lagotis (Greater Bilby)	Changed fire regimes	No data
Macrotis lagotis (Greater Bilby)	Feral animals	Foxes
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Changed fire regimes	No data
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Feral animals	Foxes and cats
Polytelis alexandrae (Princess Parrot, Alexandra's Parrot)	Grazing pressure	No data

Appendix F

Search Results of the Birds Australia Atlas Database (Murchison Bioregion)

Murchison

Order	Atlas species no	Common name	Scientific name	Proportion of sightings in bioregion
1	1	**Emu**	*Dromaius novaehollandiae*	**High**
2	7	**Malleefowl**	*Leipoa ocellata*	Low
3	9	**Stubble Quail**	*Coturnix pectoralis*	Low
4	205	**Plumed Whistling-Duck**	*Dendrocygna eytoni*	Low
5	216	**Blue-billed Duck**	*Oxyura australis*	Low
6	217	**Musk Duck**	*Biziura lobata*	Low
7	214	**Freckled Duck**	*Stictonetta naevosa*	Low
8	203	**Black Swan**	*Cygnus atratus*	Medium
9	207	**Australian Shelduck**	*Tadorna tadornoides*	Medium
10	202	**Australian Wood Duck**	*Chenonetta jubata*	Medium
11	208	**Pacific Black Duck**	*Anas superciliosa*	Medium
12	212	**Australasian Shoveler**	*Anas rhynchotis*	Low
13	211	**Grey Teal**	*Anas gracilis*	Medium
14	210	**Chestnut Teal**	*Anas castanea*	Low
15	213	**Pink-eared Duck**	*Malacorhynchus membranaceus*	Medium
16	215	**Hardhead**	*Aythya australis*	Medium
17	61	**Australasian Grebe**	*Tachybaptus novaehollandiae*	Medium
18	62	**Hoary-headed Grebe**	*Poliocephalus poliocephalus*	Medium
19	60	**Great Crested Grebe**	*Podiceps cristatus*	Low
20	101	**Darter**	*Anhinga melanogaster*	Low
21	100	**Little Pied Cormorant**	*Phalacrocorax melanoleucos*	Medium
22	99	**Pied Cormorant**	*Phalacrocorax varius*	Low
23	97	**Little Black Cormorant**	*Phalacrocorax sulcirostris*	Medium
24	96	**Great Cormorant**	*Phalacrocorax carbo*	Low
25	106	**Australian Pelican**	*Pelecanus conspicillatus*	Medium
26	188	**White-faced Heron**	*Egretta novaehollandiae*	Medium
27	189	**White-necked Heron**	*Ardea pacifica*	Medium
28	187	**Great Egret**	*Ardea alba*	Low
29	192	**Nankeen Night Heron**	*Nycticorax caledonicus*	Low
30	178	**Glossy Ibis**	*Plegadis falcinellus*	Low
31	179	**Australian White Ibis**	*Threskiornis molucca*	Low
32	180	**Straw-necked Ibis**	*Threskiornis spinicollis*	Medium
33	181	**Royal Spoonbill**	*Platalea regia*	Low
34	182	**Yellow-billed Spoonbill**	*Platalea flavipes*	Low
35	232	**Black-shouldered Kite**	*Elanus axillaris*	Low
36	230	**Square-tailed Kite**	*Lophoictinia isura*	Low
37	231	**Black-breasted Buzzard**	*Hamirostra melanosternon*	Low
38	229	**Black Kite**	*Milvus migrans*	Medium
39	228	**Whistling Kite**	*Haliastur sphenurus*	Medium
40	218	**Spotted Harrier**	*Circus assimilis*	Medium
41	219	**Swamp Harrier**	*Circus approximans*	Low
42	221	**Brown Goshawk**	*Accipiter fasciatus*	Medium
43	222	**Collared Sparrowhawk**	*Accipiter cirrhocephalus*	Medium
44	224	**Wedge-tailed Eagle**	*Aquila audax*	**High**
45	225	**Little Eagle**	*Hieraaetus morphnoides*	Medium
46	239	**Brown Falcon**	*Falco berigora*	**High**
47	235	**Australian Hobby**	*Falco longipennis*	Medium
48	236	**Grey Falcon**	*Falco hypoleucos*	Low
49	238	**Black Falcon**	*Falco subniger*	Low
50	237	**Peregrine Falcon**	*Falco peregrinus*	Low
51	240	**Nankeen Kestrel**	*Falco cenchroides*	**High**
52	177	**Brolga**	*Grus rubicunda*	Low
53	50	**Baillon's Crake**	*Porzana pusilla*	Low
54	49	**Australian Spotted Crake**	*Porzana fluminea*	Low
55	55	**Black-tailed Native-hen**	*Gallinula ventralis*	Medium
56	59	**Eurasian Coot**	*Fulica atra*	Medium
57	176	**Australian Bustard**	*Ardeotis australis*	Medium
58	18	**Little Button-quail**	*Turnix velox*	Medium

59	153	**Bar-tailed Godwit**	*Limosa lapponica*	Low
60	159	**Marsh Sandpiper**	*Tringa stagnatilis*	Low
61	158	**Common Greenshank**	*Tringa nebularia*	Low
62	154	**Wood Sandpiper**	*Tringa glareola*	Low
63	157	**Common Sandpiper**	*Actitis hypoleucos*	Low
64	155	**Grey-tailed Tattler**	*Heteroscelus brevipes*	Low
65	164	**Red Knot**	*Calidris canutus*	Low
66	166	**Sanderling**	*Calidris alba*	Low
67	162	**Red-necked Stint**	*Calidris ruficollis*	Low
68	965	**Long-toed Stint**	*Calidris subminuta*	Low
69	978	**Pectoral Sandpiper**	*Calidris melanotos*	Low
70	163	**Sharp-tailed Sandpiper**	*Calidris acuminata*	Low
71	161	**Curlew Sandpiper**	*Calidris ferruginea*	Low
72	174	**Bush Stone-curlew**	*Burhinus grallarius*	Low
73	146	**Black-winged Stilt**	*Himantopus himantopus*	Medium
74	147	**Banded Stilt**	*Cladorhynchus leucocephalus*	Medium
75	148	**Red-necked Avocet**	*Recurvirostra novaehollandiae*	Medium
76	137	**Pacific Golden Plover**	*Pluvialis fulva*	Low
77	143	**Red-capped Plover**	*Charadrius ruficapillus*	Medium
78	142	**Oriental Plover**	*Charadrius veredus*	Low
79	145	**Inland Dotterel**	*Peltohyas australis*	Medium
80	144	**Black-fronted Dotterel**	*Elseyornis melanops*	Medium
81	138	**Hooded Plover**	*Thinornis rubricollis*	Low
82	132	**Red-kneed Dotterel**	*Erythogonys cinctus*	Medium
83	135	**Banded Lapwing**	*Vanellus tricolor*	Medium
84	172	**Oriental Pratincole**	*Glareola maldivarum*	Low
85	173	**Australian Pratincole**	*Stiltia isabella*	Low
86	125	**Silver Gull**	*Larus novaehollandiae*	Low
87	111	**Gull-billed Tern**	*Sterna nilotica*	Medium
88	112	**Caspian Tern**	*Sterna caspia*	Low
89	110	**Whiskered Tern**	*Chlidonias hybridus*	Medium
90	109	**White-winged Tern**	*Chlidonias leucopterus*	Low
91	957	**Rock Dove**	*Columba livia*	Medium
92	988	**Laughing Turtle-Dove**	*Streptopelia senegalensis*	Low
93	989	**Spotted Turtle-Dove**	*Streptopelia chinensis*	Low
94	34	**Common Bronzewing**	*Phaps chalcoptera*	Medium
95	43	**Crested Pigeon**	*Ocyphaps lophotes*	**High**
96	42	**Spinifex Pigeon**	*Geophaps plumifera*	Low
97	31	**Diamond Dove**	*Geopelia cuneata*	Medium
98	30	**Peaceful Dove**	*Geopelia placida*	Low
99	264	**Red-tailed Black-Cockatoo**	*Calyptorhynchus banksii*	Low
100	273	**Galah**	*Eolophus roseicapillus*	**High**
101	271	**Little Corella**	*Cacatua sanguinea*	Medium
102	270	**Major Mitchell's Cockatoo**	*Cacatua leadbeateri*	Low
103	274	**Cockatiel**	*Nymphicus hollandicus*	Medium
104	259	**Purple-crowned Lorikeet**	*Glossopsitta porphyrocephala*	Low
105	278	**Regent Parrot**	*Polytelis anthopeplus*	Low
106	294	**Australian Ringneck**	*Barnardius zonarius*	**High**
107	296	**Mulga Parrot**	*Psephotus varius*	**High**
108	310	**Budgerigar**	*Melopsittacus undulatus*	**High**
109	304	**Bourke's Parrot**	*Neopsephotus bourkii*	Medium
110	303	**Scarlet-chested Parrot**	*Neophema splendida*	Low
111	337	**Pallid Cuckoo**	*Cuculus pallidus*	Medium
112	341	**Black-eared Cuckoo**	*Chrysococcyx osculans*	Medium
113	342	**Horsfield's Bronze-Cuckoo**	*Chrysococcyx basalis*	Medium
114	246	**Barking Owl**	*Ninox connivens*	Low
115	242	**Southern Boobook**	*Ninox novaeseelandiae*	Medium
116	249	**Barn Owl**	*Tyto alba*	Low
117	313	**Tawny Frogmouth**	*Podargus strigoides*	Medium
118	331	**Spotted Nightjar**	*Eurostopodus argus*	Medium
119	317	**Australian Owlet-nightjar**	*Aegotheles cristatus*	Medium

120	335	**Fork-tailed Swift**	*Apus pacificus*	Low
121	325	**Red-backed Kingfisher**	*Todiramphus pyrrhopygia*	Medium
122	326	**Sacred Kingfisher**	*Todiramphus sanctus*	Medium
123	329	**Rainbow Bee-eater**	*Merops ornatus*	Medium
124	561	**White-browed Treecreeper**	*Climacteris affinis*	Medium
125	556	**Rufous Treecreeper**	*Climacteris rufa*	Low
126	532	**Splendid Fairy-wren**	*Malurus splendens*	Medium
127	536	**Variegated Fairy-wren**	*Malurus lamberti*	Medium
128	535	**White-winged Fairy-wren**	*Malurus leucopterus*	Medium
129	513	**Striated Grasswren**	*Amytornis striatus*	Low
130	570	**Red-browed Pardalote**	*Pardalotus rubricatus*	Low
131	976	**Striated Pardalote**	*Pardalotus striatus*	Medium
132	502	**Rufous Fieldwren**	*Calamanthus campestris*	Low
133	497	**Redthroat**	*Pyrrholaemus brunneus*	Medium
134	465	**Weebill**	*Smicrornis brevirostris*	Medium
135	463	**Western Gerygone**	*Gerygone fusca*	Medium
136	476	**Inland Thornbill**	*Acanthiza apicalis*	Medium
137	481	**Chestnut-rumped Thornbill**	*Acanthiza uropygialis*	**High**
138	480	**Slaty-backed Thornbill**	*Acanthiza robustirostris*	Medium
139	482	**Slender-billed Thornbill**	*Acanthiza iredalei*	Low
140	486	**Yellow-rumped Thornbill**	*Acanthiza chrysorrhoa*	**High**
141	466	**Southern Whiteface**	*Aphelocephala leucopsis*	**High**
142	469	**Banded Whiteface**	*Aphelocephala nigricincta*	Low
143	638	**Red Wattlebird**	*Anthochaera carunculata*	Medium
144	640	**Spiny-cheeked Honeyeater**	*Acanthagenys rufogularis*	**High**
145	635	**Yellow-throated Miner**	*Manorina flavigula*	**High**
146	608	**Singing Honeyeater**	*Lichenostomus virescens*	**High**
147	617	**White-eared Honeyeater**	*Lichenostomus leucotis*	Medium
148	621	**Grey-headed Honeyeater**	*Lichenostomus keartlandi*	Low
149	622	**Yellow-plumed Honeyeater**	*Lichenostomus ornatus*	Medium
150	623	**Grey-fronted Honeyeater**	*Lichenostomus plumulus*	Medium
151	625	**White-plumed Honeyeater**	*Lichenostomus penicillatus*	Medium
152	583	**Brown-headed Honeyeater**	*Melithreptus brevirostris*	Low
153	597	**Brown Honeyeater**	*Lichmera indistincta*	Medium
154	594	**White-fronted Honeyeater**	*Phylidonyris albifrons*	Medium
155	599	**Grey Honeyeater**	*Conopophila whitei*	Low
156	589	**Black Honeyeater**	*Certhionyx niger*	Medium
157	602	**Pied Honeyeater**	*Certhionyx variegatus*	Medium
158	449	**Crimson Chat**	*Epthianura tricolor*	**High**
159	450	**Orange Chat**	*Epthianura aurifrons*	Medium
160	448	**White-fronted Chat**	*Epthianura albifrons*	Medium
161	377	**Jacky Winter**	*Microeca fascinans*	Medium
162	380	**Scarlet Robin**	*Petroica multicolor*	Low
163	381	**Red-capped Robin**	*Petroica goodenovii*	**High**
164	385	**Hooded Robin**	*Melanodryas cucullata*	**High**
165	441	**Southern Scrub-robin**	*Drymodes brunneopygia*	Low
166	443	**Grey-crowned Babbler**	*Pomatostomus temporalis*	Medium
167	445	**White-browed Babbler**	*Pomatostomus superciliosus*	Medium
168	865	**Chiming Wedgebill**	*Psophodes occidentalis*	Medium
169	437	**Chestnut Quail-thrush**	*Cinclosoma castanotus*	Low
170	438	**Chestnut-breasted Quail-thrush**	*Cinclosoma castaneothorax*	Medium
171	549	**Varied Sittella**	*Daphoenositta chrysoptera*	Medium
172	416	**Crested Shrike-tit**	*Falcunculus frontatus*	Low
173	419	**Crested Bellbird**	*Oreoica gutturalis*	**High**
174	403	**Gilbert's Whistler**	*Pachycephala inornata*	Low
175	398	**Golden Whistler**	*Pachycephala pectoralis*	Low
176	401	**Rufous Whistler**	*Pachycephala rufiventris*	**High**
177	408	**Grey Shrike-thrush**	*Colluricincla harmonica*	**High**
178	415	**Magpie-lark**	*Grallina cyanoleuca*	**High**
179	361	**Grey Fantail**	*Rhipidura fuliginosa*	Medium
180	364	**Willie Wagtail**	*Rhipidura leucophrys*	**High**

181	424	**Black-faced Cuckoo-shrike**	*Coracina novaehollandiae*	**High**
182	423	**Ground Cuckoo-shrike**	*Coracina maxima*	Medium
183	430	**White-winged Triller**	*Lalage sueurii*	Medium
184	543	**White-breasted Woodswallow**	*Artamus leucorhynchus*	Low
185	544	**Masked Woodswallow**	*Artamus personatus*	Medium
186	545	**White-browed Woodswallow**	*Artamus superciliosus*	Low
187	546	**Black-faced Woodswallow**	*Artamus cinereus*	**High**
188	547	**Dusky Woodswallow**	*Artamus cyanopterus*	Low
189	548	**Little Woodswallow**	*Artamus minor*	Medium
190	702	**Grey Butcherbird**	*Cracticus torquatus*	**High**
191	700	**Pied Butcherbird**	*Cracticus nigrogularis*	**High**
192	705	**Australian Magpie**	*Gymnorhina tibicen*	**High**
193	697	**Grey Currawong**	*Strepera versicolor*	Medium
194	930	**Australian Raven**	*Corvus coronoides*	Medium
195	691	**Little Crow**	*Corvus bennetti*	**High**
196	692	**Torresian Crow**	*Corvus orru*	Medium
197	681	**Western Bowerbird**	*Chlamydera guttata*	Medium
198	648	**Horsfield's Bushlark**	*Mirafra javanica*	Low
199	647	**Australian Pipit**	*Anthus novaeseelandiae*	**High**
200	653	**Zebra Finch**	*Taeniopygia guttata*	**High**
201	564	**Mistletoebird**	*Dicaeum hirundinaceum*	Medium
202	358	**White-backed Swallow**	*Cheramoeca leucosternus*	Medium
203	357	**Welcome Swallow**	*Hirundo neoxena*	**High**
204	359	**Tree Martin**	*Hirundo nigricans*	Medium
205	360	**Fairy Martin**	*Hirundo ariel*	Medium
206	524	**Australian Reed-Warbler**	*Acrocephalus australis*	Low
207	522	**Little Grassbird**	*Megalurus gramineus*	Low
208	509	**Rufous Songlark**	*Cinclorhamphus mathewsi*	Medium
209	508	**Brown Songlark**	*Cinclorhamphus cruralis*	Medium
210	574	**Silvereye**	*Zosterops lateralis*	Low

Appendix G

Birds Australia Regional Summaries (Murchison Bioregion)

IBRA Region:	**Murchison**		
Physical characteristics	*Area*	Total area of region:	28,119,906
	Rainfall Index	Comparison with average rainfall:	
		Atlas period 1:	-0.57
		Atlas period 2:	0.77
		Difference in rainfall index between Atlas periods:	Higher
	Use Index	Use zone:	Extensive
		Percent cleared:	0.0
		Continental stress:	High
Number of surveys	*Atlas 1*	10 min surveys:	540
		60 min surveys:	415
		10 min surveys used for analysis:	306
	Atlas 2	2-ha searches:	496
		500 m area searches:	457
		5 km area searches:	153
		Area searches used for analysis:	299
		Incidental records:	131

Comments

The avifauna of this semi-arid bioregion does not stand out from that of other bioregions with a similar climate elsewhere in Australia. It contains no limited range taxa, a small proportion of the Vulnerable Malleefowl population and almost no introduced birds. Reporting rates of most birds were higher, but there were no trends in any guilds despite the high level of continental stress.

Status: Typical semi-arid avifauna.
Rare and threatened: No major populations.
Increasers: None indicative of landscape health.
Indicators: Emu, Australian Bustard, Banded Lapwing, White-browed Treecreeper, Hooded Robin, Jacky Winter, Grey-crowned Babbler.
Trend: No trends detected.
Scenario: Avifauna probably largely stable within large climatic fluctuations.
Actions: No grazing in representative areas and the adoption of reduced, conservative grazing rates in key habitat across the bioregion.

Murchison

Common name	Species name		Importance of bioregion for species
Limited range species			
None			
Threatened taxa		**Status**	
Malleefowl	*Leipoa ocellata*	Vulnerable	Moderate
Introduced species		**Type of introduction**	
Rock Dove	*Columba livia*	Exotic species	Moderate
Laughing Turtle-Dove	*Streptopelia senegalensis*	Exotic species	Moderate*
Spotted Turtle-Dove	*Streptopelia chinensis*	Exotic species	Minor*

* not recorded in Atlas 2 so may no longer be present

Murchison

Group		No. of species	Index Atlas 1	Index Atlas 2	BIAS	National trend	Regional variation	Bioregional trend	Comparison with national trend
All Australian breeding species		165	294	406	-0.3	Not significant	Significant	Significant increase	Increase greater than national trend
Ground nesters	**Obligate**	30	40	26	-0.4	Significant decrease	Significant	Not significant	
Hollow nesters	**Obligate**	19	45	46	-0.3	Not significant	Significant	Not significant	
Ground seed eaters	**Obligate**	8	16	35	-0.1	Significant increase	Significant	Not significant	
	Facultative	17	61	71	-0.2	Significant decrease	Significant	Not significant	
Ground insect eaters	**Obligate**	38	88	96	-0.3	Not significant	Significant	Not significant	
	Facultative	43	73	92	-0.3	Significant decrease	Significant	Not significant	
Freshwater	**Obligate**	37	39	30	-0.4	Significant decrease	Significant	Not significant	
Grassland	**Obligate**	31	64	74	-0.5	Significant decrease	Significant	Not significant	
	Facultative	28	108	79	-0.5	Significant decrease	Significant	Not significant	

Murchison

MUR

	Area (ha)	28,119,906	6	th largest bioregion	
Class	**Value**	**Rank** (1 high-85 low)	**IBRA average**	**IBRA total**	**Units**
All species					
Atlas period 1	195	55	232	698	
Atlas period 2	188	53	226	731	
Both periods	210	59	254	743	
Australian resident species					
No. species	188	57	215	555	
No. genera	130	55	139	248	
Species/genus	1.45	64	1.53	2.24	
Species:area ratio	0.31	79	0.31	0.39	ln(no. species)/ln(bioregion area)
Australian endemic species					
No. endemic species	123	42	124	355	
Endemic/total resident species	0.65	11	0.58	0.64	
Range limitation					
Index of range limitation (frequency)	11.8	68	20.4	100	Sum(100/ no. bioregions)
Index of range limitation (reporting rate)	12.4	66	22.7	100	Sum(100xreporting rate/ no. bioregions)
No. species recorded in 10 or fewer bioregions	0	85	8	154	
Index of importance of bioregion to species recorded in 10 or fewer bioregions	0.0	85	1.2	100	Sum(100/ no. bioregions)
Threatened taxa					
No. Critically Endangered taxa	0		-	15	
No. Endangered taxa	0		-	24	
No. Vulnerable taxa	1		-	35	
Total	1	73	4.0	74	
Introduced species					
Exotic species					
No. species	3	60	6.3	30	
Representation in bioregion	1.4	55	2.6	5.4	No. ESx100/ no. spp. in bioregion
Relative abundance in bioregion	0.2	59	2.6	100	Rep. rate ESx100/ Rep rate spp. in bioregion
Percentage of Australian total	10.0	60	20.9	100	No. ES in regionx100/ no. ES in Australia
Australian translocated species					
No. species	0	85	0.9	16	
Representation in bioregion	0.0	85	0.4	3	No. ATSx100/ no. spp. in bioregion
Relative abundance in bioregion	0.0	85	0.3	100	Rep. rate ATSx100/ Rep rate spp. in bioregion
Percentage of Australian total	0.0	85	5.5	100	No. ATS in regionx100/ no. ATS in Australia
Total introduced species					
No. species	3	62	7.2	36	
Representation in bioregion	1.4	56	2.9	6	No. TISx100/ no. spp. in bioregion
Relative abundance in bioregion	0.2	62	3.0	100	Rep. rate TISx100/ Rep rate spp. in bioregion
Percentage of Australian total	6.5	62	15.5	100	No. TIS in regionx100/ no. TIS in Australia

Appendix H

Refugia for Biological Diversity in Arid and Semi-arid Australia (MUR1)

Refugia for Biological Diversity in Arid and Semi-arid Australia

Biodiversity Series, Paper No. 4
Biodiversity Unit

S.R. Morton, J. Short and R.D. Barker
with an Appendix by G.F. Griffin and G. Pearce

Contents > Previous > Next

4.10. Murchison

Area

278,360 km2.

Primary land-use

Mining, grazing by sheep.

National Parks and Nature Reserves

Goongarrie National Park and Wanjarri Nature Reserve.

Management problems

Wanjarri Nature Reserve - weeds, wildfire, and increasing numbers of tourists largely due to close proximity to gold and nickel mines.

Land degradation due to over-grazing (Wilcox and Cunningham 1994) and to goats (Freudenberger 1993).

ANZECC-listed species

Birds: Malleefowl *Leipoa ocellata* (E) at Wanjarri Nature Reserve (Keally and Chapman 1991); also Alexandra's parrot *Polytelis alexandrae* (V).

Species that are regionally endemic

The elapid snake *Pseudechis butleri* (Cogger 1992)..

Relict populations

The agamid *Egernia kintorei* (Cogger *et al.* 1993, pp. 88-90).

Other significant populations

Many surveys have revealed a rich vertebrate fauna and an extensive flora, but generally the species are widely distributed (Dell *et al.* 1992; How *et al.* 1992; Hall *et al.* 1994). The Region comprises a rich interzone between the arid and mesic biotas of south-western Australia, corresponding roughly to the "line" between the mulga/spinifex country and the eucalypt environments (Dell *et al.* 1988; McKenzie and Hall 1992).

Birds: Wanjarri Nature Reserve contains striated grass wren *Amytornis striatus*, Australian bustard *Ardeotis kori*, bush thick-knee *Burhinus grallarius*, and regent parrot *Polytelis anthopeplus* (Keally and Chapman 1991).

Plants: Dell *et al.* (1988) recorded the rare plant *Calytrix watsonii*. Leigh *et al.* (1984) noted *Hemigenia exilis* (p. 234) and *H. tysoni* (p. 236).

Wetland sites

Waterbirds occur throughout ephemeral wetlands of the interior (Lane and McComb 1988). One of particular importance is Lake Barlee, an intermittent salt lake where up to 200,000 nests of the banded stilt *Cladorhynchus leucocephalus* may be used about once every 10 years when the Lake floods (Burbidge and Fuller 1982; Jaensch and Lane 1993).

Aneen Lake is a large (12,000 ha) salt lake south-west of Meekatharra with numerous islands and peninsulas, comprising a seasonal, intermittent saline or brackish lake and marsh. Some parts of the Lake are likely to hold shallow water in most years; the whole system fills every 5-10 years from summer-autumn rain. The Lake is a regular and major breeding area for gull-billed tern *Gelochelidon nilotica* and whiskered tern *Chlidonias hybrida*. It also supports several thousand waterbirds when full (Jaensch and Lane 1993).

Wooleen Lake is a floodplain lake with associated marshes on Roderick River, which outflows to the Murchison River 6 km downstream. It experiences some inundation in most years, and the whole lake and surrounding marshes fill once every 5-10 years. The Lake may be several metres deep when full. The Lake is a major breeding area for gull-billed terns *Gelochelidon nilotica* (Jaensch and Lane 1993).

Refugia

Annen Lake (see section 10.20), Wooleen Lake (10.22) and Lake Barlee (10.24) all qualify as refugia.

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Department of the Environment and Water Resources
GPO Box 787
Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

Appendix I

Vertebrate Species Potentially Occurring over the Project Area

Native mammal species potentially occurring over the survey area

Family	Common Name	Species	WAM
Tachyglossidae	Echidna	*Tachyglossus aculeatus*	x
Dasyuridae	Kultarr	*Antechinomys laniger*	x
	Mulgara	*Dasycercus cristicauda*	x
	Wongai Ningaui	*Ningaui ridei*	x
	Wooley's Pseudantechinus	*Pseudantechinus woolleyae*	x
	Fat-tailed Dunnart	*Sminthopsis crassicaudata*	x
	Little Long-tailed Dunnart	*Sminthopsis dolichura*	x
	Hairy-footed Dunnart	*Sminthopsis hirtipes*	x
	Long-tailed Dunnart	*Sminthopsis longicaudata*	x
	Stripe-faced Dunnart	*Sminthopsis macroura*	x
	Ooldea Dunnart	*Sminthopsis ooldea*	x
Macropodidae	Euro	*Macropus robustus erubescens*	x
	Red Kangaroo	*Macropus rufus*	x
Emballonuridae	Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	x
	Common Sheathtail Bat	*Taphozous georgianus*	x
	Hill's Sheathtail Bat	*Taphozous hilli*	x
Vespertilionidae	Gould`s Wattled Bat	*Chalinolobus gouldii*	x
	Chocolate Wattled Bat	*Chalinolobus morio*	
	Lesser Long-eared Bat	*Nyctophilus geoffroyi*	x
	Greater Long-eared Bat	*Nyctophilus timoriensis timoriensis*	
	Inland Broad-nosed Bat	*Scotorepens balstoni*	x
	Little Broad-nosed Bat	*Scotorepens greyii*	x
	Inland Forest Bat	*Vespadelus baverstocki*	x
	Southern Forest Bat	*Vespadelus regulus*	x
	Finlayson's Cave Bat	*Vespadelus finlaysoni*	x
Molossidae	Beccari's Freetail-bat	*Mormopterus beccarii*	x
	Southern Freetail-bat	*Mormopterus planiceps*	
	White-striped Freetail-bat	*Tadarida australis*	x
Muridae	Spinifex Hopping-mouse	*Notomys alexis*	x
	Ash-grey Mouse	*Pseudomys albocinereus*	x
	Bolam's Mouse	*Pseudomys bolami*	x
	Desert Mouse	*Pseudomys desertor*	x
	Sandy Inland Mouse	*Pseudomys hermannsburgensis*	x

Bird species potentially occurring over the survey area

Family	Common name	Scientific name	BA	WAM
Casuaridae	Emu	*Dromaius novaehollandiae*	H	x
Megapodiidae	Malleefowl	*Leipoa ocellata*	L	x
Phasianidae	Stubble Quail	*Coturnix pectoralis*	L	
	Musk Duck	*Biziura lobata*	L	
	Black Swan	*Cygnus atratus*	M	x
	Australian Shelduck	*Tadorna tadornoides*	M	
	Australian Wood Duck	*Chenonetta jubata*	M	
	Pacific Black Duck	*Anas superciliosa*	M	
	Australasian Shoveler	*Anas rhynchotis*	L	
	Grey Teal	*Anas gracilis*	M	
	Pink-eared Duck	*Malacorhynchus membranaceus*	M	
	Hardhead	*Aythya australis*	M	
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*	M	x
	Hoary-headed Grebe	*Poliocephalus poliocephalus*	M	x
Anhingidae	Darter	*Anhinga melanogaster*	L	
Phalacrocoracidae	Little Pied Cormorant	*Phalacrocorax melanoleucos*	M	
	Little Black Cormorant	*Phalacrocorax sulcirostris*	M	
Pelecanidae	Australian Pelican	*Pelecanus conspicillatus*	M	
Areidae	White-faced Heron	*Egretta novaehollandiae*	M	x
	White-necked Heron	*Ardea pacifica*	M	x
	Great Egret	*Ardea alba*	L	
	Nankeen Night Heron	*Nycticorax caledonicus*	L	
Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	L	
	Australian White Ibis	*Threskiornis molucca*	L	
	Straw-necked Ibis	*Threskiornis spinicollis*	M	
	Royal Spoonbill	*Platalea regia*	L	
	Yellow-billed Spoonbill	*Platalea flavipes*	L	
Accipitridae	Black-shouldered Kite	*Elanus axillaris*	L	
	Square-tailed Kite	*Lophoictinia isura*	L	x
	Black-breasted Buzzard	*Hamirostra melanosternon*	L	
	Black Kite	*Milvus migrans*	M	x
	Whistling Kite	*Haliastur sphenurus*	M	x
	Spotted Harrier	*Circus assimilis*	M	x
	Swamp Harrier	*Circus approximans*	L	
	Brown Goshawk	*Accipiter fasciatus*	M	
	Collared Sparrowhawk	*Accipiter cirrhocephalus*	M	x
	Wedge-tailed Eagle	*Aquila audax*	H	x
	Little Eagle	*Hieraaetus morphnoides*	M	
Falconidae	Brown Falcon	*Falco berigora*	H	x
	Australian Hobby	*Falco longipennis*	M	x
	Grey Falcon	*Falco hypoleucos*	L	
	Black Falcon	*Falco subniger*	L	
	Peregrine Falcon	*Falco peregrinus*	L	
	Nankeen Kestrel	*Falco cenchroides*	H	x

Rallidae	Buff-banded Rail	*Gallirallus philippensis*		
	Baillon's Crake	*Porzana pusilla*	L	x
	Australian Spotted Crake	*Porzana fluminea*	L	
	Black-tailed Native-hen	*Gallinula ventralis*	M	
	Eurasian Coot	*Fulica atra*	M	
	Dusky Moorhen	*Gallinula tenebrosa*		x
Otididae	Australian Bustard	*Ardeotis australis*	M	x
Turnicidae	Little Button-quail	*Turnix velox*	M	
	Common Greenshank	*Tringa nebularia*	L	
	Wood Sandpiper	*Tringa glareola*	L	
	Common Sandpiper	*Actitis hypoleucos*	L	
	Red-necked Stint	*Calidris ruficollis*	L	
	Sharp-tailed Sandpiper	*Calidris acuminata*	L	
	Curlew Sandpiper	*Calidris ferruginea*	L	
Burhinidae	Bush Stone-curlew	*Burhinus grallarius*	L	
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	M	
	Banded Stilt	*Cladorhynchus leucocephalus*	M	
	Red-necked Avocet	*Recurvirostra novaehollandiae*	M	
	Red-capped Plover	*Charadrius ruficapillus*	M	
	Oriental Plover	*Charadrius veredus*	L	
	Inland Dotterel	*Peltohyas australis*	M	
	Black-fronted Dotterel	*Elseyornis melanops*	M	x
	Red-kneed Dotterel	*Erythogonys cinctus*	M	
	Banded Lapwing	*Vanellus tricolor*	M	
Glareolidae	Australian Pratincole	*Stiltia isabella*	L	
Laridae	Silver Gull	*Larus novaehollandiae*	L	
	Gull-billed Tern	*Sterna nilotica*	M	
	Caspian Tern	*Sterna caspia*	L	
	Whiskered Tern	*Chlidonias hybridus*	M	
	White-winged Tern	*Chlidonias leucopterus*	L	
Columbidae	Common Bronzewing	*Phaps chalcoptera*	M	x
	Crested Pigeon	*Ocyphaps lophotes*	H	x
	Spinifex Pigeon	*Geophaps plumifera*	L	
	Diamond Dove	*Geopelia cuneata*	M	x
	Peaceful Dove	*Geopelia placida*	L	x
Cacatuidae	Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	L	
	Galah	*Eolophus roseicapillus*	H	x
	Little Corella	*Cacatua sanguinea*	M	
	Major Mitchell's Cockatoo	*Cacatua leadbeateri*	L	
	Cockatiel	*Nymphicus hollandicus*	M	x
Psittacidae	Princess Parrot	*Polytelis alexandrae*		x
	Regent Parrot	*Polytelis anthopeplus*	L	x
	Australian Ringneck	*Barnardius zonarius*	H	x
	Mulga Parrot	*Psephotus varius*	H	x
	Budgerigar	*Melopsittacus undulatus*	H	x
	Bourke's Parrot	*Neopsephotus bourkii*	M	x
	Scarlet-chested Parrot	*Neophema splendida*	L	
	Night Parrot	*Pezoporus occidentalis*		
Cuculidae	Pallid Cuckoo	*Cuculus pallidus*	M	x
	Black-eared Cuckoo	*Chrysococcyx osculans*	M	
	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	M	x
Strigidae	Barking Owl	*Ninox connivens*	L	
	Southern Boobook	*Ninox novaeseelandiae*	M	x
Tytonidae	Barn Owl	*Tyto alba*	L	

Podargidae	Tawny Frogmouth	*Podargus strigoides*	M	x
Caprimulgidae	Spotted Nightjar	*Eurostopodus argus*	M	x
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*	M	x
Apodidae	Fork-tailed Swift	*Apus pacificus*	L	
Halcyonidae	Red-backed Kingfisher	*Todiramphus pyrrhopygia*	M	x
	Sacred Kingfisher	*Todiramphus sanctus*	M	
	Laughing Kookaburra	*Dacelo novaeguineae*		
Meropidae	Rainbow Bee-eater	*Merops ornatus*	M	
Climacteridae	White-browed Treecreeper	*Climacteris affinis*	M	x
	Rufous Treecreeper	*Climacteris rufa*	L	
Maluridae	Splendid Fairy-wren	*Malurus splendens*	M	x
	Variegated Fairy-wren	*Malurus lamberti*	M	x
	White-winged Fairy-wren	*Malurus leucopterus*	M	x
	Striated Grasswren	*Amytornis striatus*	L	x
	Rufous-crowned Emu-wren	*Stipiturus ruficeps*		x
Pardalotidae	Red-browed Pardalote	*Pardalotus rubricatus*	L	x
	Striated Pardalote	*Pardalotus striatus*	M	x
	Rufous Fieldwren	*Calamanthus campestris*	L	x
	Redthroat	*Pyrrholaemus brunneus*	M	x
	Weebill	*Smicrornis brevirostris*	M	x
	White-browed Scrubwren	*Sericornis frontalis*		x
	Western Gerygone	*Gerygone fusca*	M	x
	Inland Thornbill	*Acanthiza apicalis*	M	x
	Chestnut-rumped Thornbill	*Acanthiza uropygialis*	H	x
	Slaty-backed Thornbill	*Acanthiza robustirostris*	M	x
	Slender-billed Thornbill	*Acanthiza iredalei*	L	
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	H	x
	Southern Whiteface	*Aphelocephala leucopsis*	H	x
	Banded Whiteface	*Aphelocephala nigricincta*	L	
Meliphagidae	Red Wattlebird	*Anthochaera carunculata*	M	
	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	H	x
	Yellow-throated Miner	*Manorina flavigula*	H	x
	Singing Honeyeater	*Lichenostomus virescens*	H	x
	White-eared Honeyeater	*Lichenostomus leucotis*	M	
	Grey-headed Honeyeater	*Lichenostomus keartlandi*	L	x
	Yellow-plumed Honeyeater	*Lichenostomus ornatus*	M	
	Grey-fronted Honeyeater	*Lichenostomus plumulus*	M	x
	White-plumed Honeyeater	*Lichenostomus penicillatus*	M	x
	Brown-headed Honeyeater	*Melithreptus brevirostris*	L	
	Brown Honeyeater	*Lichmera indistincta*	M	
	White-fronted Honeyeater	*Phylidonyris albifrons*	M	x
	Grey Honeyeater	*Conopophila whitei*	L	
	Black Honeyeater	*Certhionyx niger*	M	
	Pied Honeyeater	*Certhionyx variegatus*	M	x
	Crimson Chat	*Epthianura tricolor*	H	
	Orange Chat	*Epthianura aurifrons*	M	x
	White-fronted Chat	*Epthianura albifrons*	M	
	Jacky Winter	*Microeca fascinans*	M	
	Scarlet Robin	*Petroica multicolor*	L	
	Red-capped Robin	*Petroica goodenovii*	H	x
	Hooded Robin	*Melanodryas cucullata*	H	x
	Southern Scrub-robin	*Drymodes brunneopygia*	L	

Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*	M	
	White-browed Babbler	*Pomatostomus superciliosus*	M	
Cinclosomatidae	Chiming Wedgebill	*Psophodes occidentalis*	M	
	Chestnut Quail-thrush	*Cinclosoma castanotus*	L	
	Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*		
	Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*	M	x
Neosittidae	Varied Sittella	*Daphoenositta chrysoptera*	M	
Pachycephalidae	Crested Shrike-tit	*Falcunculus frontatus*	L	
	Crested Bellbird	*Oreoica gutturalis*	H	x
	Gilbert's Whistler	*Pachycephala inornata*	L	
	Golden Whistler	*Pachycephala pectoralis*	L	
	Rufous Whistler	*Pachycephala rufiventris*	H	x
	Grey Shrike-thrush	*Colluricincla harmonica*	H	x
Dicruridae	Magpie-lark	*Grallina cyanoleuca*	H	x
	Grey Fantail	*Rhipidura fuliginosa*	M	x
	Willie Wagtail	*Rhipidura leucophrys*	H	x
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	H	x
	Ground Cuckoo-shrike	*Coracina maxima*	M	
	White-winged Triller	*Lalage sueurii*	M	x
Artamidae	White-breasted Woodswallow	*Artamus leucorhynchus*	L	
	Masked Woodswallow	*Artamus personatus*	M	x
	White-browed Woodswallow	*Artamus superciliosus*	L	
	Black-faced Woodswallow	*Artamus cinereus*	H	
	Dusky Woodswallow	*Artamus cyanopterus*	L	
	Little Woodswallow	*Artamus minor*	M	
	Grey Butcherbird	*Cracticus torquatus*	H	
	Pied Butcherbird	*Cracticus nigrogularis*	H	x
	Australian Magpie	*Gymnorhina tibicen*	H	x
	Grey Currawong	*Strepera versicolor*	M	x
Corvidae	Australian Raven	*Corvus coronoides*	M	
	Little Crow	*Corvus bennetti*	H	x
	Torresian Crow	*Corvus orru*	M	x
Ptilonorhynchidae	Western Bowerbird	*Chlamydera guttata*	M	x
Alaudidae	Singing Bushlark	*Mirafra javanica*	L	
Motacilidae	Australian Pipit	*Anthus novaeseelandiae*	H	
Passeridae	Zebra Finch	*Taeniopygia guttata*	H	x
Dicaeidae	Mistletoebird	*Dicaeum hirundinaceum*	M	
Hirundinidae	White-backed Swallow	*Cheramoeca leucosternus*	M	x
	Welcome Swallow	*Hirundo neoxena*	H	
	Tree Martin	*Hirundo nigricans*	M	
	Fairy Martin	*Hirundo ariel*	M	
Sylviidae	Australian Reed-Warbler	*Acrocephalus australis*	L	
	Little Grassbird	*Megalurus gramineus*	L	
	Rufous Songlark	*Cinclorhamphus mathewsi*	M	x
	Brown Songlark	*Cinclorhamphus cruralis*	M	
Zosteropidae	Silvereye	*Zosterops lateralis*	L	

BA: Species identified from Birds Australia database (H,M,L = High, Medium and Low reporting rates for bioregion)

WAM: Species identified from the Faunabase Data search of the Western Australian Museum

Reptile species potentially occurring over the survey area

Family	Species	WAM
Agamidae Dragon Lizards	*Caimanops amphiboluroides*	x
	Ctenophorus caudicinctus	x
	Ctenophorus fordi	x
	Ctenophorus isolepis	x
	Ctenophorus nuchalis	x
	Ctenophorus ornatus	x
	Ctenophorus reticulatus	x
	Ctenophorus salinarum	x
	Ctenophorus scutulatus	x
	Diporiphora winneckei	x
	Lophognathus longirostris	x
	Moloch horridus	x
	Pogona minor minor	x
	Tympanocryptis cephala	x
Gekkonidae Geckos	*Diplodactylus conspicillatus*	x
	Diplodactylus pulcher	x
	Diplodactylus elderi	x
	Diplodactylus granariensis	x
	Diplodactylus pulcher	x
	Diplodactylus squarrosus	x
	Diplodactylus stenodactylus	x
	Gehyra punctata	x
	Gehyra purpurascens	x
	Gehyra variegata	x
	Heteronotia binoei	x
	Nephrurus laevissimus	x
	Nephrurus levis levis	x
	Nephrurus vertebralis	x
	Nephrurus wheeleri	x
	Oedura marmorata	x
	Rhynchoedura ornata	x
	Strophurus assimilis	x
	Strophurus elderi	x
	Strophurus strophurus	x
	Strophurus wellingtonae	x
	Underwoodisaurus milii	x
Pygopodidae Legless Lizards	*Delma butleri*	x
	Delma fraseri petersoni	x
	Delma nasuta	x
	Lialis burtonis	x
	Pygopus nigriceps	x
Scincidae Skinks	*Cryptoblepharus carnabyi*	
	Cryptoblepharus plagiocephalus	x
	Ctenotus atlas	
	Ctenotus ariadnae	x
	Ctenotus calurus	x
	Ctenotus dux	x
	Ctenotus grandis grandis	x
	Ctenotus greeri	x
	Ctenotus hanloni	
	Ctenotus helenae	x
	Ctenotus leonhardii	x

Appendix J

Short-range Endemic Invertebrate Delivery Tables

Outback Ecology Services: Short Range Endemic Study - Lake Way

Job Code: RLW-FS-0307

Mygalomorph Spiders

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Date	Comments	Photo Number
NLW01	Melaleuca	Lycosa?	A		During other digging	20/10/07	Araneomorphae: found while digging	
		Non-Mygalomorph?	B		Hand searching	24/10/07	Burrow 15-20 cm deep extending up against a log.	72-73
		Mygalomorph	C		Hand searching	24/10/07	Open burrow found on border of Mulga scrubland	74-76
		Mygalomorph	D		Hand searching	25/10/07	Open Burrow (20cm deep) within Melaleuca Stand	
		Trapdoor	E		Hand searching	26/10/07	Nth Mel site. Approx 20cm deep	106-110
		Burrows of above	F		Hand Searching	24/10/07	Burrows were in areas of slight elevation with thick cryptogamic crusts	
NLW02	Mulga over Spinifex	Mygalomorph	B		Hand Searching	23/10/07	Found in a Spinifex clump	43-46
		Mygalomorph	C		Hand Searching	24/10/07	Y shaped burrow with 1 entrance	62-67 Old Burrows of trapdoors in the area
		Trapdoor	D		Hand Searching	25/10/07	Trapdoor within old Spinifex hummock under Mulga	77 – 85
		Burrow of above trapdoor	E				Burrow of above trapdoor	

NLW04	Mulga over Chenopod	Mygalomorph	A		Hand searching	19/10/07	Funnel shaped burrow made from sticks and silk. Burrows were typically small in size and often occurred in number of 5-10 under mulga plants	6897BH
		Burrow of Above	B		Hand searching	19/10/07		
		Mygalomorph	C		Hand searching	19/10/07	Damaged specimen found when digging vert traps	
		Possible Mygalomorph	D		Hand searching	23/10/07	Raised stick entrance in sheet flooding area	50-51
		Huntsman?	E		Vert Pit Trap	23/10/07		60
		Mygalomorph	F		Hand searching	23/10/07		
		Mygalomorph	G		Invert Trap	27/10/07	(submitted with specimens from RLM-FS-0807)	
NLW05	Mallee over Spinifex	Mygalomorph	A		Hand searching	19/10/07	Open burrow with fine webbing across entrance. Depth ~30 cm.	21
		Possible Mygalomorph	C		Hand searching	23/10/07	Open stand funnel entrance into base of mallee	
		Possible Mygalomorph	D		Hand searching	24/10/07	Loose funnel like entrance going underground between leaf litter	

		Mygalomorph Trapdoor	E		Hand searching	26/10/07	Found by scraping back surface	100-103
		Mygalomorph trapdoor	F		Hand searching	27/10/07		
NLW06	Calcrete Woodland	2 x Spiders	A		Hand searching	23/10/07	Found in raised funnel entrance ~ 10 mm above the ground surface	52-57
		Burrow of above	B		Hand searching	23/10/07	Raised burrow of sticks and earth	
		Possible Mygalomorph	C		Sieving	24/10/07	Found when sieving to 10 cm of soil for snails. Looked similar to stick tower spiders from mulga/cheno site	Note: the stick tower spider from LW04 also appears at LW06
NLW09	Floodplain	Trapdoor mygalomorph	A		Hand searching	26/10/07	High density of these spiders occur with in the area. Sub-straight would certainly become inundated. Hard clay surface once dried.	104
		Burrow of above	B		Hand searching	26/10/07		

Outback Ecology Services: Short Range Endemic Study - Lake Way

Job Code: RLW-FS-0307

Terrestrial Snails

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Destination	Date	Comments
NLW 01	Melaleuca	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	24/10/07	
NLW 03	Eucalypt over chenopod	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	24/10/07	
NLW 04	Mulga over Chenopod	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	24/10/07	
NLW 05	Mallee over Spinifex	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	24/10/07	
NLW 06	Calcrete Woodland	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	24/10/07	
NLW 07	Halosarcia	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	27/10/07	
NLW08	Freshwater Lake bank	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	27/10/07	Amongst vegetation on bank of lake
NLW 09	Flood Plain	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	27/10/07	
Nth Lake	Freshwater Lake playa	Terrestrial Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	27/10/07	Margin of lake playa – likely to be aquatic snails

Outback Ecology Services: Short Range Endemic Study - Lake Way

Job Code: RLW-FS-0307

Pseudoscorpions, Scorpions, Centipedes

		Pseudoscorpion	E	Bijou Vial	Invertebrate Pit Trap	Mark Harvey	23/10/07-27/10/07	8 x pseudoscorpions
LW 06	Calcrete Woodland	2 x Centipedes	C	220 mL Perspex	Vert Pit Trap	Mark Harvey	23/10/07	3 x centipedes
		Centipede + Scorpion	E	Yellow Lid	Vert Pit Trap	Mark Harvey	25/10/07	Scorpion found in burrow
		Pseudoscorpion	F	Bijou Vial	Invertebrate Pit Trap	Mark Harvey	23/10/07-27/10/07	18 x pseudoscorpions
		Centipedes	G	Yellow Lid	Invertebrate Pit Trap	Mark Harvey	21/10/07	2 x centipedes
LW 07	Halosarcia							
LW08	Freshwater Lake							
LW 09	Flood Plain							

Appendix K

Summary Tables Describing Conservation Status

IUCN categories also used under the Commonwealth EPBC Act and by DEC

Status	Code	Description
Extinct	(EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild	(EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
Critically Endangered	(CR)	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.
Endangered	(EN)	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	(VU)	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Lower Risk	(LR)	A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories: o Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years. o Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable. o Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.
Data Deficient	(DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.
Not Evaluated	(NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Schedules of the Western Australian Wildlife Conservation Act 1950: Wildlife Conservation (Specially Protected Fauna) Notice.

Status	Code	Description
Schedule 1	(S1)	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	(S2)	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	(S3)	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be faunathat is in need of special protection
Schedule 4	(S4)	Fauna that is in need of special protection, otherwise than for the reasons mentioned above

Priority Fauna Codes used by the Western Australian DEC

Status	Code	Description
Priority One Taxa with few, poorly known populations on threatened lands.	(P1)	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Two Taxa with few, poorly known populations on conservation lands.	(P2)	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Three Taxa with several, poorly known populations, some on conservation lands.	(P3)	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Four Taxa in need of monitoring.	(P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority Five Taxa in need of monitoring.	(P5)	Taxa which are not considered threatened but are subject to a specific conservatin program, the cessation of which would result in the species becoming threatened within five years.

Appendix L

SRE Report – Barbara York Main

SPIDER IDENTIFICATIONS FOR OUTBACK ECOLOGY SERVICES

SHORT RANGE ENDEMIC STUDY:

LAKE WAY
JOB CODE: RLW-FS-0307

By Barbara York Main
School of Animal Biology MO92
University of W Ausatralia. Crawley WA 6009

Email: bymain@cyllene.uwa.edu.au 17April2008

[F Female, M Male, j juvenile]

SITE No. NLWO1
ARANEOMORPHAE
Vial no. A F, Family Sparassidae

Vial no. B j , Sparassidae

MYGALOMORPHAE "
Vial no. C j, Nemesiidae. ***Aname*** sp.

Vial no. D j, Nemesiidae, ***Aname*** sp.

Vial no. E penultimate male, Idiopidae, ***Eucyrtops*** sp.

Vial no. F Door of **(?)** ***Eucyrtops*** sp (of above?)

SITE No. NLWO2
Vial no. B F. Nemesiidae, ***Aname*** sp.***"armigera*** sp. group" ("Wish bone spider")

Vial. no.C F, Nemesiidae, ***Aname*** sp. ***"armigera"*** sp group

Vial no. D F, Barychelidae, **(?)** ***Idiommata*** sp.

Vial no. E Burrow trapdoor of above spider

SITE No. NLWO4
ARANEOMORPHAE
Vial no. A 3FF, Segestriidae, ***Ariadna*** sp.

Vial no. B burrow top(s) of above

Vial no.D J Male, Sparassidae. (same species as NLWO1 B)

MYGALOMORPHAE
Vial no. C j , Idiopidae. Damaged specimen, Tentatively id. as ***Aganippe*** sp.

Vial No. E M, Barychelidae (**nec** ***Idiommata***) sp.

Vial.no. F F, Idiopidae, ***Eucyrtops*** sp.

SITE NLWO5
MYGALOMORPHAE
Vial no. A F, Nemesiidae, ***Aname*** sp. (?) ***"armigera"*** sp. group

Vial no. E F, Barychelidae, **(nec *Idiommata*)**

Vial no. F J, Idiopidae, ***Aganippe sp. A***

ARANEOMORPHAE
Vial no. C F, M, Amaurobiidae. ***Badumna*** or ***Phryganoporus***

Vial no. D J, Gnaphosidae or Prodidomidae

SITE NLWO6
ARANEOMORPHAE
Vial no. A 2JJ, Sparassidae

Vial no. B Burrow top(s) of above

Vial no. C No spider or burrow top located but description suggests ***Ariadna*** (re LWO4)

SITE NLWO9
MYGALOMORPHAE
Vial no. A F, Idiopidae ***Aganippe sp. (A. "occidentalis sp. group")***

Vial no.B Trapdoor of above

SUMMARY

Several burrowing araneomorphs are included in the collection. The immature gnaphosid or prodidomid ? is probably of conservation interest.

Of the Mygalomorphae represented from the six sample sites there were three families, five genera and six species collected (Barychelidae (***Idiommata sp.*** and unidentified genus sp.), Idiopidae (***Eucyrtops*** sp and two ***Aganippe*** species) and Nemesiidae (***Aname*** sp "unnamed species in ***"armigera species group"***).

It is not possible to place the species more precisely due to the current inadequate taxonomic status of the genera. However the barychelid with the double door may be a named species. The ***Aname*** species (represented here by females and juveniles), is almost certainly a widespread species, the ***Aganippe*** species and the ***Eucyrtops*** may be more restricted in their distribution.

Appendix M

SRE Report – Shirley Slack-Smith

Report to *Outback Ecology Services*

Molluscs from the area of Lake Way, Western Australia, collected by *Outback Ecology Services* in October, 2007

S. Slack-Smith and C. Whisson
Western Australian Museum
March 2008

Background

Eight samples of snail specimens collected by staff of the environmental consultancy company, *Outback Ecology Services*, were presented for identification and comment to the Department of Aquatic Zoology (Mollusc Section), Western Australian Museum.

The samples had been collected at eight sites during a faunal survey of the Lake Way area of Western Australia in October, 2007 by staff of *Outback Ecology Services*. Specimen data, including the collecting dates and the co-ordinates of the survey sites were provided with the specimens.

Procedures

Specimens in the eight samples of molluscs were examined and sorted under a dissecting microscope and compared with descriptions and figures in relevant publications and with specimens in the dry and wet Molluscan Collections of the Western Australian Museum.

Results

The specimens in the samples belong to the non-marine aquatic family Planorbidae and to the terrestrial family Pupillidae (see Table 1). In general, species identifications are based, in this instance and in previous studies, almost exclusively on shell characters, which vary only slightly within the genera.

All of the species identified in this report form part of the indigenous Western Australian fauna.

Family Pupillidae

Members of this diverse and speciose family are small and are generally of an elongate shape. They inhabit the litter/soil interface under shrubs and grasses, or shelter under rocks or within rock piles.

Species of the genus *Pupoides* have been distinguished on their shell characters alone. Most are dextrally coiled but a few are coiled sinistrally. Other shell characters used in identification are the shell size, width to length ratios, degree of rotundity of the whorls, shape of the aperture, etc.

As with other molluscan taxa, there are very few records of the occurrence of species of *Pupoides* in the central and eastern areas of Western Australia.

Table 1. Locality data and mollusc species recorded during the Lake Way survey.

Site	Coordinates (Zone 51)		Date	Identification	No. Specimens
	Easting	Northing			
LW01	237847	7028276	24/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	2 whole shells
LW01	237847	7028276	24/10/2007	*Pupoides ?myoporinae* (Tate, 1880)	1 whole shell
LW03	232643	7045345	24/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	4 whole shells
LW03	232643	7045345	24/10/2007	*Pupoides ?myoporinae* (Tate, 1880)	Series
LW04	233276	7045360	24/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	1 whole shell, 1 broken shell
LW05	234900	7043846	24/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	2 whole shells
LW06	235516	7045409	24/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	1 whole shell
LW07	238165	7028067	27/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	3 whole shells
LW08	235159	7047492	27/10/2007	*Glyptophysa* (*Glyptophysa*) sp.	1 whole shell, 3 broken shells
LW08	235159	7047492	27/10/2007	Clam shrimp (?*Limnadopsis* sp.)	1 carapace
LW08	235159	7047492	27/10/2007	*Gastrocopta ?larapinta* (Tate, 1896)	4 whole shells, 1 broken shell
LW09	236566	7044342	27/10/2007	*Pupoides ?adelaidae* (Adams & Angas, 1864)	1 broken shell

Pupoides ?myoporinae (Tate, 1880)

Pupoides myoporinae is one of the few sinistrally coiled species in this family. It was reported to have a wide but apparently disjunct geographic range in Victoria/southern South Australia and in the south eastern area of Western Australia (Solem 1986).

Because of the published records that exist of its occurrence to the east and west of that area and the fact that it is the only sinistrally coiled species with such a distributional range, specimens from Lake Way are tentatively identified as the species *Pupoides myoporinae,* despite some apparently-minor morphological differences.

Pupoides ?adelaidae (Adams & Angas, 1864)

Pupoides adelaidae is a dextrally coiled species that, like *Pupoides myoporinae*, has a wide geographic distribution from Victoria to the eastern wheatbelt of Western Australia (Solem 1986)

There are no published records of this species in the Lake Way area but there are records of its occurrence to the east and west of that area. One other dextrally coiled and very similar species has a central Australian distribution but is not recorded from as far west and south as the Lake Way area.

Gastrocopta ?larapinta (Tate, 1896)

Gastrocopta larapinta is a minute dextrally-coiled species that has a wide but patchy distribution in central Australia (southern part of the Northern Territory), with a few records from the north-west and the east coast of Queensland. There is a single record of this species from the Oscar Ranges, in the southern Kimberley region of Western Australia (Pokryszko 1996).

The structure of the apertural teeth of the Lake Way specimens is similar to that of *G. larapinta* and differs from that of those other species of *Gastrocopta* (e.g. *G. margaretae* (Cox, 1868); *G. deserti* Pilsbry, 1917 and *G. mussoni* Pilsbry, 1917) that may possibly have distributional ranges extending to the area of investigation. Because the Lake Way record would indicate a substantial range extension southwards for *G. larapinta*, we have only tentatively identified the specimens as belonging to that species.

Family Planorbidae

***Glyptophysa* (*Glyptophysa*) sp.**

Species of this world-wide family of sinistrally coiled freshwater gastropods are thought to be widespread - particularly in inland areas of Australia (Walker 1988; Smith 1992). However this family has had very little taxonomic attention at the species level – most work on the Australian taxa having been at the generic level.

Although the shell characters of the specimens are consistent with those of the Australian representatives of the genus *Glyptophysa* and its sub-genus *Glyptophysa*, we are unable to ascertain a species name for these fragile, damaged specimens from Lake Way.

Phylum Arthropoda, Class Crustacea, Order Diplostraca

?*Limnadopsis* sp.

This specimen is of the non-calcified exoskeleton of an aquatic clam shrimp.

Remarks

We have no reason to believe that, **at the species level,** any of these four molluscan taxa exhibit any degree of short range endemicity, as all are believed to belong to species that occupy wide geographic ranges.

However, because we did not carry out the field survey, we have no way of evaluating the relationship of the molluscan taxa to the available habitats, nor of the cohesiveness of the population or populations.

Therefore we cannot comment upon the likelihood of short range endemicity at the population level. Nor are we able, in the absence of data on the spatial relationship between the collecting sites and the boundaries of the proposed area(s) of interference, to comment upon the possible effect of such interference on the population/populations of molluscan species in the Lake Way area.

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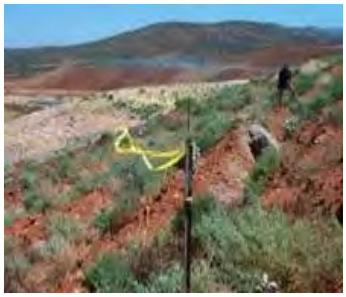

Toro Energy Limited

Wiluna Uranium Project

Terrestrial Fauna Assessment

January 2011

DRAFT REPORT

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Toro Energy Limited

Wiluna Uranium Project

Terrestrial Fauna Assessment 2010

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Company	Copies	Contact Name
Toro Energy Limited	1 (Electronic)	Kathryn Taylor

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Executive Summary

Toro Energy Limited (Toro) commissioned Outback Ecology to undertake a terrestrial fauna assessment of the Wiluna Uranium Project (the Project). The Project is located approximately 15 kilometres (km) to south-east of the town of Wiluna, 720 km to the north-east of Perth in the Murchison region of Western Australia.

The overall objectives of this terrestrial fauna assessment were to:

- Develop an inventory of terrestrial vertebrate fauna species and terrestrial invertebrate short-range endemic (SRE) fauna species identified from within the Study area, or likely to be present within the Study area;
- Identify terrestrial vertebrate and invertebrate SRE fauna species of conservation significance potentially occurring over the Study area;
- Identify, characterise and map the broad vertebrate fauna habitat, potential invertebrate SRE habitat occurring within the Study area;
- Assess findings in the regional context by comparisons with available data from other localities within the bioregion; and
- Assess the potential impacts of the Project on vertebrate fauna and their habitats.

This report documents the results of two fauna surveys conducted over the Study area by Outback Ecology: a summer reconnaissance survey from the 30 November to 4 December 2009; and detailed autumn survey from 3-15 March 2010. The report also presents a summary of terrestrial fauna species previously recorded in the Study area and surrounds between 1978 and 2010, including the findings of the detailed spring fauna survey conducted by Outback Ecology in the Study area from 18 to 28 October 2007.

Vertebrate fauna

The detailed autumn survey involved a variety of sampling techniques, including systematic and opportunistic sampling. Systematic and targeted sampling was undertaken in the twelve broad fauna habitats identified in the Study area, comprising Melaleuca Stands, Open Mulga Woodland over Spinifex, Eucalypt Woodland, Mulga Woodland over Chenopod Shrubland, Mallee/Mulga Complex over Spinifex, Mulga over Calcrete, Minor Drainage Line, Red Sand Dune, Chenopod Floodplain, Creek Line with River Red Gum, Open Mulga Woodland over Spinifex on Hardpan, and Major Drainage Line. Eight systematic sites were surveyed via trapping techniques, active hand searching, spotlighting searches and fixed time avifauna censusing. Trapping methods included the use of pitfall, Elliott, funnel and cage traps. In addition, 14 targeted survey sites were searched for signs of conservation significant species utilising the Study area.

A total of 216 vertebrate fauna species have been recorded in the Study area and immediate surrounds, comprising 31 mammals (20 native), 75 reptiles, 105 birds and five amphibians. During the 2009 reconnaissance survey and 2010 detailed autumn survey, a total of 109 vertebrate species were recorded, comprising 21 mammals (12 native), 36 reptiles, 52 birds and no amphibians.

No threatened fauna species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act) or Western Australian *Wildlife Conservation Act* 1950 (WC Act); or Priority fauna species listed under the Western Australia Department of Environment and Conservation (DEC) Priority Species List, were recorded during these surveys nor have been previously recorded in the Study area.

Two conservation significant fauna species listed under the EPBC Act as Migratory were recorded within the Study area during these surveys; the Rainbow Bee Eater (*Merops ornatus*) and Sharp-tailed Sandpiper (*Calidris acuminatus*).

Based on database search results, available literature and findings of previous terrestrial fauna surveys, it is considered an additional 18 conservation significant fauna species could potentially occur within the Study area, comprising:

- Five species listed under the EPBC Act and WC Act: the Mulgara (*Dasycercus cristicauda* - Vulnerable and Schedule 1), Malleefowl (*Leipoa ocellata* - Vulnerable and Schedule 1), Slender-billed Thornbill (*Acanthiza iredalei iredalei* – Vulnerable), Major Mitchell's Cockatoo (*Cacatua leadbeateri* - Schedule 4) and Peregrine Falcon (*Falco peregrinus* - Schedule 4);
- Four priority species listed under the Western Australia DEC Priority Species List: the Australian Bustard (*Ardeotis australis* - P4), Bush Stone-curlew (*Burhinus grallarius* - P4), the Grey Falcon (*Falco hypoleucos* - P4) and the Striated Grasswren (*Amytornis striatus striatus* – P4); and
- Nine species listed as Migratory under the EPBC Act: the Fork-tailed Swift (*Apus pacificus pacificus*), Eastern Great Egret (*Ardea alba*), Common Greenshank (*Tringa nebularia*), Wood Sandpiper (*Tringa glareola*), Common Sandpiper (*Actitis hypoleucos*), Curlew Sandpiper (*Calidris ferruginea*), Red-necked Stint (*Calidris ruficollis*), Oriental Plover (*Charadrius veredus*) and Oriental Pratincole (*Glareola maldivarum*).

The Project will impact vertebrate fauna through direct loss of fauna during land clearing, loss of habitat and indirect impacts. The Project is unlikely to have a significant impact on any fauna species, including any conservation significant fauna species, due to the presence of similar habitat in close proximity.

Short range endemic (SRE) invertebrate fauna

SRE invertebrates tend to have limited means of dispersal, low levels of reproduction and tend to have specific habitat requirements. The detailed autumn survey implemented systematic sampling methods and targeted searching to collect the following SRE groups: mygalomorph spiders; pseudoscorpions; terrestrial molluscs; terrestrial isopods; scorpions; and millipedes. Systematic sampling methods included: vertebrate fauna pitfall traps; SRE invertebrate pitfall traps; leaf litter collection; soil sieving; and UV night searching.

The detailed SRE survey conducted in autumn 2010 yielded a total of 95 invertebrate specimens from the targeted SRE groups, comprising 14 mygalomorph spiders, 34 scorpions, 6 pseudoscorpions, 6 slaters and 35 terrestrial snail specimens.

Based on current scientific knowledge, five invertebrate species have been identified as putative SRE species from within the Study area. Of these species, *Aname* MYG177, *Kwonkan* MYG175 and *Urodacus* 'yeelirrie' have been recorded from within the Project footprint. Although *Aname* MYG177 was not recorded outside the project footprint, it was recorded from a habitat that is widespread within the study area. The remaining two species recorded within the project footprint were recorded outside this footprint also. *Urodacus* 'yeelirrie' was recorded in the local surrounds and both species were recorded at regional sites.

Habitats which have a moderate to high potential to support SRE species that occur within the proposed Project impact footprint include Melaleuca Stands, Chenopod Flood Plain and the Mallee/Mulga complex over Spinifex habitats. The Melaleuca Stands habitat, which is a fringing habitat that has a patchy distribution around Lake Way, does not appear to be well represented outside the Project impact footprint. The Chenopod Flood Plain and the Mallee/Mulga complex over Spinifex habitats are moderately to well represented at a local scale outside the Project impact footprint.

With consideration to survey findings and the habitat assessment, no known putatative SRE invertebrate fauna species are restricted in their occurrence to the proposed Project impact footprint.

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1. INTRODUCTION

1.1 Project Background and Location

Toro Energy Limited (Toro) commissioned Outback Ecology to undertake a terrestrial fauna assessment of the proposed Wiluna Uranium Project (the Project). The Project is located approximately 15 kilometres (km) to the south-east of the town of Wiluna and 720 km to the north-east of Perth, in the Murchison region of Western Australia (WA) (**Figure 1**).

The Project encompasses parts of the Centipede East deposit (M53/224), Centipede West (M53/0113, P53/1355, P53/1356, P53/1357, P53/1396), the Lake Way deposit (M53/1090) and Borefields (L53/0150), collectively known herein as the Study area (**Figure 2**).

The principal activities planned for the Project include:

- Development and operation of an open cut uranium mine encompassing the Lake Way and Centipede East deposits;
- Construction and operation of a uranium ore processing, packing and handling facility;
- Refurbishment and upgrade of the disused West Creek borefield to supply water to the Project;
- Support facilities including an accommodation village, mine administration buildings and workshops, haul roads, power generation and transmission facilities, communications systems and water and waste management;
- Transport of uranium product within Australia for export; and
- Rehabilitation and closure of the mine and other areas disturbed by the Project (Toro Energy Ltd., 2010).

The proposed total area of disturbance required for the development of the Project over the planned 14 year life span is approximately 1,300 hectares. This area predominantly comprises native vegetation, with the exception of minor areas of existing disturbance associated with roads and access tracks and previous mining activity including trials (by others) in the Project locality (Toro Energy Ltd, 2010).

The Study area and conceptual general layout of the Project is provided on **Figure 2**.

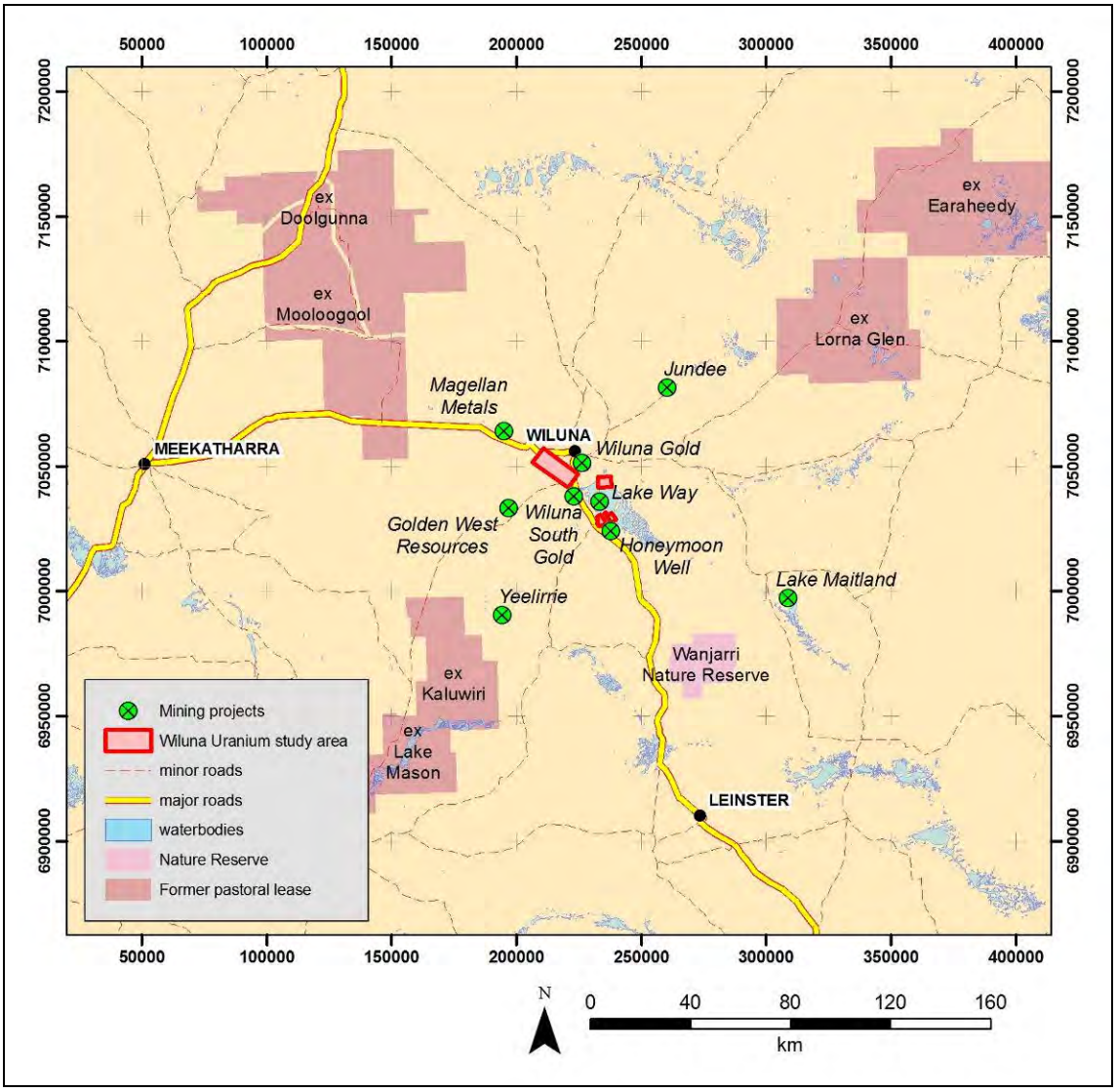

Figure 1: Regional location of the proposed Wiluna Uranium Project

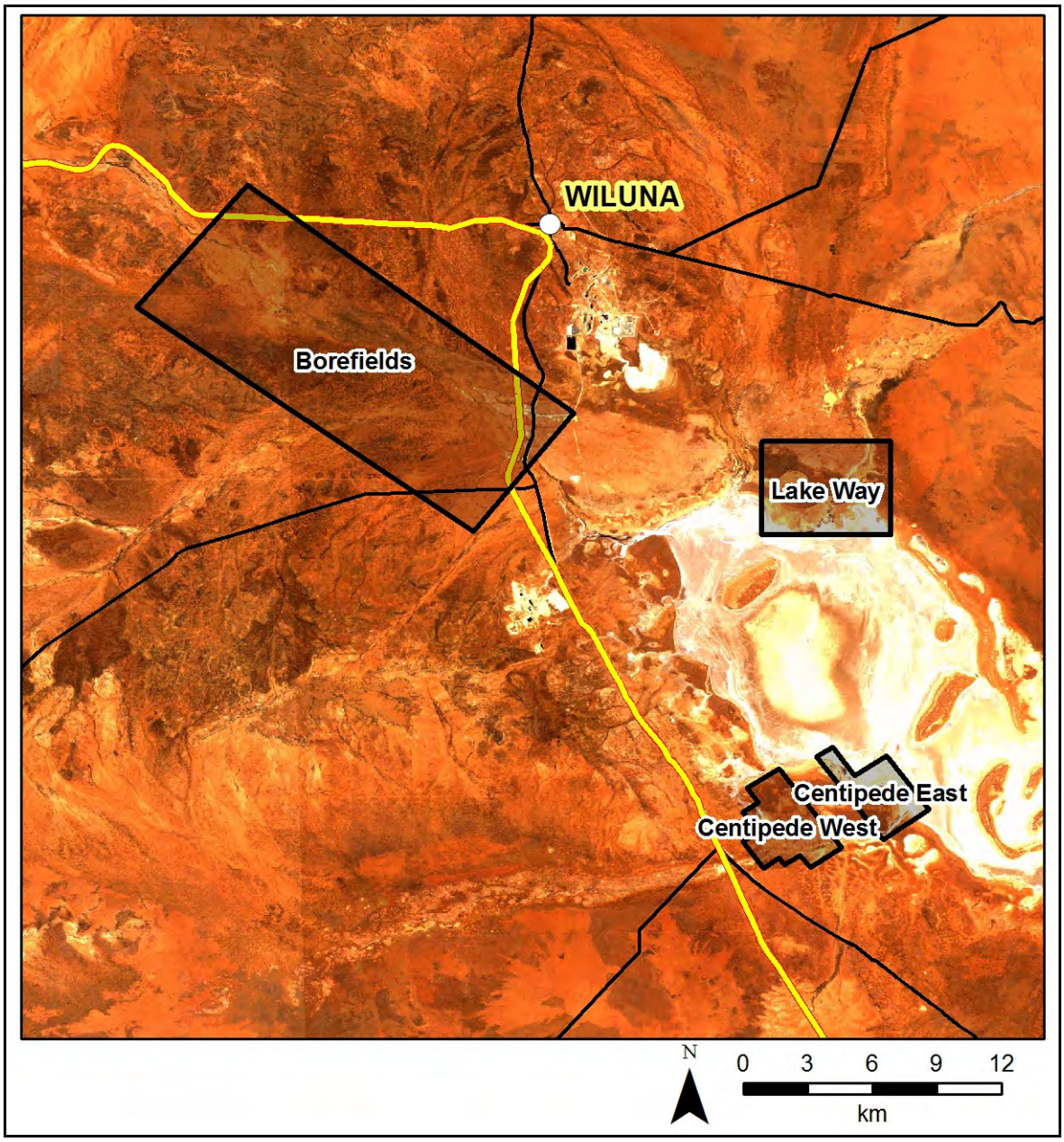

Figure 2: Wiluna Uranium Project Study area

1.2 Report Scope and Objectives

This report documents the results of the following surveys:

- A comprehensive desktop study of the Study area encompassing database searches and a review of relevant literature;
- A reconnaissance survey undertaken over the Study area from the 30 November to 4 December 2009 to verify the accuracy of the desktop study, further delineate and characterise the fauna habitats present and conduct targeted searches for species of conservation significance; and
- A detailed autumn survey undertaken from 3-15 March 2010 which involved a variety of sampling techniques, including systematic, targeted and opportunistic sampling terrestrial vertebrate fauna species and terrestrial invertebrate short-range endemic (SRE) fauna species.

In addition to the two terrestrial fauna surveys conducted in 2009 and 2010, a detailed spring terrestrial fauna survey was conducted over the Study area from 18 to 28 October 2007 by Outback Ecology. Findings of this survey are given consideration within this assessment.

The report also presents a summary of terrestrial fauna species previously recorded in the Study area and surrounds between 1978 and 2010.

The overall objectives of this terrestrial fauna assessment were to:

- Develop an inventory of terrestrial vertebrate fauna species and terrestrial invertebrate short-range endemic (SRE) fauna species identified from within the Study area, or likely to be present within the Study area;
- Identify terrestrial vertebrate and invertebrate SRE fauna species of conservation significance potentially occurring over the Study area;
- Identify, characterise and map the broad vertebrate fauna habitat and potential invertebrate SRE habitat occurring within the Study area;
- Assess findings in the regional context by comparisons with available data from other localities within the bioregion; and
- Assess the potential impacts of the planned development on vertebrate fauna and their habitats.

The surveys were designed and conducted as far as practicable in accordance with the WA Environmental Protection Authority's (EPA's) Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002); Guidance Statement No. 56 *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004); and Guidance Statement No. 20 *Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA, 2009).

2. EXISTING ENVIRONMENT

2.1 Biogeographic Region

The Study area is situated in the semi-arid to arid Eyrean Sub-region, one of three very broad sub-regions covering the entire Australian continent defined by Heatwole (1987), with the others being the tropical Torresian and the temperate Bassian sub-regions. Thackway and Cresswell (1995) describe a more refined system of 85 'biogeographic regions' (bioregions) covering the whole of Australia. Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The Study area is located within the Murchison bioregion. The Murchison bioregion encompasses the transitional zone between the eucalypt dominated environs of south-western Australia and the mulga/spinifex dominated areas of central Australia (Morton *et al*., 1995). The bioregion contains several large ephemeral wetlands, providing refuge for waterbirds. The vegetation in the bioregion is closely associated with geology, soils and climate. Areas of outcropping rock with skeletal soils support mulga low woodlands. Hummock grassland grows predominantly on calcareous soils and samphire (*Tecticornia* sp.) low shrubland mostly on the saline alluvial areas. In the east of the bioregion, the red sand plains support mallee-mulga parkland over hummock grassland (Thackway and Cresswell, 1995).

The Murchison covers an area of 278,360 km^2 with mining and grazing as the two main land uses (Morton *et al*., 1995). The Murchison bioregion is further divided into two sub-regions; the Eastern Murchison (MUR1) and the Western Murchison (MUR2). The Study area is located within the Eastern Murchison sub-region (**Figure 3**), which is characterised by Cowan (2001) as:

> "internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake systems are associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains are widespread. Vegetation is dominated by mulga woodlands often rich in ephemerals, hummock grasslands, saltbush shrublands and *Halosarcia* (now *Tecticornia*) shrublands".

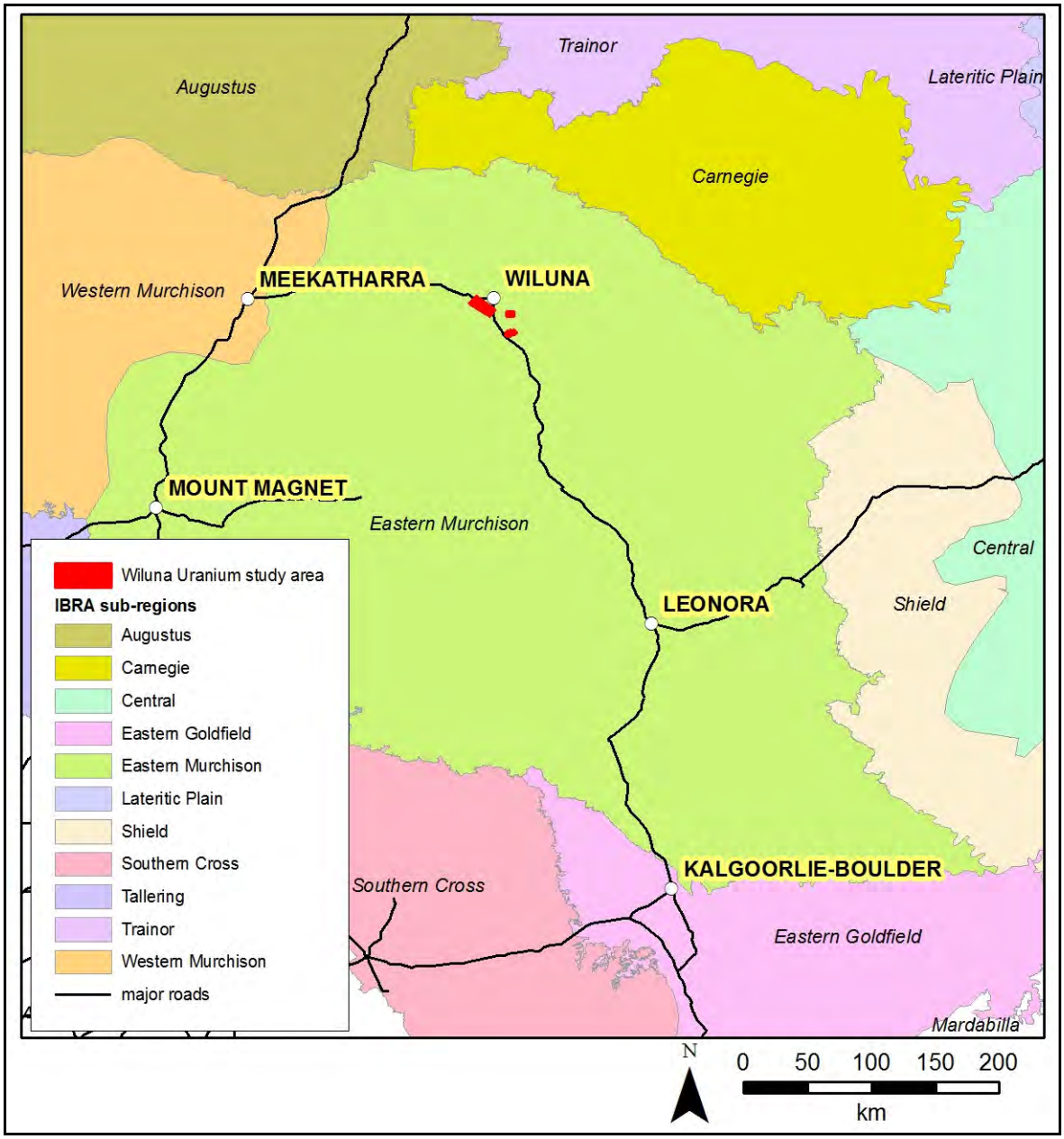

Figure 3: Location of the Project within the Eastern Murchison (MUR1) subregion

2.2 Climate

The Murchison region has an arid climate, with hot and dry summers and winters which are typically mild with cool nights. Annual rainfall within the Murchison is in the range of 200 millimetres (mm) and is known to be unpredictable throughout the year.

Summer weather in the region is influenced by anticyclonic systems to the south-east, which result in a pattern of clear skies and easterly winds (Pringle *et al.*, 1994). The Murchison region borders the southern end of the Intertropic Convergence Zone and, as a consequence, thunderstorm activity and summer

rainfall is generated (Pringle *et al.*, 1994). While summer rainfall is a feature of the region, most years have a dry spell lasting four to six months, typically commencing around September - October (Pringle *et al.*, 1994).

Winter weather patterns are directly influenced by the anticyclonic system, which results in the generation of westerly winds and rain-bearing frontal systems (Pringle *et al.*, 1994). Winter rains are usually heaviest around late May into August, and subside during the months of September and October as the anticyclonic conditions stabilise (Pringle *et al.*, 1994).

The nearest Bureau of Meteorology (BOM) weather station to the Study area is located in Wiluna, approximately 15km to the north-west. Wiluna experiences an arid climate characterised by hot dry summers and mild dry winters with irregular rainfall averaging 256 mm per annum. Most rainfall occurs in January to June (**Figure 4**), resulting from summer cyclonic rains and isolated thunderstorms. Average daily maximum temperatures range from 19.4° C in July and up to 37.9° C in January. Average daily minimum temperatures range from 5.4 °C in July to 22.8 °C in January (BOM, 2010).

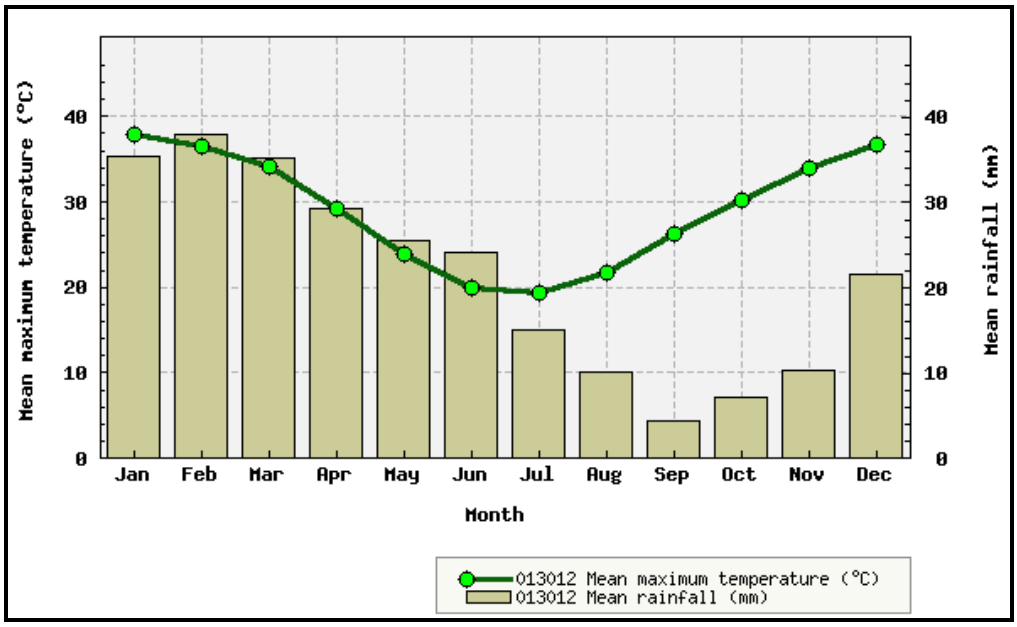

Figure 4: Climate data for Wiluna weather station (Bureau of Meteorology, 2010)

2.3 Land Systems of the Study Area

The Western Australian Department of Agriculture completed a regional survey of land systems occurring within the Murchison to develop a comprehensive description of biophysical resources and to provide an assessment of the condition of the soils and the vegetation of the north-eastern Goldfields (Pringle *et al.*, 1994). A component of the survey was the mapping of land types, land units and land systems of the Murchison.

The Study area is located across ten land systems (**Figure 5**). The majority of the Lake Way and Centipede study areas are located predominantly over the Carnegie land system which is characterised by salt lakes and dunes. The Borefield study area is located predominantly over the Cunyu and the Yanganoo land systems which are characterised by calcrete platforms and hardpan plains, respectively (**Table 1**).

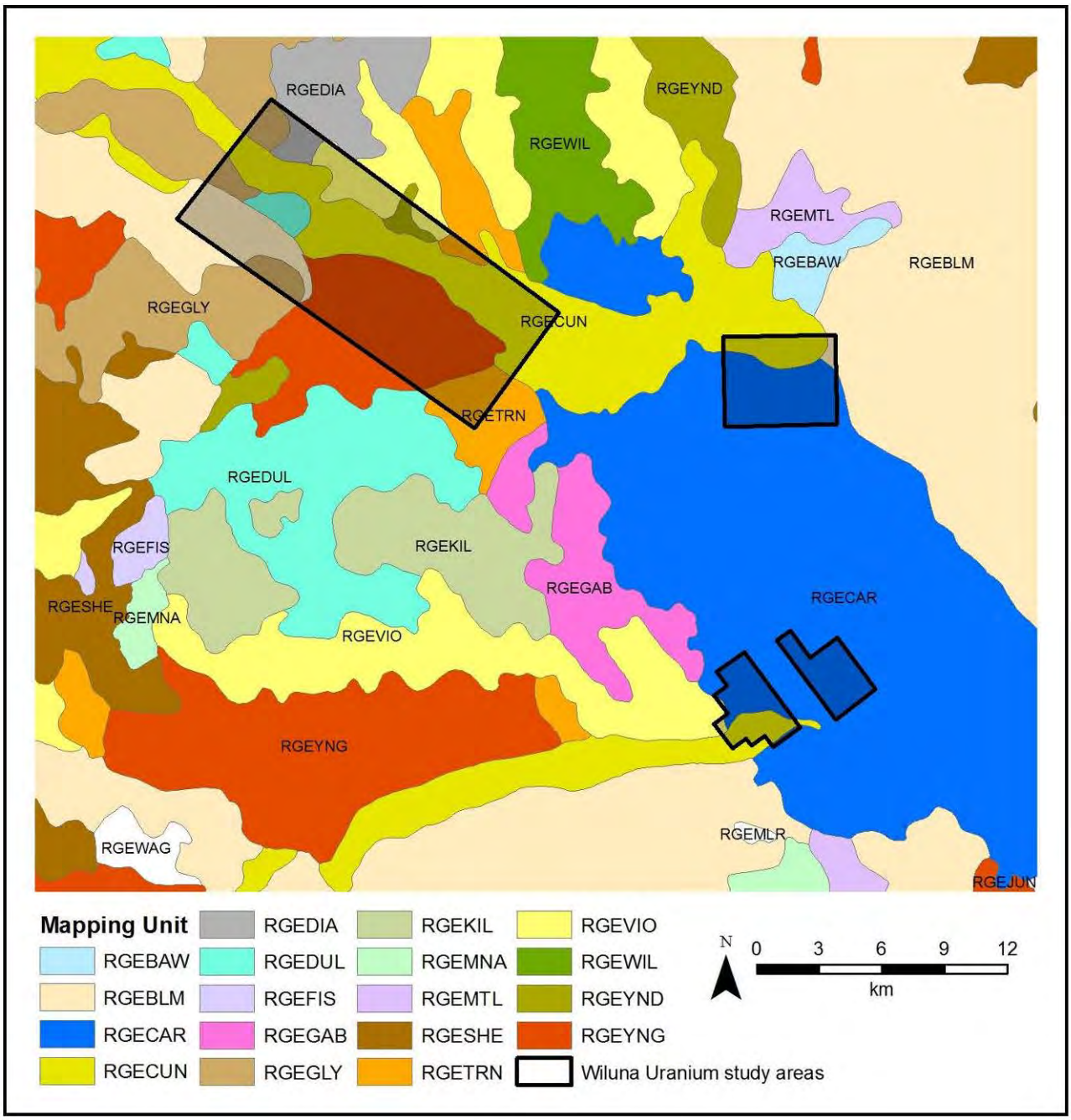

Figure 5: Land systems within and surrounding the Study area

Table 1: Land systems within the Study area and surrounds

Land Type (Broad descriptive unit)	Land System (Mapping unit)	Description	Area within Study area (Ha)	Proportion of Study area (%)
Salt lakes and fringing alluvial plains with saline soils and halophytic shrublands	Carnegie (RGECAR)	Salt lakes with extensively fringing saline plains, dunes and sandy banks, supporting low halophytic shrublands and scattered tall acacia shrublands; lake beds are highly saline; gypsiferous and mainly unvegetated. Forms the majority of both Centipede and Lake Way study areas.	4 781	28.8
Wash plains and sandy banks on hardpan, with mulga shrublands and wanderrie grasses or spinifex	Yanganoo (RGEYNG)	Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks. Represents a substantial component of the Borefields study area.	3 675	22.2
	Trennaman (RGETRN)	Sandy hardpan plains and broad drainage zones supporting groved mulga shrublands and wanderrie grasses. Represents a minor component of the Borefields study area.	803	4.8
Calcreted drainage plains with mixed halophytic and non-halophytic shrublands	Cunyu (RGECUN)	Calcrete platforms and intervening alluvial floors and minor areas of alluvial plains, including channels with *Acacia* shrublands and minor halophytic shrublands. Occurs within all three study areas.	3 182	19.2
Sandplains with Spinifex hummock grasslands, *Acacia* shrublands, heath and eucalypts	Bullimore (RGEBLM)	Extensive sand plains supporting spinifex hummock grasslands. Occurs in the north-west of the Borefields study area.	1 386	8.4
Hills and ranges with acacia shrublands	Glengarry (RGEGLY)	Sandstone plateaux, summits and hillslopes supporting mainly dense mulga and other acacia shrublands, spinifex, and numerous low shrubs. Represents a minor component of the Borefields study area.	901	5.4
Irregular plains and low rises supporting mulga, bowgada and halophytic shrublands	Violet (RGEVIO)	Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and patchy halophytic shrublands. Represents a minor component of the Borefields and Centipede study area.	901	5.4
Plains with calcrete intrusions fringing salt lake systems, with Eucalyptus-Casuarina – Acacia woodlands or shrublands	Dural (RGEDUL)	Strongly undulating terrain on weathered mudstone and basalt supporting open mulga shrublands with mallee and spinifex. Represents a minor component of the Borefields study area.	412	2.5
Wash plains on hardpan with mulga shrublands	Diamond (RGEDIA)	Gently undulating plains supporting sometimes groved mulga tall shrublands with dense low shrubs. Represents a minor component Borefields study area in the north-west section.	337	2
Wash plains on hardpan with mulga shrublands	Yandil (RGEYND)	Flat hardpan wash plains with mantles of small pebbles and gravels; supporting groved mulga shrublands and occasional wanderrie grasses. Represents a minor component of the Borefields study area.	210	1.3

2.4 Land Use

Land use within the Eastern Murchison sub-region (MUR1) consists of grazing, mining, customary indigenous purposes, unallocated crown land (UCL), crown reserves and conservation reserves (Cowan, 2001; NLWRA, 2002).

2.4.1 Grazing

The dominant land use of the MUR1 sub-region is grazing of stock on pastoral leases, with approximately 85% of the sub-region used for this purpose (Cowan, 2001). Sheep stations were established in the Wiluna area in the 1920s and were once the dominant non-Indigenous land use in the area. The Lake Way tenement (E53/1132) and Borefields tenement (L 53/0150) are located on Millbillillie pastoral lease and the Centipede tenements (M 53/0113, P53/1355, P53/1356, P53/1357, P53/1396, M 53/224) are located on the Lake Way pastoral lease (**Figure 6**).

In the past decade, many pastoral leases in the area have been purchased by mining companies and de-stocked. However, both the Millbillillie and Lake Way pastoral leases are currently stocked with cattle; Lake Way Station was re-stocked in 2000.

2.4.2 Mining

There is an extensive history of mining activity and associated disturbance within the Wiluna region, with gold first being discovered at Wiluna in 1896. Since then the area has produced in excess of 3 million ounces of gold (Agincourt Resources Limited, 2006). The largest of these historic operations was the Wiluna Gold Mine, which is located 4 km south of Wiluna, and approximately seven km to the northwest of the Study area. The mine once supported a population of around 9,000 people. The existing Wiluna Gold Mine and associated operating infrastructure footprint covers a total area of approximately 1,970 ha and currently consists of a large open pit and underground mine development (Outback Ecology, 2010).

Other mining projects in the Wiluna region include but are not limited to:

- Wiluna South Gold Mine, located five kilometres to the west of the Study area. This operation has been rehabilitated and is currently closed.
- Jundee Gold Mine, approximately 50 km north east of Wiluna. Operated by Newmont, production began in 1995 and continues from two underground mines.
- Magellan Lead Mine, approximately 30 km west of Wiluna. The operation has been producing lead carbonate concentrate intermittently since 1995 from a treatment and concentrating plant.
- Golden West Resources Wiluna West Iron Ore Exploration Project, approximately 40 km west of Wiluna.
- The proposed Yeelirrie Uranium Project, 75 km to the south west of Wiluna; and
- The proposed Lake Maitland Uranium Project, 80 km to the south east of Wiluna.

The location of these operations (and proposed projects) in relation to the proposed Wiluna Uranium Project is shown in **Figure 1**.

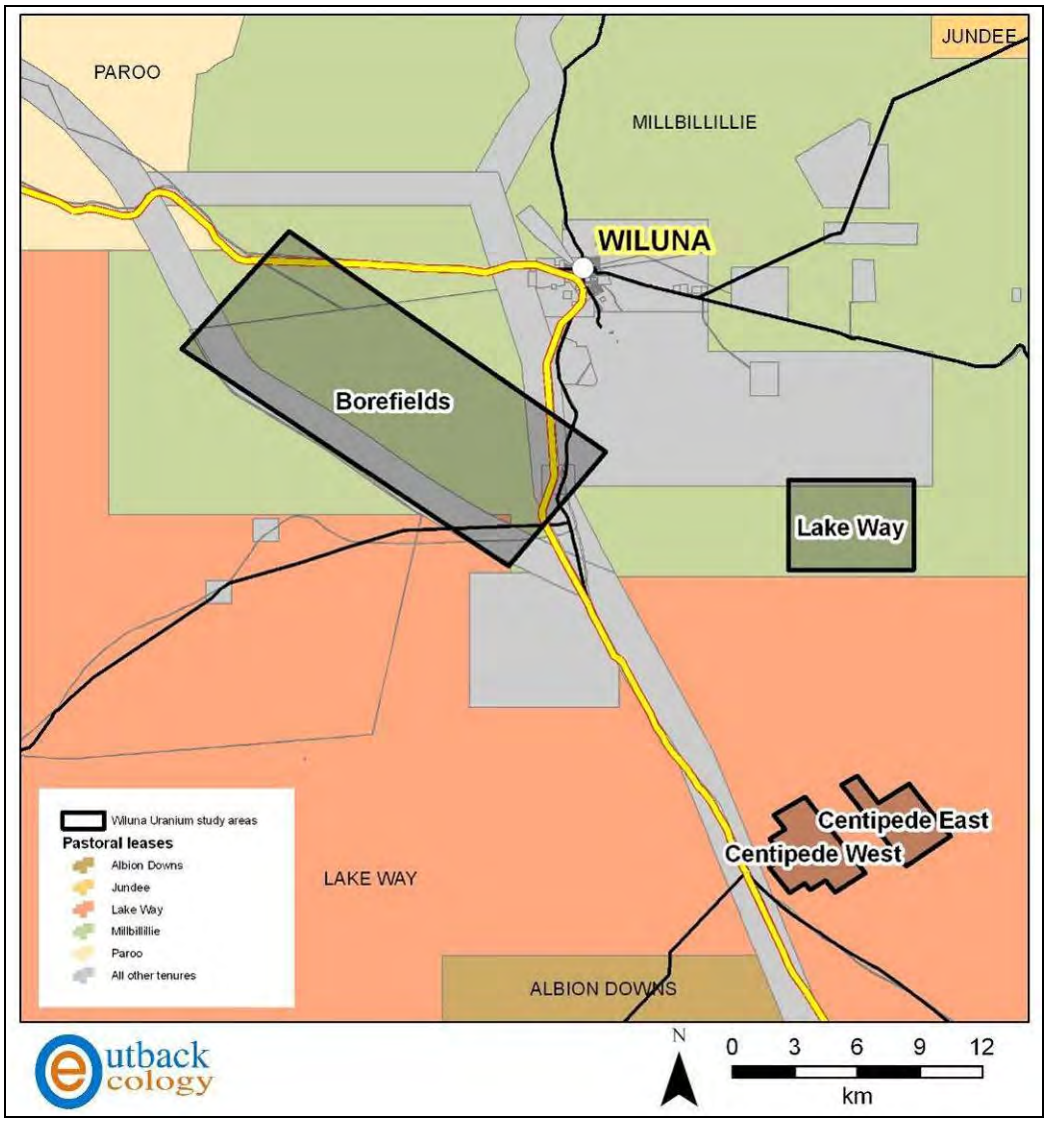

Figure 6: Location of the Study area in relation to the surrounding pastoral leases.

Lake Way Deposit

The Delhi International Oil Corporation (Delhi) and Vam Limited Joint Venture discovered the Lake Way uranium deposit in 1972 while exploring for base metal mineralisation within the Wiluna district. Delhi completed virtually all of the exploration and feasibility work until CSR Limited acquired Delhi in December 1981. In 1983, exploration and development plans were suspended and assets were dispersed in response to the Federal Labour Government's 'Three Mines" Policy' uranium mining policy.

Extensive exploration and evaluation has been undertaken on the Lake Way deposit involving drill holes, bulk samples, trial mining, topographic surveys, groundwater analysis, hydrologic and environmental studies including vertebrate fauna studies.

In April 1981, draft Environmental Impact Statements and Environmental Management Plans for the Lake Way Project were made available for public review (Lancaster and Associates, 1981), and the final documents were assessed by the Environmental Protection Authority (EPA). The EPA did not identify any 'unacceptable' potential environmental impacts preventing the proposed development from proceeding. However, the EPA recommended that additional baseline data collection; monitoring and impact assessment work would be needed to satisfy environmental protection and management regulatory requirements.

Centipede Deposit

It is thought that the Centipede deposits were discovered around 1977 by Esso as acting manager and operator of a joint venture comprising of MIM, Inco and Seltrust. The majority of exploration was undertaken by Esso between 1977 and 1981. Rights to the Centipede project were acquired by Delhi in 1982. Exploration and development plans were suspended after the 'Three Mines Policy' was initiated in 1983.

2.4.3 Conservation

The National Land and Water Resources Audit (NLWRA) states that just 1.4% of the Murchison bioregion is classified as conservation estate (NLWRA, 2002). In 2001, Cowan reported that 1.82% of the MUR1 sub-region was classified as conservation estate. Since that time a comprehensive land acquisition program has contributed additional land for conservation purposes and in 2009 land vested in conservation reserves increased to 7.98% (Department of Environment and Conservation [DEC], 2009).

Wanjarri Conservation Reserve

The Wanjarri Nature Reserve (53,000 ha) is located 55 km to the south-east of the Study area. It is consists mostly of extensive undulating sandplains featuring sand dunes, with breakaways and low granite hills also common. The reserve has been recognised as possessing a rich vertebrate fauna (DEC, 1996), particularly for birds (122 species recorded). Conservation values of this reserve are as follows:

- An arid land and desert landscape supporting a variety of habitats;
- Spinifex grasslands that characterise what most people perceive to be the deserts of the Australian inland;
- The development of plant communities since grazing ceased that provide useful baseline data about the recovery of the rangelands;
- The use of particular habitats by threatened wildlife.

2.4.4 Indigenous Land Use

2.4.5 Wetlands of Significance

The closest listed wetland of significance to the Study area is the Lake Carnegie System, located approximately 225 km to the east north-east. Lake Carnegie is listed in the Directory of Important Wetlands in Australia (Environment Australia, 2001).

3. SURVEY ASSESSMENT AND METHODOLOGY

The methods used to assess the presence of terrestrial fauna during this assessment include: database searches (Section 3.1), a literature review (Sections 3.2 and 3.3), a site reconnaissance survey and terrestrial vertebrate fauna survey (Section 3.4) and a terrestrial invertebrate SRE fauna survey (Section 3.5).

3.1 Database Searches

Database searches were undertaken in December 2009 prior to the field surveys to develop a list of potential bird, reptile, mammal and amphibians that occur in the Study area. Search areas were defined by a fixed point that was centred between the Centipede, Lake Way and Borefield study areas (latitude -26.77° and longitude 120.26°) and extending over a 150 km radius in order to encompass similar habitats across a variety of tenures. Database searches of this area were made using the following databases and internet tools:

- Threatened and Priority Fauna Database (DEC,2009a);
- NatureMap database (DEC, 2009b);
- Environmental Reporting Tool (DEWHA,2009a);
- Protected Matters Search Tool(DEWHA,2009b);
- The Australian Wetlands Database (DEWHA,2009c);
- Birds Australia (2009) database;
- Australian Museum (2009) database; and
- Species Profile and Threats Database (SPRAT) (DEWHA, 2009d).

Species listed in regional summary documents such as the Australian Natural Resources Atlas (ANRA, 2007) and the Biodiversity Audit of Western Australia's 53 Biogeographical Subregions (McKenzie and May, 2003) were also considered in this assessment.

3.2 Previous Surveys within the Study Area

A literature review was undertaken to provide a list of mammals, birds, reptiles, amphibians and fish species and invertebrate SRE fauna species that have previously been recorded in the Study area. Surveys previously conducted in the Study area or surrounds (<150km) are briefly discussed below:

3.2.1 Lake Way Baseline Terrestrial Fauna Survey (Outback Ecology, 2008)

A detailed spring level 2 terrestrial fauna baseline assessment was conducted over the Lake Way and Centipede study areas from 18 to 28 October 2007.

Systematic and opportunistic sampling methods were utilised to target: mammals, birds, reptiles and amphibians; and potential SRE invertebrate fauna groups, specifically mygalomorph spiders, centipedes, scorpions, pseudoscorpions, millipedes and molluscs. Systematic methods included trapping techniques,

active hand searching, soil sieving, spotlighting searches and fixed time avifauna censusing. Six trapping grids were established that incorporated pitfall (PVC pipes and 20L buckets), Elliott, funnel and cage traps and micro pit traps for SRE invertebrate fauna. ANABAT monitoring was conducted over a period of six nights. Additional targeted searches for conservation significant species including the Malleefowl (*Leipoa ocellata*), Mulgara (*Dasycercus cristicauda*), Slender-billed Thornbill (*Acanthiza iredalei*) and mygalomorph spiders were made in specified habitats.

Nine broad fauna habitats were identified in the Lake Way and Centipede study areas comprising Melaleuca Grove, Mulga over Spinifex, Eucalypt Woodland, Mulga Woodland, Mallee over Spinifex, Woodland on Calcrete Flats, Samphire Flats, Claypan and Drainage Line and Floodplain.

A total of 109 vertebrate fauna species were recorded comprising 22 mammals (15 native), 55 birds and 32 reptiles (**Appendix A**). The survey recorded one vertebrate species of conservation significance; the Rainbow Bee-eater (*Merops ornatus*) which is listed as a Migratory species under the EPBC Act 1999.

Of the terrestrial invertebrate fauna groups targeted during this survey, a total of 22 species were recorded, comprising six mygalomorph spiders, three pseudoscorpions, five scorpions, four centipedes and four snail species. Invertebrate specialists of the Western Australian Museum (WAM) and University of Western Australia (UWA) concluded that none of the centipede, snail, and pseudoscorpion species collected were short-range endemic species. Three mygalomorph spider species (*Eucyrtops sp* , *Aganippe sp A* and *Aganippe "occidentalis sp group"*) and one scorpion species (*Urodacus 'yeelirrie'*) recorded from the Study area were considered to represent putative SRE species.

Dr Volker Framenau (WAM) has recently completed a review of the mygalomorph spider specimens collected during the spring 2007 survey (Framenau & Harvey 2010; **Appendix E**). Since all of these specimens in question were either immature or female, it was not possible to accurately identify the specimens to species level and therefore it was not possible to determine if they represented putative SRE species. The scorpion species *Urodacus* 'Yeelirrie' remains listed as a putative SRE species and the species Urodacus 'Lake Way 1' is awaiting formal identification by Dr Erich Volschenk.

3.2.2 Waterbird Management Guidelines for Lake Way (Outback Ecology, 2005)

This desktop assessment examines past literature for waterbirds that may potentially occur at Lake Way, and provides a set of management recommendations for these species to address potential impacts associated with the Wiluna Gold Mine. A total of 47 waterbird species were identified as potentially occurring at Lake Way, with 18 deemed conservation significant species (i.e. listed as Migratory under the EPBC Act 1999, **Appendix A**). The assessment did not include any field observations.

3.2.3 Review of the Wetland Avifauna of Lake Way (Bancroft and Bamford, 2004)

Bancroft and Bamford (2004) collated an avifauna desktop assessment for Agincourt Resources for the proposed mining of Honeymoon Well, which is located on the western shore of Lake Way, approximately ten kilometres to the south of the Study area. A combination of database searches, using a three degree search area of the Birds Australia Atlas and WA Museum databases, and personal communication, identified 47 wetland bird species that have been recorded from or are expected to occur at Lake Way (**Appendix A**). A more specific search (one degree search area) identified 13 wetland bird species. Of these 13 species, five species were listed as conservation significant (i.e. listed as Migratory and/or Marine species under the EPBC Act 1999). The assessment did not include any field observations.

3.2.4 Lake Way Project Baseline Fauna Surveys (Outback Ecology, 2002).

A detailed terrestrial fauna assessment was undertaken over the western shore and surrounds of Lake Way by Outback Ecology from 2 to 7 October 2002. Systematic and opportunistic sampling methods were utilised to target mammals, birds, reptiles, amphibians and SRE invertebrate fauna. Systematic methods included trapping techniques, active hand searching, spotlighting searches and avifauna censusing. Nine trapping grids were established across a range of habitats that incorporated pit traps, Elliott box traps, Sheffield cage traps, funnel traps and micro pit traps for SRE invertebrate fauna. Lake sediments were collected for water quality and invertebrate studies.

Habitat mapping was not conducted as part of this survey, although notes on fauna habitat characteristics were taken for each of the nine survey sites. Broad habitats as noted at each site included Open woodland of *Acacia ayersianna* over shrubland of *Santalum spicatum*, Open woodland of *Acacia ayersianna* over *Cratistylis subspinescens*, and Open woodland of *Acacia aneura* over *Grevillea* and *Melaleuca* species.

A total of 11 vertebrate fauna species were recorded, comprising one mammal (House Mouse *Mus musculus* - introduced), 22 birds and nine reptiles and one amphibian (**Appendix A**). No waterfowl or waders were recorded, owing to dry conditions during the survey.

No conservation significant species were recorded during the survey.

3.2.5 A Survey of the Vertebrate Fauna of the Lake Way Area, Mid-western Australia (CSIRO, 1978).

A comprehensive survey of terrestrial vertebrate fauna was carried by CSIRO for the Wyoming/Delhi/VAM Joint Venture during spring 1977 and autumn 1978. The area surveyed is located between the northern shores of Lake Way and the town of Wiluna, coinciding with the Lake Way study area from the current study.

Thirteen habitat types were identified comprising Samphire, Chenopodiaceous Steppe, Melaleuca Thicket, Freshwater Claypans, River Gum Woodland, Calcrete Woodland, Alluvial Mulga Woodland, Stony Mulga Woodland, Stony Mulga on Quartzitic Outcrops, Stony Mulga on Breakaways, Mulga-Spinifex Sandplains, Mallee-Spinifex Sandplains, and Spinifex Sandplains.

A total of 201 vertebrate fauna species were recorded over these two surveys, comprising 16 mammals (12 native), 46 reptiles, 139 birds and six amphibian species.

The comprehensive nature of this survey and fortuitous timing with respect to favourable seasons and rainfall produced a wealth of records for waterbirds, including 12 species listed as Migratory under the EPBC Act 1999. No threatened species were recorded during these surveys.

3.3 Previous Surveys in the Study Area Surrounds

A number of studies have been conducted in the wider Wiluna region which provide useful contextual information for this assessment. These previous studies are summarised below.

3.3.1 Vertebrate Fauna Assessment of the Yeelirrie Project Area (Bamford Consulting Ecologists, 2010)

A detailed fauna assessment of the Yeelirrie Project area was conducted by Bamford Consulting Ecologists, comprising intensive trappings surveys during March and November 2009 and two surveys to target significant species (July 2009 and May 2010). The Yeelirrie Project is located approximately 75 km to the south of the Study area.

The trapping surveys involved a variety of sampling techniques, including systematic and opportunistic sampling to target mammal, bird, reptile, and amphibian species; and terrestrial SRE invertebrate fauna groups; and more specifically, mygalomorph spiders, scorpions, pseudoscorpions, millipedes and molluscs. Systematic sampling was conducted at seven survey sites, and involved trapping techniques, active hand searching, spotlighting searches for nocturnal animals and fixed time avifauna censusing. Inventory searches, micro-pit trapping and soil sieving for invertebrates was undertaken over all seven survey sites. Pitfall traps, Elliott traps, funnel traps and cage traps were installed at five of the survey sites. Bats were sampled by the recording of echolocation calls using an AnaBat system over both survey periods. Additional targeted searches for conservation significant species were made in specified habitats.

Seven broad habitats were identified and surveyed during the assessment, comprising Granite Outcrops and Breakaways, Scattered Shrubs over Spinifex Sandplain, Mulga over Spinifex Sandplain, *Acacia* Woodland over Sparse Spinifex, Hardpan Mulga, Calcrete (inc. *Eucalyptus gypsophila*) and Calcrete Outwash with Thickets and Shrubland.

A total of 196 vertebrate species were recorded during the surveys, comprising 25 mammals (21 native), 82 birds, and 49 reptiles and four amphibians (**Appendix A**). Eight conservation significant species were recorded during the 2009 and 2010 surveys. These included the Malleefowl (*Leipoa ocellata*), Mulgara (*Dasycercus cristicauda*) and Black-flanked Rock-Wallaby (*Petrogale lateralis*) – Vulnerable EPBC Act 1999, Schedule 1 Wildlife Conservation Act 1950 [WC Act]); Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*) and Greater Long-eared Bat (*Nyctophilus timoriensis*) – Priority Four

Fauna; Peregrine Falcon (*Falco peregrinus*) – Schedule 4 WC Act 1950); and Rainbow Bee-eater (*Merops ornatus*) – Migratory EPBC Act 1999.

3.3.2 Short-range Endemic Invertebrate Baseline Survey of the Yeelirrie Project Area (Draft Report) (Ecologia, 2010)

A Level 2 SRE invertebrate survey was conducted over the Yeelirrie Project area (70 km south south west of the Study area) over a series of three phases in 2009 and 2010. The first phase involved a foraging survey of 10 sites and was undertaken in July 2009. The second phase incorporated the wet pitfall trapping of 20 sites within the project area between October 2009 and January 2010. The third phase incorporated wet pitfall trapping of 10 sites outside the project area between April and May 2010.

During the first and second phase of the survey, a total of two SRE species (both isopods) and nine potential SRE species (five species of trap-door spider, one species of pseudoscorpion, one species of scorpion, one species of isopod and one species of centipede) were recorded. The third phase of the survey resulted in the collection of a single specimen of *Idiosoma* (*nigrum* group) from a burrow. *Idiosoma nigrum* (Shield-backed trapdoor) is listed as a Schedule 1 species under the 1950 *Wildlife Conservation Act*; however, it is unclear whether the specimen from Yeelirrie represents *I. nigrum* or a closely related species.

3.3.3 Lake Maitland Terrestrial Fauna Habitat Assessment (Outback Ecology, 2010)

A Level 1 terrestrial fauna assessment was conducted over the Lake Maitland study area in 2009 (Outback Ecology, 2010). The Lake Maitland Project is located approximately 90 km to the south east of the Study area. This assessment included a desktop review of literature and relevant databases, and a reconnaissance survey from 14 to 21 October 2009. Habitat assessments were conducted for vertebrate and SRE invertebrate fauna, as well as spotlighting and targeted searches for species of conservation significance.

Ten broad fauna habitats were identified from the Lake Maitland study area and surrounds during the survey, comprising Calcrete Plain, Claypan, Kopi Dune, Lake Edge Spinifex, Mallee Spinifex Sandplain, Mulga Woodland/Shrubland Plain, Samphire Flats, Shrubland on Sandplains, Spinifex Shrubland, and Woodland/Shrubland on Calcrete Flats.

A total of 50 terrestrial vertebrate fauna species were recorded within the Lake Maitland study area during the Level 1 survey, comprising nine mammal (four native), 31 bird and 10 native reptile species. The survey recorded one vertebrate species of conservation significance; the Rainbow Bee-eater (*Merops ornatus*) which is listed as a Migratory species under the *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

Four potential SRE habitats were identified within the revised Lake Maitland study area on the criteria of being isolated habitats, comprising Samphire Flats, Lake Edge Spinifex, Claypan and Kopi Dune habitats; although all of these habitats were exposed with little shelter and considered to have a relatively low potential to support SRE invertebrate fauna.

3.3.4 Lake Maitland Project Baseline Terrestrial Fauna Survey (Outback Ecology, 2009)

Two detailed fauna surveys of Lake Maitland Uranium Project area were conducted by Outback Ecology from the 7 to 16 May 2007 (autumn survey) and the 7 to 13 December 2007 (summer survey). Both surveys involved a variety of sampling techniques, including systematic and opportunistic sampling to target mammal, bird, reptile, and amphibian species; and terrestrial SRE invertebrate fauna groups, and more specifically, mygalomorph spiders, scorpions, pseudoscorpions, millipedes and molluscs. Systematic sampling was conducted at seven survey sites, and involved trapping techniques, active hand searching, spotlighting searches for nocturnal animals and fixed time avifauna censusing. Inventory searches, micro-pit trapping and soil sieving for invertebrates was undertaken over all seven survey sites. Pitfall traps, Elliott traps, funnel traps and cage traps were installed at five of the survey sites. Bats were sampled by the recording of echolocation calls using an AnaBat system over both survey periods. Additional targeted searches for conservation significant species were made in specified habitats.

Seven broad habitats were identified and surveyed during the assessment, comprising Spinifex Plains, Mulga Woodland, Mallee over Spinifex, Bull Spinifex on Lake Edge, Woodland on Calcrete Flats, Samphire Flats and Kopi Ridge.

A total of 123 vertebrate species were recorded during the surveys, comprising 24 mammals (17 native), 60 birds, and 39 reptiles (**Appendix A**). No amphibian species were detected. The Mulgara (*Dasycercus cristicauda),* which is listed as Vulnerable under the EPBC Act 1999 and Schedule 1 under the WC Act 1950, was recorded during both surveys. The Priority 4 Bush Stone-curlew (*Burhinus grallarius)* was recorded during the autumn 2007 survey.

A total of 16 distinguishable invertebrate species were collected during the surveys, including seven mygalomorph spiders, six scorpions, one pseudoscorpion and two terrestrial snail species. Some of the collected specimens were either immature or female and consequently could not be identified down to species level. Of the species identified, four mygalomorph spider species and two scorpion species were identified as possible SRE species.

3.3.5 Barwidgee Pastoral Lease Mulgara *Dasycercus cristicauda* Survey. (Halpern Glick Maunsell, 1997).

The assessment of the status of the Mulgara (*Dasycercus cristicauda*) on the Barwidgee Pastoral Station, located approximately 90km south of the Study area, was undertaken in 1997 and comprised systematic searches of suitable habitat and a follow-up trapping program. It was concluded from the survey that

suitable habitat for Mulgara consisted of sandplains supporting pure stands of mature clumps of Spinifex with large intervening spaces, and a sparse overstorey. Trapping using Elliott traps was undertaken from the 25 August to 3 October 1997 at three survey sites: Charlies Well, Sisters Well and Wanjarri Border. A total trapping effort of 1,117 trapping nights was conducted, resulting in the capture of eight individuals.

3.3.6 Wanjarri Nature Reserve Management Plan 1996 – 2006 (Department of Conservation and Land Management, 1996)

This document details the conservation values and management issues associated with Wanjarri Nature Reserve, located 55 km to the south-east of the Wiluna Study area. The main landforms that occur within the Nature Reserve include Breakaways, Drainage Lines, Broad Valleys, Sandplains, Dunefields, Low Granite Hills and Undulating Plains.

Threatened fauna previously recorded within the Reserve include the Mulgara (*Dasycercus cristicauda:* Vulnerable - EPBC Act, Schedule 1 – WC Act) and Malleefowl (*Leipoa ocellata:* Vulnerable - EPBC Act, Schedule 1 – WC Act). The Malleefowl has not been recorded on the Reserve since 1969 and the Grey Honeyeater has not been recorded within the Reserve since 1972. The Mulgara was recorded in 1994 (two years before the Management Plan was released). Spinifex sandplains were identified as important habitat for the Mulgara.

3.3.7 The Biological survey of the Eastern Goldfields of Western Australia. Part 10. Sandstone – Sir Samuel and Laverton - Leonora Study areas. (Hall et al., 1994).

The Sandstone – Sir Samuel area lies approximately 150 km to the south of the Wiluna Uranium Project Study area and was surveyed from January 1980 to August 1982 and October 1987 to September 1992. Trapping sites used in this regional biological survey were located approximately 55 from the Study area, in Wanjarri Nature Reserve. Trapping grids comprising of six pitfall traps, nine Elliotts, nine break-backs and three cage traps were established at 14 survey sites over the two biological study areas. Avifauna censusing was undertaken at each site.

Ten broad landform units were recognised from this regional biological study with the most extensive including Sandplains and Broad Valleys, Salt Lake Features, Calcareous Plains bordering salt lakes and undulating plains.

A total of 175 vertebrate species were recorded during the survey, including 26 (18 native) mammal, 54 reptile, three frog and 92 bird species from the study areas (**Appendix A**). One conservation significant species was recorded during the survey - Australian Bustard (*Ardeotis australis*, Priority Four Fauna).

3.3.8 Vertebrate Fauna Assessment of the Proposed Bronzewing Gold Project (Ninox, 1993)

The Bronzewing Gold Project is located approximately 160 km to the south-east of the Study area. A Level 1 fauna survey was conducted over the Bronzewing project area in January 1993 by Ninox Wildlife Consulting. Sampling involved opportunistic searching and spotlighting for nocturnal species.

Five broad fauna habitats were identified in the project area, comprising Creeklines, Mulga Flats, Spinifex and Mulga Flats, Gravelly Rises and Rocky Hills.

A total of 72 vertebrate fauna species were recorded, comprising eleven mammals (six native), 55 birds and 6 reptiles (**Appendix A**). No amphibians were recorded during this survey.

One species of conservation significance, the Australian Bustard, (*Ardeotis australis* – Priority Four Fauna) was recorded during the survey.

3.3.9 The Small Vertebrate Ground Fauna of Mulga Habitats near Wiluna, Western Australia (Dunlop, 1990).

A fauna survey for small vertebrates was undertaken at a site approximately nine kilometres to the north-west of Centipede study area between June 1988 and May 1989, using pit trapping (4525 trap nights) and opportunistic hand collection. The primary objective of this survey was to investigate the relationships between the occurrence of various vertebrate species and broadly defined habitat components. A total of 46 vertebrate fauna species were recorded, comprising five mammals, 38 reptiles and four amphibians. No conservation significant species were recorded during this survey.

3.3.10 Malleefowl Searches at Yeelirrie Station 2006 (Benshemesh et al., 2006)

The distribution and population trends of Malleefowl were ascertained using ground tracking surveys in suitable habitat on Yeelirrie Station. Searches were focussed on the edges of the old plateau, which supported relatively tall shrublands (over 2m) of bowgada, mulga and other acacias. This survey was a continuation of surveys that had commenced in 2000. The species was found to be present in low densities and was highly localised within the “suitable” habitats and avoided more open areas or those that had been recently burnt. It was concluded the Malleefowl population at Yeelirrie Station had not declined since in commencement of surveying in 2000.

3.4 Terrestrial Vertebrate Fauna Survey

A reconnaissance survey and a detailed vertebrate fauna survey were conducted as part of this assessment. The reconnaissance survey was undertaken in December 2009 in order to ground truth fauna habitat types and survey site selections prior to the detailed autumn survey. This section details the methods used during the vertebrate fauna component of these surveys.

3.4.1 Survey Timing and Weather

The site reconnaissance survey was undertaken from 30 November to the 4 December 2009. Maximum temperatures during the survey ranged between 38ºC and 42ºC, with minima between 19ºC and 25ºC (BOM, 2009). The average minimum and maximum temperatures during the survey period were 22ºC and 40ºC respectively. No rainfall was recorded during the survey (BOM, 2009).

The detailed autumn terrestrial vertebrate fauna survey was undertaken from 3 to 15 of March 2010. Maximum temperatures during the survey ranged between 30°C and 39ºC, with an average maximum temperature during the survey period of 34ºC (**Table 2**). Minimum temperatures were not available for this time period (BOM, 2010).

No rainfall was recorded during the survey (BOM, 2010). A total of 107 mm of rainfall was recorded at the Wiluna weather station over the twelve months prior to the autumn survey, which represents 41% of the mean annual rainfall. In the months leading up to the autumn survey, the area had not received substantial rainfall (> 10 mm in one day) since mid January 2010 (BOM, 2010).

Weather conditions experienced during the 2010 autumn survey were considered appropriate to conduct the fauna surveys, as temperatures were neither too low nor too high to inhibit animal activity, except perhaps for birds. The hot conditions experienced in the autumn survey are likely to have resulted in reduced movement and song by most species, reducing their detectability. Warm daytime temperatures were considered favourable for increased reptile activity. Warm balmy nights provided optimal conditions for nocturnal spotlighting. The prolonged period of drought is likely to have affected the presence of waterbirds (Section 4.2.4).

Weather data for the autumn survey period is presented in **Table 2**.

Table 2: Climate data for the 2010 autumn survey period

Date	Temperature Min (°C)	Temperature Max (°C)	Rainfall (mm)	Relative Humidity (9 am)
3/03/2010	-	36.5	0	61
4/03/2010	-	39	0	54
5/03/2010	-	31	0	80
6/03/2010	-	29.6	0	74
7/03/2010	-	31.5	0	73
8/03/2010	-	32.5	0	75
9/03/2010	-	32.5	0	77
10/03/2010	-	34.7	0	73
11/03/2010	-	35.5	0	76
12/03/2010	-	35.1	0	100
13/03/2010	-	36.7	0	-
14/03/2010	-	37	0	64
15/03/2010	-	38.5	0	67

3.4.2 Site Selection, Locations and Habitat Descriptions

Prior to the 2009 reconnaissance survey, broad habitat types present within the Study area were identified from analysis of aerial imagery and topographical mapping; and with consideration to previous habitat assessment and vegetation mapping work conducted over the Centipede East and Lake Way study areas in 2007 (Outback Ecology, 2007). During the 2009 reconnaissance survey, the broad habitat types present throughout the entire Study area were confirmed, characterised and mapped, and the location of systematic and targeted fauna survey sites were selected.

Fauna habitats were assessed separately for their complexity and the quality of habitat that they provide for fauna, with a focus on suitability for conservation significant species. The following habitat characteristics were recorded: landscape features, vegetation type, litter cover abundance and type, soils, outcropping of rock, quantification of bare ground, evidence of disturbance (e.g. fire, tracks) and level of severity in terms of the effect that it has had on the vegetation (e.g. density of vegetation present, complexity of understorey).

A representative 20m x 20m quadrat was used at each survey site to conduct this vertebrate fauna habitat assessment. Sites were given a rating of excellent, very good, good, moderate, degraded or completely degraded based on the overall condition of the habitat for fauna. The dominant vegetation types within each habitat was identified, described and cross-referenced with vegetation mapping conducted over the Study area (Niche Consulting, unpubl. data).

Survey sites were primarily selected on the basis of being:

- Characteristic of the major fauna habitats present in the Study area;
- Existing systematic survey sites previously sampled in the 2007 spring fauna survey;
- Distributed across the Study area; and
- Outside of culturally sensitive areas, to which access was restricted.

Eight systematic survey sites were surveyed during the 2010 autumn survey. Systematic sites 1, 2, 3, 4 and 6 were originally surveyed during detailed fauna survey conducted by Outback Ecology in October 2007. Site 5 was not re-surveyed in 2010 due to heritage constraints. Sites 7, 8 and 11 were new systematic survey sites established in 2010. The major fauna habitats present and the co-ordinates of the fauna survey sites are summarised in **Table 3**. The locations of these sites within the Study area are shown in **Figure 7**.

Table 3: Fauna habitats identified within the Study area

Fauna Habitat	Site	Plate	Description (Niche Consulting, unpubl. data)	Coordinates (WGS 84)
Melaleuca Stands	1 & SRE A	1	Fringing Low Forest B of *melaleuca xerophila*	51 J 232898 7028007
Open Mulga Woodland over Spinifex	2 & SRE B, C, D	2	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	51 J 237980 7028261
Eucalypt Woodland	3	3	Calcrete Low Woodland A of *Eucalyptus gypsophila* over Low Woodland B of *Acacia* spp	51 J 232742 7045579
Mulga woodland over chenopod shrubland	4	4	Plains Open Low Woodland B of *Acacia* spp	51 J 233320 7045491
Mallee/mulga complex over Spinifex	5*	5	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	51 J 235063 7044011
Mulga over calcrete	6	6	Calcrete platform Low Woodland B of *Acacia* spp.	51 J 234517 7028474
Minor drainage line	7	7	*Casuarina pauper* woodland with scattered Eucalypt species over saline white/grey soils	51 J 232898 7028007
Red sand dune	8	8	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	51 J 237870 7028808
Chenopod floodplain	9*	9	Plains Low woodland B of *Acacia* spp	51 J 236627 7044595
Creek line with River Red Gum and Casuarina	10*	10	Creekline Woodland of *Eucalyptus camaldulensis* ssp *obtusa*	51 J 210980 7054114

Fauna Habitat	Site	Plate	Description (Niche Consulting, unpubl. data)	Coordinates (WGS 84)
Open Mulga Woodland over Spinifex on Hardpan	11	11	Clay plains Low Woodland B of *Acacia aneura var aneura* over Open Tall Grass of *Eriachne mucronata* (arid form)	51 J 211753 7049392
Major drainage line	12*	12	Clay plains Open Woodland of *Eucalyptus camaldulensis* ssp *obtusa* Over Low Woodland B of *Acacia* spp	51 J 217600 7049707
Claypan	-	13	Mixed samphire species with fringing chenopods and mulga (*Acacia aneura*)	-
Acacia victoriae on calcrete	-	14	Open shrubland of *Acacia victoriae* with scattered chenopods and very sparse to no ground cover	-
Mixed shrubland floodplain	-	15	Mulga over *Acacia* and *Cassia* spp.	-
Stony rise	-	16	Mulga over *Eremophila forresti* on stony substrate	-
Mulga over quartz loam	-	17	Mulga dominated low open woodland over scattered *Acacia* sp. *Cassia* sp. and *Grevillea* sp. on a loamy substrate with quartz gravel	-
Samphire flats	-	18	Low heathland of halophilic species incl. *Halosarcia* sp and *Frankenia* sp.	-
Salt lake	-	-	Bare salt pan	-

* Not trapped due to heritage constraints

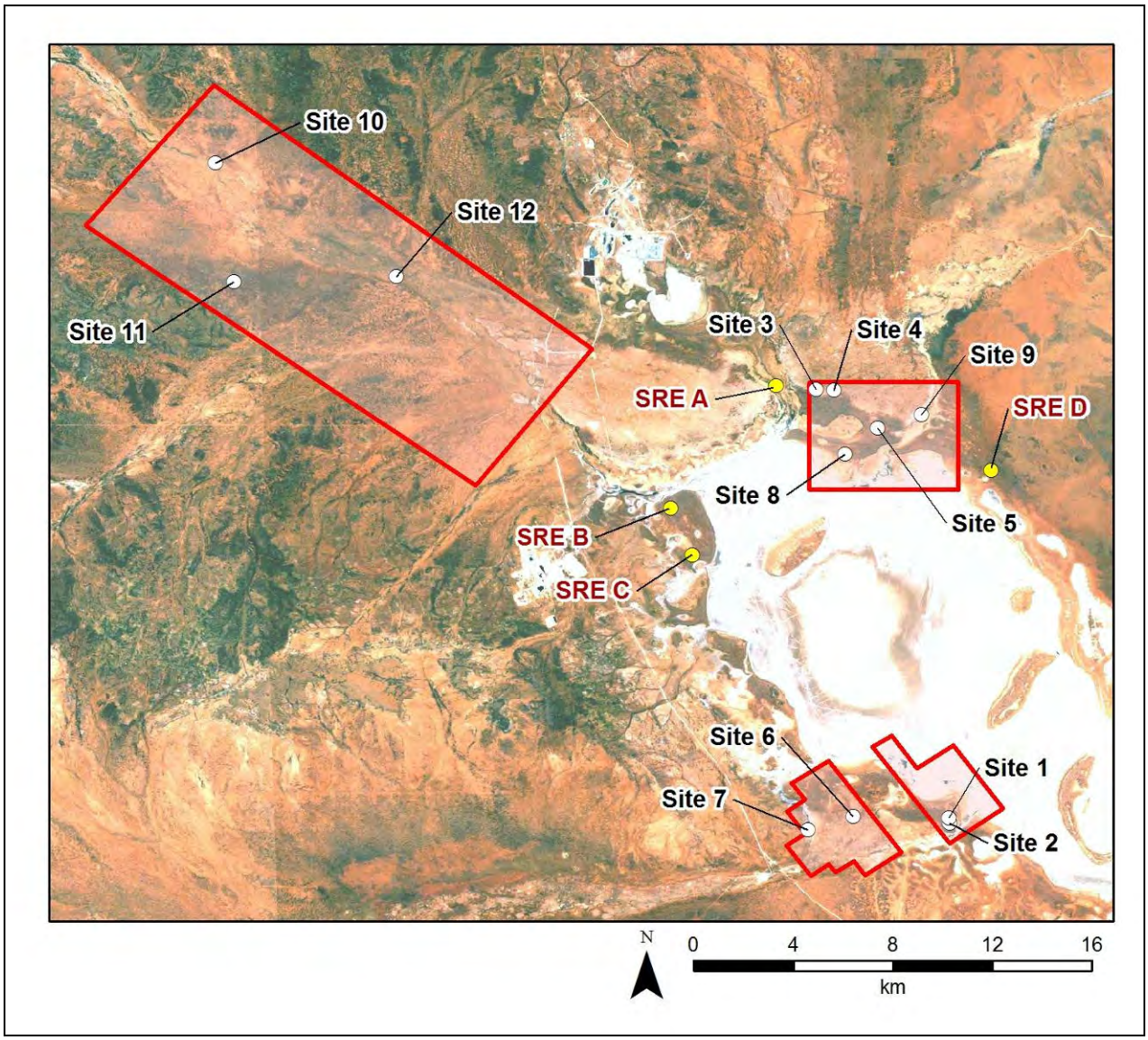

Figure 7: Fauna survey site locations

Plate 1: Melaleuca Stands (Site 1)

Plate 2: Open Mulga woodland over Spinifex (Site 2)

Plate 3: Eucalypt Woodland (Site 3)

Plate 4 Mulga Woodland Over Chenopod Shrubland (Site 4)

Plate 5: Mallee/ Mulga Complex Over Spinifex (Site 5)

Plate 6: Mulga Over Calcrete (Site 6)

Plate 7: Minor Drainage Line (Site 7)

Plate 8: Red Sand Dune (Site 8)

Plate 9: Chenopod Floodplain (Site 9)

Plate 10: Creekline with River Red Gum and Casuarina (Site 10)

Plate 11: Mulga Over Hardpan (Site 11)

Plate 12: Major Drainage Line (Site 12)

Plate 13: Claypan

Plate 14: *Acacia victoriae* Over Calcrete

Plate 15: Mixed Shrubland Floodplain

Plate 16: Stony Rise

Plate 17: Mulga Over Quartz Loam

Plate 18: Samphire Flats

Plate 19: Salt Lake

3.4.3 Systematic Sampling

Systematic sampling was conducted over a fixed time period in the defined broad fauna habitats during the autumn 2010 survey. The focus of systematic sampling centred upon the establishment of the eight survey sites (Section 3.4.2). Systematic surveys involved establishing a trapping grid at each survey sites, systematic hand searching, fixed-time bird census and spotlight searching at night. These survey techniques are described in further detail below.

Trapping Grids

Trapping grids were aimed at catching terrestrial mammals, reptiles and amphibians. Trapping grids were surveyed at a total of eight sites during the autumn survey. Each trapping grid consisted of two drift fences set into the substrate, which were 40 centimetre (cm) high and 50 metres (m) in length. Traps were left open over night and checked early each morning.

Two types of pit traps were installed along the drift fences: five standard 20 litre (L) PVC buckets and five PVC pipe traps 15 cm in diameter and 40 cm deep. Pit traps were set flush with the surface of the ground with the drift fence running across the middle. Funnel traps measuring 75 cm x 18 cm x 18 cm were placed along the drift fence, with one side pressed firmly against the fence. Ten baited Elliott box traps and two Sheffield cage traps were positioned in two lines on either side of the trap lines (**Figure 8**).

Traps were opened for a period of seven nights. Setting each grid resulted in 52 traps being open each night, resulting in a total trapping effort of 2912 trap nights over the detailed autumn 2010 survey across all grids.

To protect animals from heat stress, Elliott, cage and funnel traps were placed in as much shade as possible and covered with shade covers. Shelter (e.g. egg cartons, glare shield insulation) was placed in the bottom of pit traps to provide refuge for captured animals.

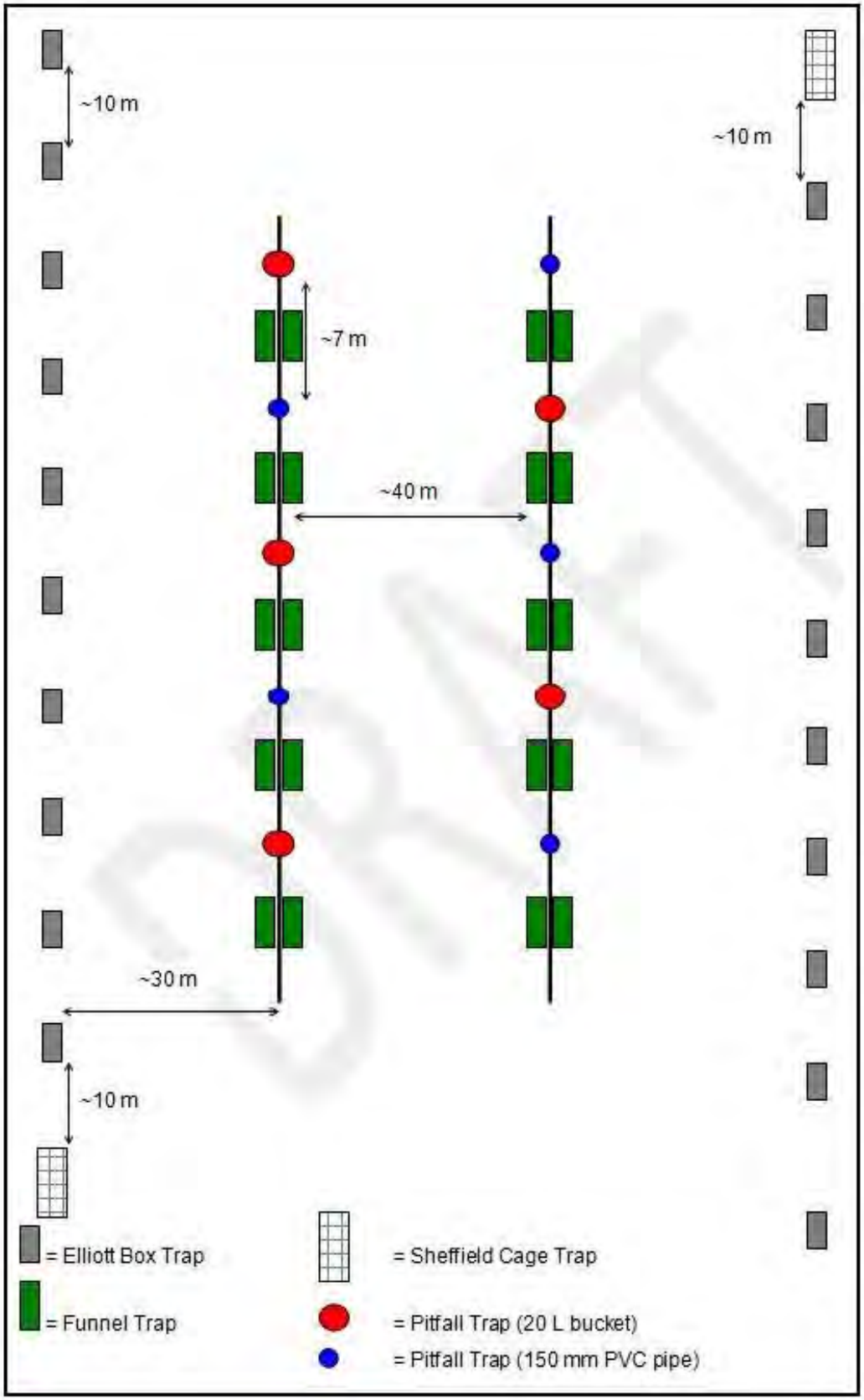

Figure 8: Layout of systematic trapping grids used during surveys

Systematic Hand-searching

Systematic hand-searching for cryptic vertebrate species was conducted at all sites. Techniques included identification of active animals, raking leaf and bark litter, overturning logs and stones, searching beneath the bark of trees, investigating caves and crevices, investigating burrows, recording tracks, diggings, scats and any other signs. Time spent systematic searching totalled 12 hours with a total of 1.5 person hours spent at each site.

Avifauna census

Birds were recorded by means of several 20 minute duration bird surveys within a 500 m radius of each systematic search site, and limited to the habitat type within the vicinity of the trapping grid. All bird species seen or heard were recorded. Seven systematic bird surveys were carried out at each sampling site during autumn 2010. Each census was carried out as soon after dawn as was practicable, with each site being surveyed within two hours of dawn at least four times. Time spent on sampling avifauna combined totalled 18 hrs 40 minutes.

Spotlighting

Spotlighting was undertaken over a period of two nights at all eight systematic survey sites during the 2010 autumn survey; and at Site 3, 7, 10 and 12 during the 2009 reconnaissance survey. Spotlighting was conducted by traversing each site on foot using head torches and hand held potable spotlights. A total of one person hour was spent covering an area within a 500m radius of each survey site. Additionally, a hand held spotlight and car headlights were used to target nocturnal species on or adjacent to the tracks whilst driving at low speeds between sites. Sites 5, 9, 10 and 12 were not surveyed during autumn 2010 due to heritage constraints.

Spotlighting was aimed at targeting nocturnally active species such as Bush Stone-curlew (*Burhinus grallarius*), owls, nightjars, frogs and nocturnal gecko species. In conjunction with spotlighting, 'call playback' was conducted at all sites to detect three nocturnal bird species: Bush Stone-curlew, Masked Owl (*Tyto novaehollandiae*) and Barking Owl (*Ninox connivens*). Recorded bird calls for these species were played through a car stereo system. A period of ten minutes silence was then undertaken to determine if any of these species were responding to the call play back. This procedure was then repeated once.

Time spent spotlighting totalled four person hours for the 2009 summer reconnaissance survey and totalled eight person hours during the 2010 autumn survey. **Figures 8-10** display the nocturnal survey coverage undertaken at survey sites and roads and tracks traversed over the combined 2010 autumn survey and the 2009 reconnaissance survey.

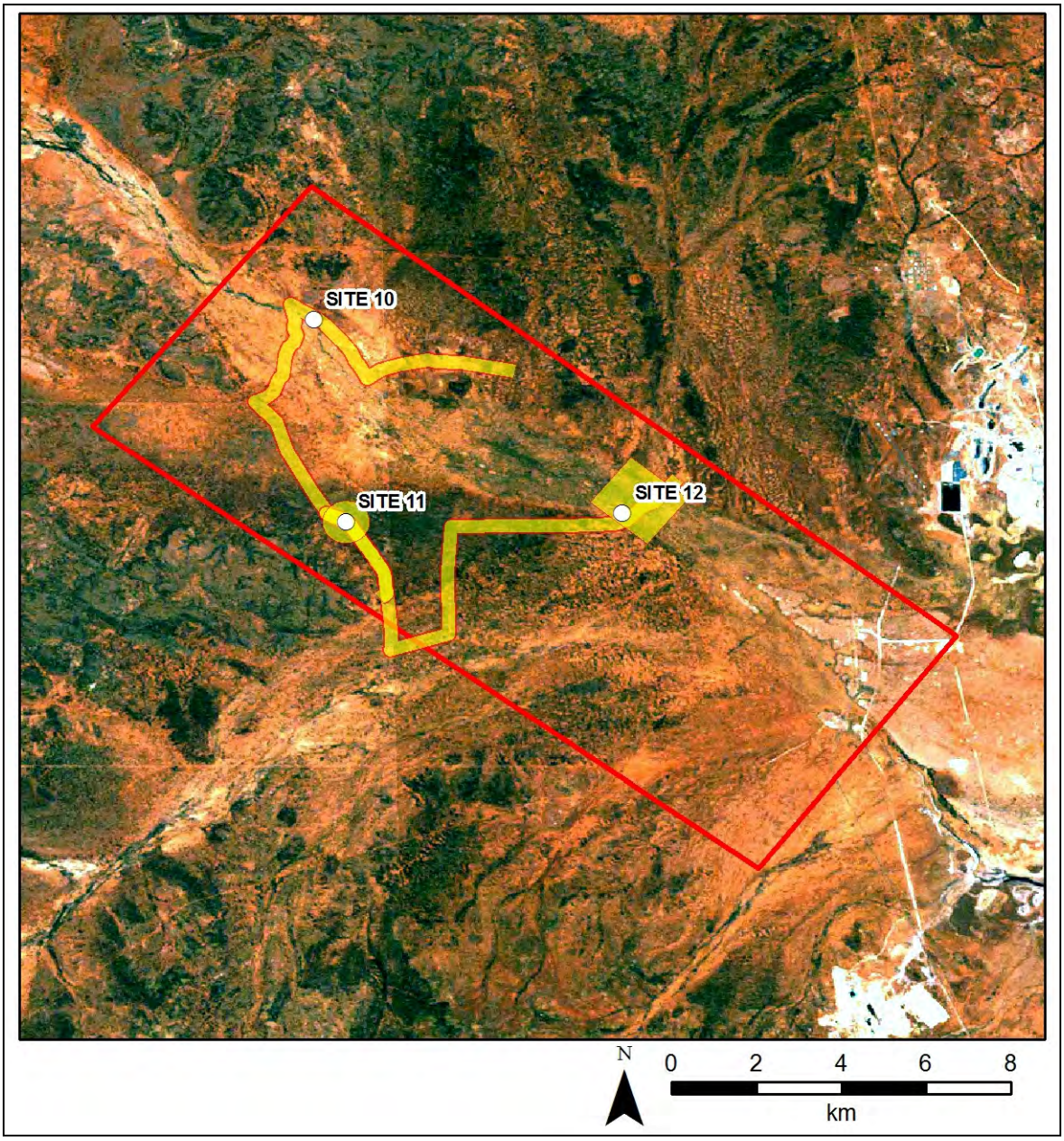

Figure 9: Spotlighting coverage within the Borefield study area

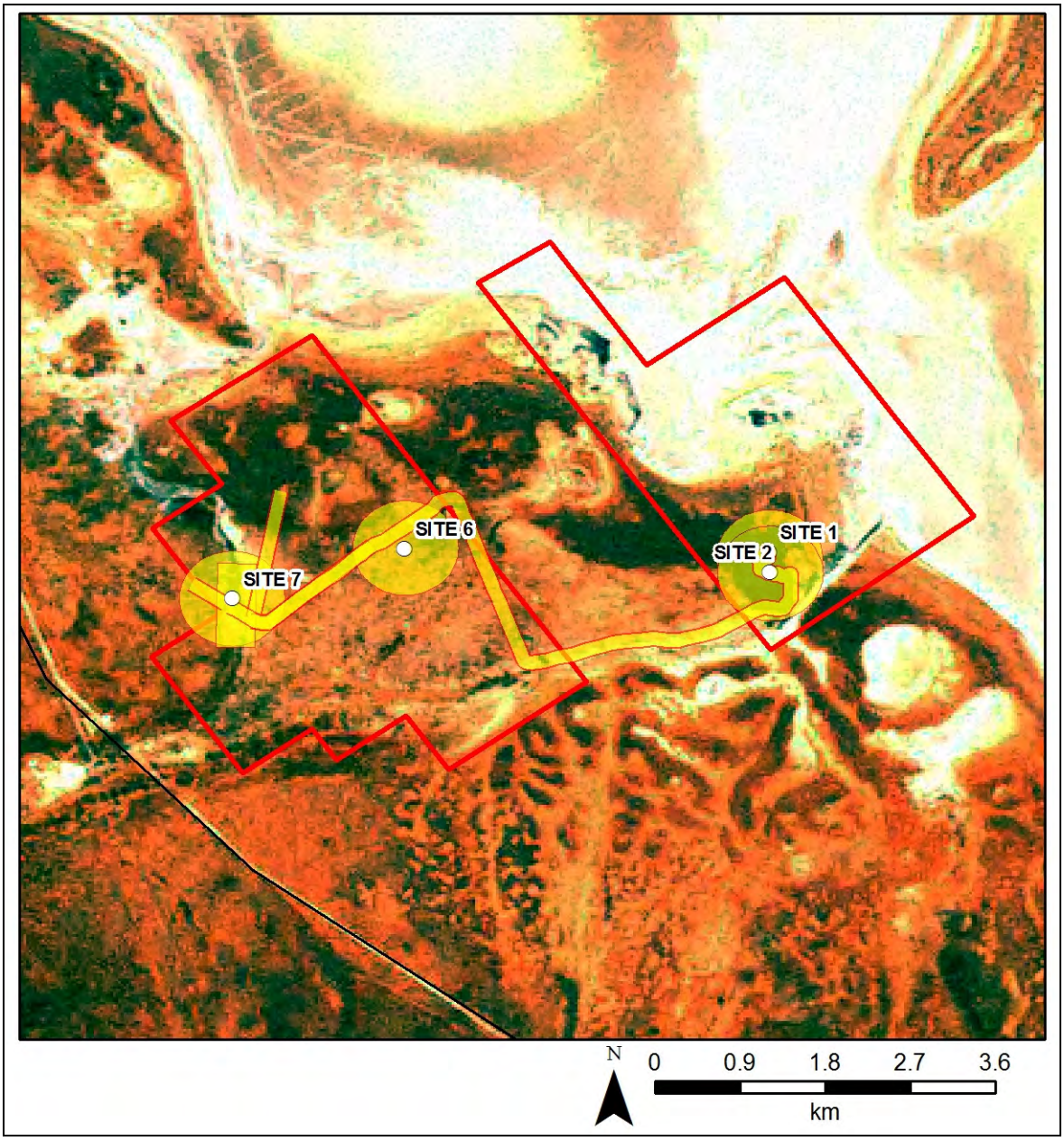

Figure 10: Spotlighting coverage within the Centipede study area

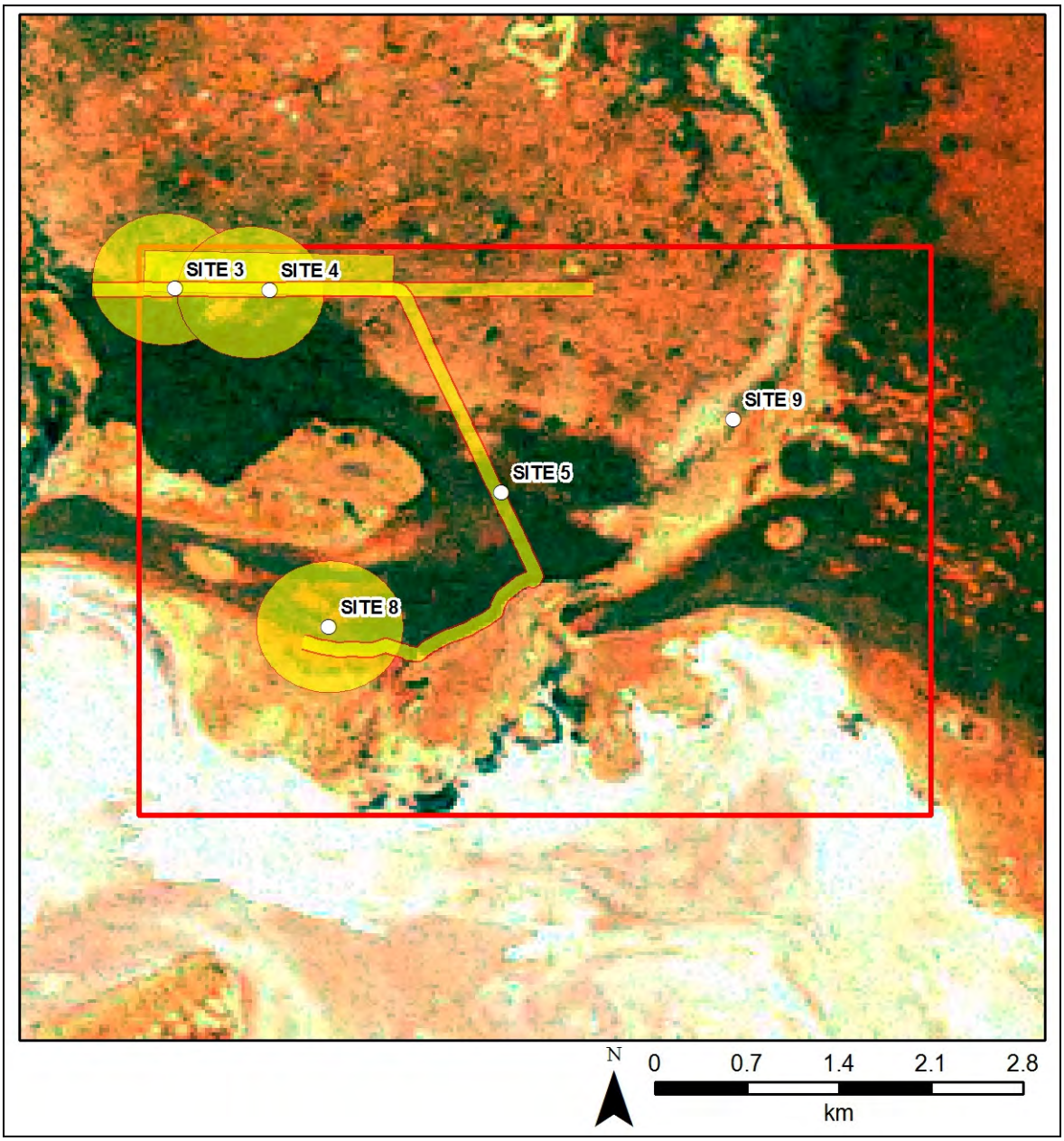

Figure 11: Spotlighting coverage within the Lake Way study area

3.4.4 Opportunistic Sampling

To supplement systematic sampling, the presence of all vertebrate species was recorded wherever and whenever possible within the Study area during the survey periods. Opportunistic or non-systematic sampling involved recording all sightings of vertebrate fauna species while working and travelling within the Study area during the day and night. These included species sighted:

- Before or after the fixed-time active searches or bird censuses;
- During reconnaissance visits to the survey sites;

- During trap line establishment; and
- While travelling to and from the survey sites throughout the day and during spotlighting surveys.

3.4.5 Targeted Survey Methods

Habitats within the region with potential to support fauna species of conservation significance (those listed under the EPBC Act, the WC Act or as Priority by the DEC) were identified during the desktop study and the reconnaissance survey to the Study area. The systematic and opportunistic methods utilised during both the reconnaissance and detailed autumn surveys were appropriate to detect these species as outlined in **Table 4**. In addition to these methods, targeted searches for conservation significant species were undertaken at targeted search sites in suitable habitats as follows:

- Mallee and Mulga (Lake Way and Centipede study areas): Four targeted searches were conducted during the 2009 reconnaissance survey for Mulgara (*Dasycercus cristicauda*) burrows and Malleefowl (*Leipoa ocellata*) nests;
- Chenopod Floodplain (Lake Way study area): Avifauna search was conducted in the denser chenopods for the Slender-billed Thornbill (*Acanthiza iredalei iredalei*).
- Major Drainage Line (Borefield study area): Searches were made for the Central Long-eared Bat (*Nyctophilus major tor* [Parnaby 2009]) focussing on tree cavities/ hollows and underneath loose bark on trees, specifically large *Eucalyptus* spp.
- Salt Lake (Lake Way study area): During the autumn 2010 survey, two avifauna searches were undertaken at the discharge point to the west of the Lake Way study area, focusing on migratory and marine waterbird activity around the artificial water body.
- Samphire (Lake way and Centipede study area): Three avifauna searches were conducted during the autumn survey in samphire habitat bordering Lake Way (two within Lake Way study area and one within Centipede) targeting the Slender-billed Thornbill (*Acanthiza iredalei iredalei*).

Time spent conducting targeted searches during the reconnaissance survey totalled 24 person hours, with approximately 2 hours spent searching at each targeted site. Time spent targeted searching during the 2010 detailed autumn survey totalled 5.7 hours, with approximately two hours spent at each targeted site. A total of 29.7 hours were spent targeted searching over the two surveys. The search areas covered during the targeted surveys undertaken during both surveys is shown in **Figures 11-13**.

Table 4: Methods used to target conservation significant species

Group	Name	Conservation status[1]			Method					
		EPBC Act	WC Act	DEC Priority	Trapping	Systematic Searching	Spotlighting	Avifauna Census	ANABAT	Targeted Searching
Mammals	Mulgara (*Dasycercus cristicauda*)	VU	S1	-	•	•[2]	-	-	-	•[2]
	Greater Bilby (*Macrotis lagotis*)	VU	S1	-	-	•[2]	-	-	-	•[2]
	Central Long-eared Bat (*Nyctophilus major tor* (Parnaby 2009))	-	-	P4	-	-	-	-	•	•
Birds	Night Parrot (*Pezoporus occidentalis*)	EN	S1	-	-	-	-	•	-	
	Malleefowl (*Leipoa ocellata*)	VU	S1	-	-	•[2]	-	•	-	•[2]
	Slender-billed Thornbill (*Acanthiza iredalei iredalei*)	VU	-	-	-	•	-	•	-	•
	Princess Parrot (*Polytelis alexandrae*)	VU	-	-	-	-	-	•	-	-
	Major Mitchell's Cockatoo (*Cacatua leadbeateri*)	-	S4	-	-	-	-	•	-	-
	Peregrine Falcon (*Falco peregrines*)	-	S4	-	-	-	-	•	-	-
	Striated Grasswren (*Amytornis striatus striatus*)	-	-	P4	-	-	-	•	-	-
	Thick-billed Grasswren (*Amytornis textilis textilis*)	-	-	P4	-	-	-	•	-	-
	Australian Bustard (*Ardeotis australis*)	-	-	P4	-	•[2]	-	•	-	-
	Bush Stone-curlew (*Burhinus grallarius*)	-	-	P4	-	•[2]	•	•	-	-
	Grey Falcon (*Falco hypoleucos*)	-	-	P4	-	-	-	•	-	-
	Masked Owl (*Tyto novaehollandiae*)	-	-	P3	-	-	•	•	-	-
	Migratory waterbirds	M	-	-	-	-	-	•	-	•
Reptiles	Woma (*Aspidites ramsayi*)	-	-	P4	•	•	•	-	-	-
	Great Desert Skink (*Egernia kintorei*)	VU	S1	-	•	•	-	-	-	-

1 Threatened species status under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act): VU = Vulnerable, EN = Endangered, M = Migratory

Threatened species status under the WA *Wildlife Conservation Act, 1950* (WC Act): Schedule S1, S4. DEC Priority Species List = Priority 1, P2, P3, P4

2 Searching for secondary evidence (e.g. mounds, burrows, tracks, scats and runways).

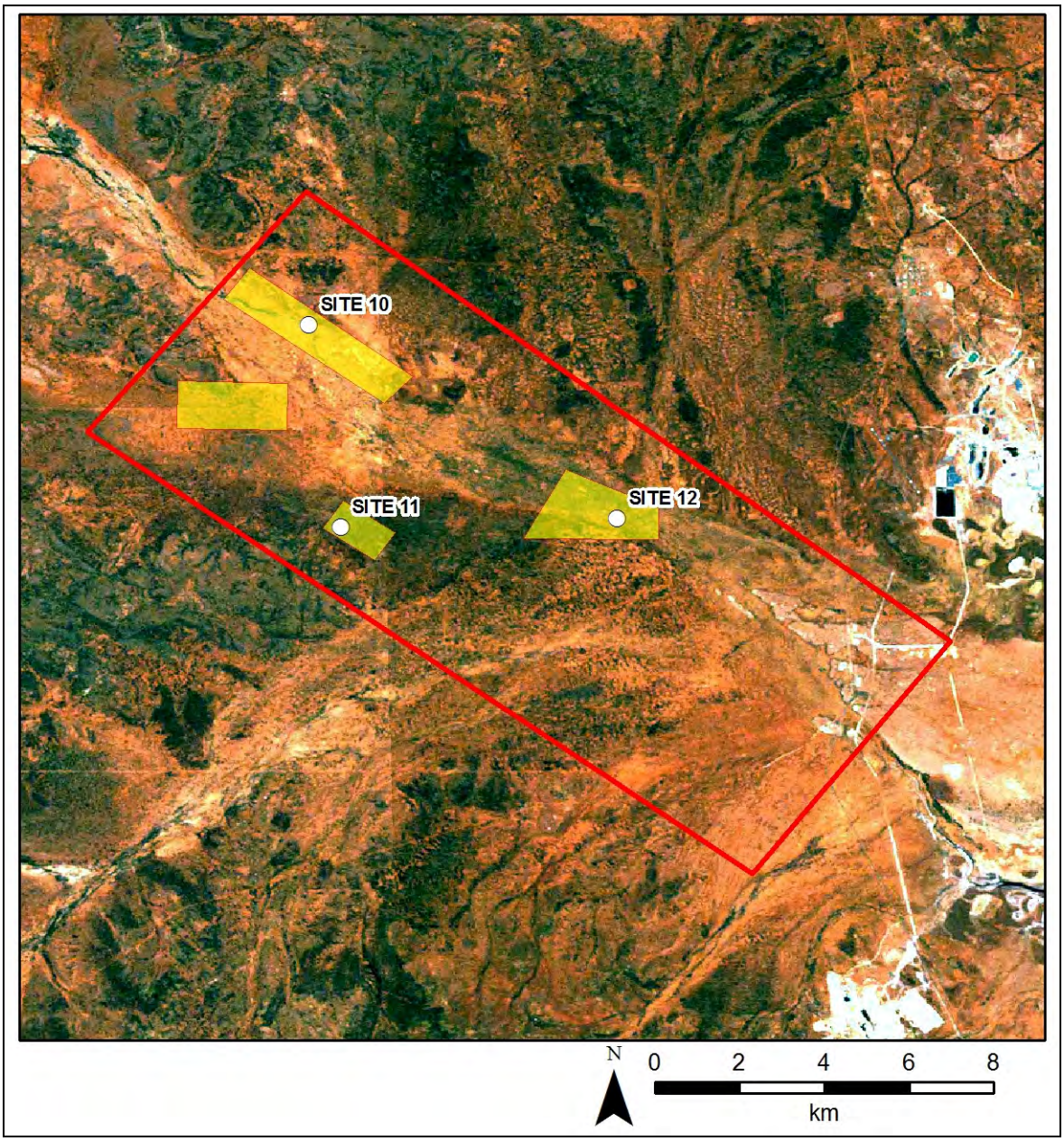

Figure 12: Targeted searches conducted within the Borefield study area

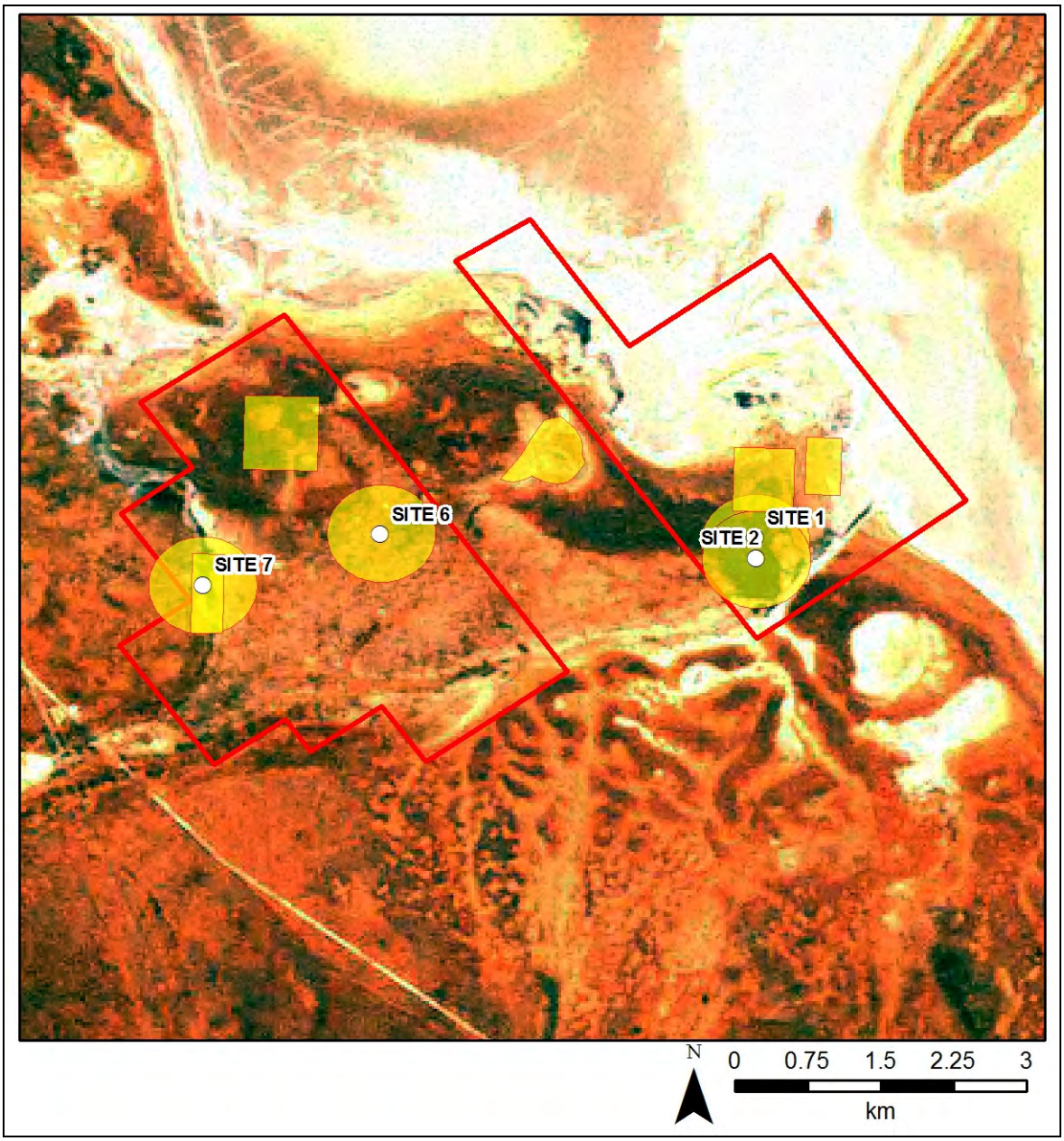

Figure 13: Targeted searches conducted within the Centipede study area

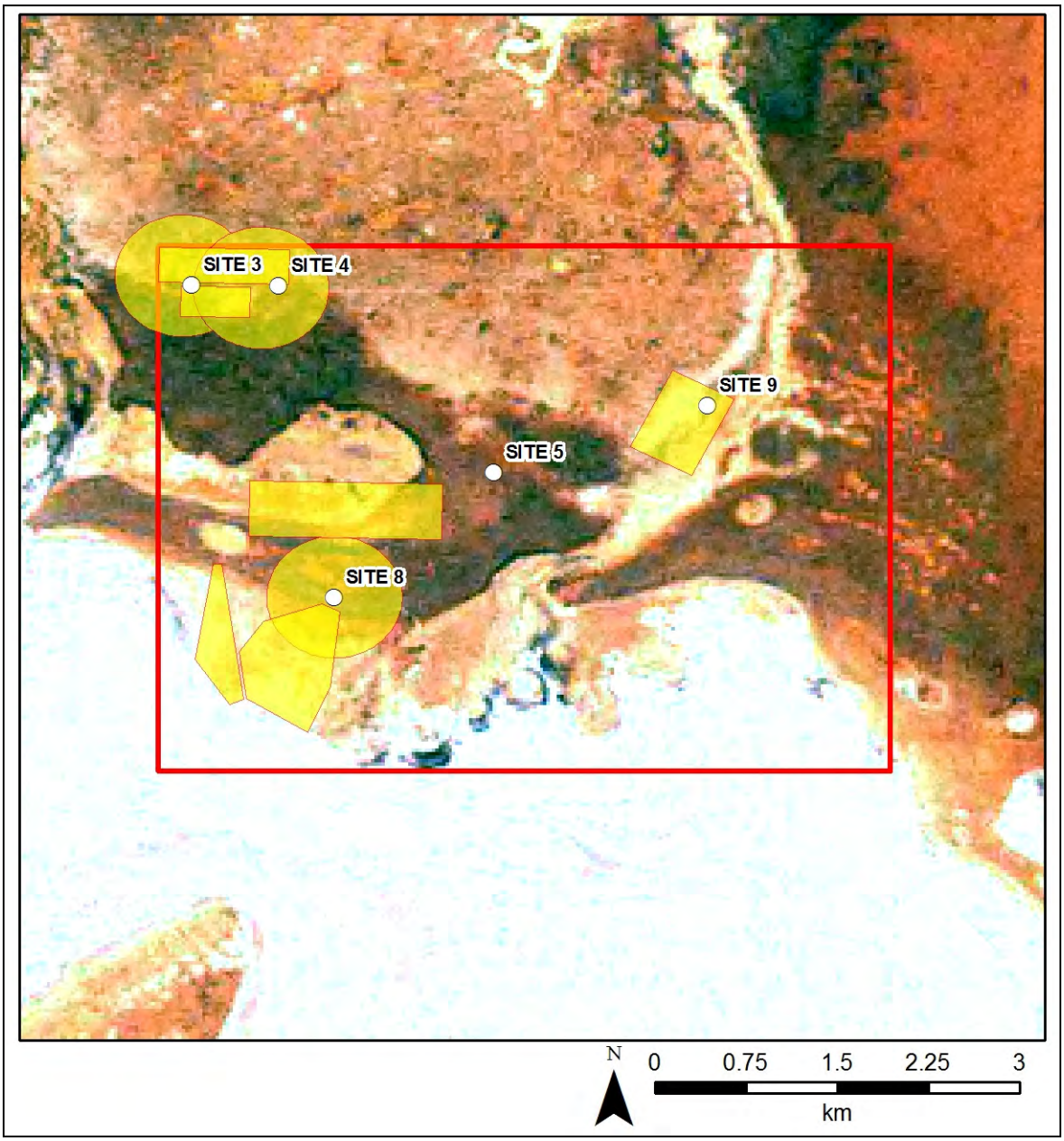

Figure 14: Targeted searches conducted within the Lake Way study area

3.4.6 Targeted Bat Survey

Bat species were recorded using AnaBat II electronic detectors (Titley Electronics, Ballina, NSW). The AnaBat records ultrasonic echolocation bat calls directly onto minidisc for later analysis. Two AnaBat units were set up for a period of four nights during the 2009 reconnaissance survey from the 30 November to 4 of December 2009.

AnaBat locations were chosen in Major Drainage Line habitat in areas supporting mature stands of Eucalypts, as bats are known to shelter in these habitats, or around water bodies where bats drink or forage after emerging from shelter at dusk. AnaBat recording locations within the Study area are shown in **Figure 15 and 16** and listed in **Table 5**. To provide an overall representation of bat survey coverage within the Study area, the locations of the six AnaBat recording sites used in the 2007 spring survey are also shown on these figures.

Table 5: AnaBat recording details

ANABAT Site Reference	Site Description	Habitat	Recording Date	Site Location (WGS84)
AN01*	Permanent water	Minor Drainage Line	30/11/09	51 J 232851 7028159
AN02	Windmill	Mulga over Calcrete	30/11/09	51 J 232984 7027564
AN03	Water Tank Overflow	Minor Drainage Line	01/10/09	51 J 233171 7027777
AN04	Permanent water /	Minor Drainage Line	01/12/09	51 J 232860 7028159
AN05	Semi permanent water /	Creekline with River Red Gum and Casuarina	02/12/09	51 J 212300 7052771
AN06	Woodland of *Eucalyptus camaldulensis* ssp *obtusa*	Major Drainage Line	02/12/09	51 J 217554 7049688
AN07	Permanent water	Minor Drainage Line	03/12/09	51 J 232846 7028164
AN08	Dry creek line	Creekline with River Red Gum and Casuarina	03/12/09	51 J 210970 7054120

** AN01 did not record due to technical failure*

Recorded calls were analysed by Western Australian Bat expert Bob Bullen (Bat Call WA) (2009) to identify bat species utilising the Study area. The software COOL EDIT 2000 was used to display each "continuous call" sequence for identification. Only high quality call sequences were used.

Bat activity was characterised as "Low", "Medium" or "High" based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing greater than ten minutes,
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a significant time period.
- High species activity refers to call recording more often than two minutes apart for significant periods.

Findings of the desktop assessment indicate one conservation significant species of bat, the Central Long-eared Bat (*Nyctophilus major tor* [Parnaby 2009]), could potentially occur within the Study area (Outback

Ecology, 2010). The Central Long-eared Bat is known to roost in tree cavities/ hollows and underneath loose bark on trees (Churchill, 2008). Habitats with permanent water sources and areas containing *Eucalyptus* spp. with tree hollows were targeted for this species during these surveys. .The AnaBat survey work was conducted during the November-December 2009 reconnaissance survey as this timing corresponds to the peak breeding period for this species (Churchill 2008; Bob Bullen pers comm. Nov 2009).

AnaBat results are discussed in further detail in **Section 4.2.1**.

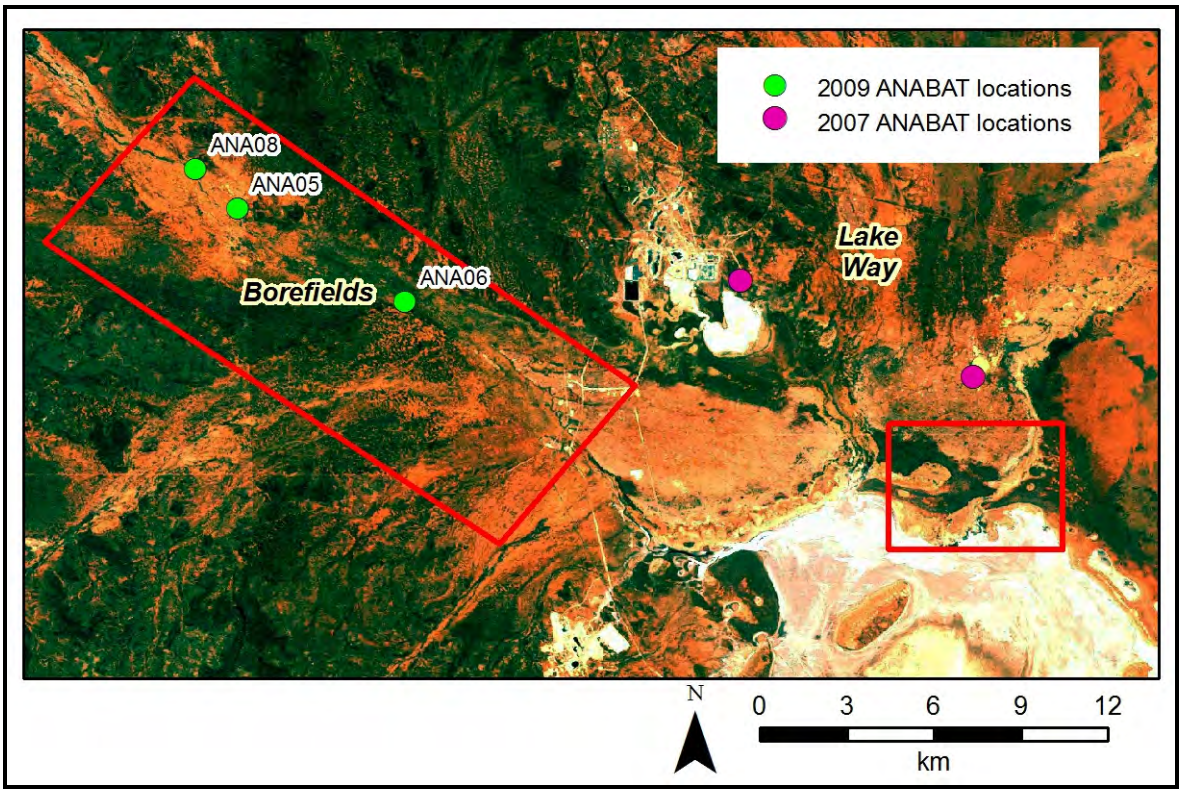

Figure 15: AnaBat locations within the Borefield and Lake Way study areas

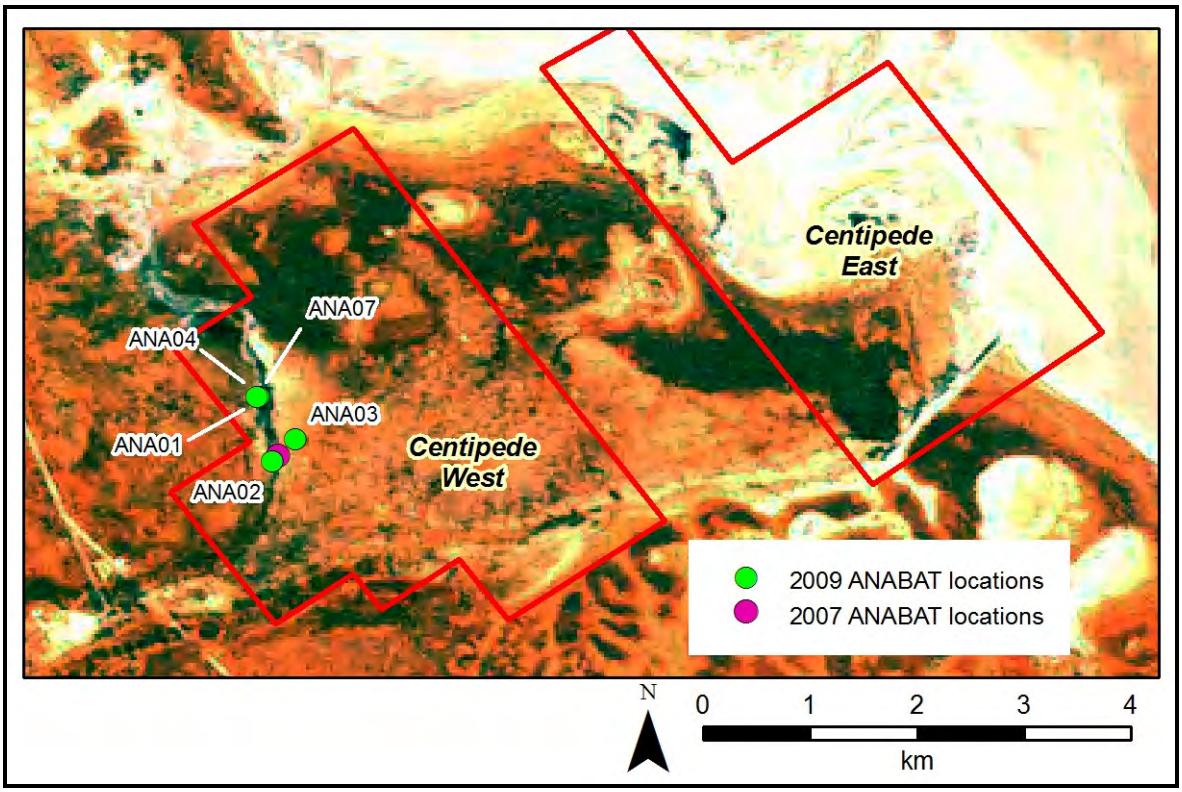

Figure 16: AnaBat survey locations within the Centipede study area

3.5 Terrestrial Invertebrate SRE Fauna Survey

3.5.1 Short-range Endemism

Endemism refers to the restriction of a species to a particular area, at a continental, national or local scale (Allen et al., 2002). Short-range endemic species have naturally restricted ranges of less than approximately 10,000 square kilometres (km²) (Harvey, 2002). A combination of intrinsic and extrinsic factors, such as dispersal capabilities or opportunities, habitat preferences, life history attributes, physiological attributes, habitat availability, biotic and abiotic interactions and historical factors, determine not only the geographic distribution of a taxon, but its propensity for population differentiation and speciation (Ponder and Colgan, 2002).

In Western Australia (WA) many terrestrial SRE invertebrate species have Gondwanan origins and are relics of previously widespread species common to the continents of the southern hemisphere. The subsequent aridification of Australia resulted in the fragmentation and contraction of once common mesic habitats. Consequently, populations dependent on mesic habitats were also fragmented, resulting in the evolution of SRE fauna (EPA, 2009).

Taxa prone to short-range endemism tend to share several ecological and life-history characteristics, such as poor powers of dispersal, confinement to discontinuous habitats, highly seasonal activity patterns and low fecundity (Harvey, 2002).

3.5.2 Targeted Groups

With consideration to the findings of the desktop study and consultation with invertebrate specialists of the DEC and Western Australian Museum (WAM), the following invertebrate groups that have potential for short-range endemism could occur within the region and are discussed below:

Mygalomorph spiders

Class: Arachnida
Order: Araneae
Sub-order: Mygalomorphae

Represented by some 10 families, Mygalomorphae is a primitive group of spiders which constitute approximately 13% of Australia's described spider species (Brunet 1994, Main 2005). Mygalomorphs have several distinctive morphological features that differentiate them from modern araneomorph spiders including: parallel fangs, two pairs of book-lungs and the presence of four (sometimes six) spinnerets (Brunet, 1994; ABRS, 2010).

Unlike araneomorphs, and with few exceptions, no mygalomorph constructs a web for capturing prey. Instead they build burrows in which they wait for prey, some species spending their entire lives in a single burrow (Main, 1982). Burrow morphology is highly variable and burrows may be up to 60 centimetres (cm) deep

depending on the species and terrain (Brunet, 1996). Females rarely venture from the burrow and it is usually the males which are observed above ground when they are wandering in search of females (Main, 1982).

Harvey (2002) indicates that Mygalomorphae is likely to have SRE taxa, which is at least partly due to the group's limited powers of dispersal and low fecundity. The cryptic lifestyle and highly seasonal variation in above ground abundance makes collecting mygalomorphs problematic. The use of pitfall traps during the wetter parts of the year generally yield wandering males, whereas both sexes can be dug from the burrow at anytime. Mature male specimens are usually required for definitive species identifications based on morphology.

Pseudoscorpions

Class: Arachnida

Order: Pseudoscorpionida

It is estimated that there are more than 700 species of pseudoscorpion in Australia; however currently, only 150 species are described with many specimens awaiting description (ABRS, 2010). Pseudoscorpions are found in virtually all terrestrial habitats and are generally found amongst leaf litter and beneath rocks and bark (Harvey and Yen, 1989). Pseudoscorpions are usually no more than several millimetres long and have a pair of pincer-like pedipalps which they use to subdue small invertebrate prey (Harvey and Yen, 1989). Very few terrestrial pseudoscorpions are SREs (EPA, 2009). Hand collection, soil sieving, the processing of leaf litter in Tullgren funnels and wet pitfall trapping can be used to collect pseudoscorpions. Mature male specimens are usually required for definitive species identifications based on morphology.

Scorpions

Class: Arachnida

Order: Scorpionida

Current classifications of the scorpions usually recognise five superfamilies, but only members of the Scorpionoidea and Buthoidea are present in Australia (ABRS, 2010). Scorpions are nocturnal, solitary, predatory arachnids that have a pair of pincer-like pedipalps and an elongate metasoma (tail) tipped with a sting. Australian scorpions may reach up to 12 cm in length (Harvey and Yen, 1989). Some species construct spiral burrows that can extend up 70 cm below ground.

Currently, many Australian scorpions belong to species-complexes where a number of 'species' are grouped until further taxonomic delineation is carried out. With future taxonomic revision the number of SRE species is likely to increase. Mature male specimens are usually required for definitive species identifications based on morphology. Males are generally active above ground on warm or humid nights, when they can be spotted using an ultraviolet light under which they fluoresce. Scorpions can also be dug from their burrows and males can be collected using pitfall traps.

Millipedes

Class: Diplopoda

Orders: eg. Polydesmida, Chordeumatida, Polyzoniida, Spirostreptida

There are nine millipede orders present in Australia, represented by some 250 described species (ABRS, 2010). Millipedes are elongate; generally detritivorous arthropods that usually have two legs per body segment. Little is known of the biology and ecology of Australian millipedes. The orders Polydesmidae and Chordeumatida either have or are likely to have representatives which are SREs. The propensity for short-range endemism in other millipede orders is unknown but considered low. Millipedes are typically collected from mesic habitats and microhabitats and are commonly found among leaf litter and beneath rocks and bark in sheltered locations. Hand collection, soil sieving, the processing of leaf litter in Tullgren funnels and wet pitfall trapping are used to collect millipedes. Mature males which are generally present during the wetter parts of the year are usually required for definitive species identifications based on morphology.

Slaters

Class: Malacostraca

Order: Isopoda

Slaters are terrestrial isopods that belong to the crustacean suborder Oniscoidea. They are generally detritivorous arthropods that usually do not exceed 15 mm in length. Seven families of slaters are known from Australia and nearly all species are undescribed (ABRS, 2010; pers. comm. Simon Judd). Slaters are found in tropical to arid climates, where they inhabit moist and sheltered locations such as those beneath rocks, logs and bark. Slaters can be collected by hand or by using wet pitfall traps. Slaters are likely to contain species which are SREs (EPA, 2009). Species identification based on morphology generally requires adult male specimens.

Land snails

Class: Gastropoda

Order: Eupulmonata

The Eupulmonata includes almost all terrestrial snails and slugs. There are approximately 1000 species of slugs and snails in Australia. Snails tend to be either herbivorous or detritivorous. Snails prefer moist habitats and microhabitats and can be found in leaf litter, under rocks and logs and in crevices. In dryer areas snails may aestivate for an extended period up to 50 cm below ground (pers. com. Shirley Slack-Smith). The best methods of collecting snails are by hand and by sieving leaf litter and soil. Many terrestrial snails have extremely restricted ranges and numerous species are known to be SREs, indeed some families consist entirely of SREs (EPA, 2009, Harvey, 2002). Mature live specimens are usually required for definitive species identifications based on morphology.

3.5.3 Habitat Assessment

Potential habitat for SRE groups within the region is likely to be associated with:

- Isolated Habitats. Habitat isolates are more likely to support SREs than extensive swathes of continuous habitats such a contiguous habitat. Examples of habitat isolates include exposed dolomites or calcretes, granite outcrops and the Banded Ironstones Formations (BIF) of the Mid-west and Goldfields (EPA, 2009).
- Sheltered Habitats and Microhabitats. SREs are most likely to be encountered in sheltered, relatively mesic environments such as slopes with south-west facing aspects, rock piles and outcrops, drainage systems, deep gullies and other similar habitats (EPA, 2009).

The potential terrestrial SRE habitat within the Study area was identified, assessed and described separately for complexity and the quality of habitat provided for the above listed groups; and to determine the connectivity and extensiveness of the habitat within the landscape. A SRE habitat assessment was conducted within each of the broad habitat units occurring in the Study area. This assessment entailed:

- Establishment of habitat assessment reference points, of suitable replication, within representative habitat inside and outside of the proposed disturbance areas (where known) to characterise the extent of SRE habitat in the local vicinity.
- A standardised Habitat Assessment Field Sheet was completed at each site. The assessment will be made in an area of approximately 50 x 50 m. The following information was recorded: landscape position, outcropping, soil type, broad vegetation type, litter cover, existing disturbance, extensiveness and physical connectivity within the landscape.

The information collected during the habitat assessments has been incorporated into the descriptions of each habitat under Section 4.1

3.5.4 Survey Sites

A total of twelve terrestrial SRE invertebrate fauna sites were sampled during the 2010 autumn survey, comprising the eight systematic survey sites established for the vertebrate fauna survey and an additional four targeted sites established outside the Study area. These sites are described in **Table 3** and locations shown in **Figure 7**.

The primary purpose of the four targeted SRE sites was to collect specimens of the putative SRE scorpion species *Urodacus* ‘’Yeelirrie’ which were previously collected during the October 2007 survey. Specimens of this species had been collected from the Mulga/Mallee complex over Spinifex and the Open Mulga over Spinifex on Sandplain habitats. Each of the SRE targeted sites were selected in the Mulga/Mallee complex over Spinifex and the Open Mulga over Spinifex on Sandplain habitats. Targeted site SRE A was

established in the Melaleuca Stands habitat, as this habitat had been identified as potentially restricted in the landscape and had potential to support SRE species that also occurred within proposed project impact footprint.

The location of all SRE survey sites as well as additional targeted sites is shown in Figure 7

3.5.5 Survey Techniques

Methods for the sampling and collection of SRE taxa that were undertaken during this survey are summarised in **Table 6** and described below. These methods are aligned with those specified in EPA Guidance Statement No. 20 (EPA 2009) and endorsed by invertebrate SRE specialists of the WAM and DEC.

Table 6: SRE sampling methods for each survey site

Methodology	Target Group	Sampling Effort/Site
Vertebrate fauna pitfall traps	Mygalomorph spiders, pseudoscorpions, scorpions, millipedes	10 traps per site
SRE invertebrate pitfall traps: Targeted SRE Sites	Mygalomorph spiders, pseudoscorpions, scorpions, millipedes	5 Traps per site
Targeted searching	All groups	3 hours per site
Leaf litter collection	Pseudoscorpions, scorpions, millipedes and snails	3 samples per site
Soil sieving	Pseudoscorpions, scorpions, millipedes and snails	3 samples per site
UV night searching	Scorpions	1 hour per site

Pitfall trapping

Vertebrate fauna pitfall traps

The use of vertebrate pitfall traps for the collection of invertebrate specimens is a suggested method as outlined under EPA Guidance Statement 20. A total of ten pitfall traps (five bucket and five pipe traps) were established at each of the eight systematic survey sites as described above in Section 3.4.3. This equates to a total of 80 pitfall traps which were set for a period of seven trapping nights. All traps were cleared of vertebrates and invertebrate fauna each morning of the survey.

SRE invertebrate pitfall traps

Five invertebrate pitfall traps were established at each of the three targeted SRE sites. Traps were spaced at 5 to 10 m intervals. Pitfall traps consisted of a cylindrical 4 litre (L) plastic container (20 cm diameter x 20 cm height) dug into the ground. Particular attention was given to ensure the top of the container was flush with the natural surface profile, and all obstructions with the potential to reduce catch were removed. To increase the effectiveness of the pitfall traps, two drift fences (flywire mesh) measuring approximately 75 cm in length and 15 cm in height were set on each side of the container. The base of the fence was buried into the ground.

To provide shade for any fauna caught in the traps, a lid was suspended approximately 5 cm over the trap by four pegs. A 'rescue rock' was placed at the bottom of the trap to provide refuge for caught fauna in the event of the trap filling with water during rain. Traps were set for a period of seven days and checked daily for catch and pitfall maintenance. Invertebrate and vertebrate by-catch was released. No evidence of catch predation was noted. GPS co-ordinates of each trap location were recorded.

Targeted Searching

Each survey site and general surrounds was systematically searched for the target groups in the following microhabitats:

- Amongst layers of deep leaf litter;
- Under logs, rocks and in crevices;
- At the base of shrubs, trees and spinifex; and
- Under bark and amongst debris.

At each site, two people undertook targeted searching for 1.5 hours, totalling 3 person hours per site for the survey.

Mygalomorph spiders were targeted by searching for burrow entrances which are typically cryptic in appearance and can be made of mud or silk lids. Active searching is considered to be the most effective method of collecting female mygalomorph spiders. Selected burrows were excavated and resident spiders

collected. The presence of scorpion burrows (which are typically in the form of horizontal slits) was also noted and scorpions were collected from these burrows where possible.

Leaf Litter Collection

Three samples of leaf litter, approximately 1 L in volume, were collected from each survey site within areas of accumulation under trees and around rocks. A total of 36 leaf litter samples were collected. The top layer of litter was scraped back to reveal the decomposition layer above the soil. Samples of the decomposition layer were taken at various locations around the survey site and collected in plastic zip lock bags. The filled bags were sealed, kept cool and transported to the Outback Ecology laboratory.

Soil Sieving

At each survey site, three soil samples, approximately 2 L in volume, were collected and sieved (total of 36 soil samples). Areas where terrestrial snails were likely to inhabit were targeted for soil sieving, including under vegetation and around the base of Spinifex hummocks. The soil fraction between 1 and 10 mm was retained and transported to the Outback Ecology laboratory for sorting. All terrestrial mollusc specimens were sent to the WAM for identification.

Ultraviolet Spotlighting

Two people conducted 30 minutes of UV spotlighting at each sample site; this totalled one person hour per site. Different sites were searched during each night of spotlighting. The main focus of spotlighting was the collection of scorpions. Handheld ultraviolet torches were used to locate scorpions which are nocturnal and fluoresce under ultraviolet light.

3.5.6 Sorting and Identification of Specimens

With the exception of mollusc specimens, all specimens were preserved *in situ* using 70% ethanol. The third left leg of spiders and scorpions were removed following preservation of the specimen and placed in a smaller vial containing 100% ethanol for future DNA analysis. The vial containing the leg was placed inside the larger vial which contained the entire specimen. All samples (litter and soil) and specimens collected in the field were transported to the Outback Ecology Perth laboratory for sorting and distribution to taxonomic experts.

The leaf litter samples were placed in berlese funnels for 48 hours to extract invertebrates (**Plate 14**). The incandescent globes mounted above these funnels provides a heat source which dries out leaf litter, and a bright light source which causes invertebrates to move down through the leaf material into a collection vial containing ethanol. Specimens retrieved from the ethanol catchment vials were sorted using standard identification keys (e.g. Brunet, 1996; Harvey and Yen, 1989; Raven *et al.,* 2002).

Plate 20: Leaf litter samples in Berlese funnels within the Outback Ecology laboratory

The sieved soil samples were spread in a plastic tray and inspected under a 2.75 X magnifier. Terrestrial snail specimens were placed in vials fitted with suitable padding.

All collected specimens were prepared as per the WAM guidelines on the preservation and lodgement of specimens (**Appendix D**) and delivered to the Museum for identification and evaluation. These specimens included mygalomorph spiders, scorpions, millipedes, pseudoscorpions and terrestrial snails and were identified by taxonomic specialists as outlined in **Table 7**.

Table 7: Taxonomic specialists

SRE Group	SRE ID Specialist
Mygalomorph spiders	Dr Volker Framenau
Scorpions	Dr Erich Volschenk
Pseudoscorpions, myriopods (millipedes)	Dr Mark Harvey,
Terrestrial molluscs	Dr Shirley Slack-Smith and Corey Whisson
Terrestrial isopods	Dr Simon Judd

3.6 Taxonomy and Nomenclature

Nomenclature and taxonomy of all vertebrate fauna species follows that of the Western Australian Museum (WAM) provided in the *Checklist of the Vertebrates of Western Australia* for amphibians, reptiles and mammals (WAM, 2009), and for the *Bird's Australia Checklist of Australian Birds*, based on Christidis and Boles (2008). Relevant texts from which information on general patterns of distribution were obtained included:

Mammals (non-volant)- Van Dyck and Strahan (2008) and Menkhorst and Knight (2004);

Bats	Churchill (2008)
Birds -	Johnstone and Storr (1998; 2004), Pizzey and Knight (2007) and Morcombe (2003);
Reptiles -	Storr *et al.* (1999; 2002), Cogger (2000) and Wilson and Swan (2008);
Amphibians -	Cogger (2000).

4. RESULTS AND DISCUSSION

4.1 Fauna Habitat

The Study area is characteristic of the region: the salt lake has formed as part of the occluded Paleodrainage system and is dominated by fringing saltbush and *Tecticornia* shrublands; calcareous deltas dominated by low Mulga; deep red sands with Mallee-Mulga complexes over hummock grasslands; and plains of red brown soils supporting Mulga shrublands and Eucalypts.

Nineteen broad fauna habitats were identified in the Study area on the basis of location, landform, substrate, vegetation community and the vertebrate fauna habitat which they offer. These fauna habitat types are:

Melaleuca Stands;
Open Mulga woodland over Spinifex;
Eucalypt Woodland;
Mulga Woodland over Chenopod Shrubland;
Mallee/mulga Complex over Spinifex;
Mulga over Calcrete;
Minor Drainage Line;
Red Sand Dune;
Chenopod Floodplain;
Creek Line with River Red Gum and Casuarina;
Mulga over Hardpan;
Major Drainage Line;
Claypan;
Acacia victoriae on Calcrete;
Mixed Shrubland Floodplain;
Stony Rise;
Mulga over Quartz Loam;
Samphire Flats; and
Salt Lake.

Most of the habitats occurring within the Study area are considered widespread and typical of the Eastern Murchison bioregion; however, some are considered uncommon and of limited extent. Habitats of limited extent include Melaleuca stands, Eucalypt woodland, Minor Drainage Line, and Creekline with River Red Gum and Casuarina. A rangeland condition assessment conducted on Lake Way Station in 2006 by the Pastoral Lands Board found 43% of the vegetation to be in good condition, 41% in fair condition and 16% in poor condition. A similar assessment of Millbillilie Station showed 50, 33 and 17% of vegetation to be in good, fair and poor condition, respectively.

The key characteristics of each of the broad fauna habitats identified within the Study area are summarised in **Table 8**. Fauna habitat maps of each study area are provided in **Figures 17-19**.

A brief description of the nineteen habitats identified, with a focus on the complexity and the quality that each provides for the local fauna assemblages and specific suitability for conservation significant species, is provided below.

Table 8: Habitat assessment of survey sites

Fauna Habitat	Site No.	Vegetation Association	Habitat Assessment	Overall Condition of Fauna Habitat (after Keighery 1994)	Disturbance	Extent in Study area (ha, %)
Melaleuca Stands	1	Fringing Low Forest B of *melaleuca xerophila*	20% bare ground, 80% live vegetation, 40% leaf litter. No evidence of recent fire	Good	Cattle	118 (0.7%)
Open Mulga Woodland over Spinifex	2	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	30% bare ground, 60% live vegetation, 8% leaf litter, 2% dead wood. No evidence of recent fire	Good	Cattle, Rabbits	1,728 (10.4%)
Eucalypt Woodland	3	Calcrete Low Woodland A of *Eucalyptus gypsophila* over Low Woodland B of *Acacia* spp	40% bare ground, 50% live vegetation, 8% leaf litter, 2% dead wood. No evidence of recent fire	Good	Cattle, Rabbits	37 (0.2%)
Mulga Woodland over Chenopod Shrubland	4	Plains Open Low Woodland B of *Acacia* spp	70% bare ground, 40% live vegetation, 2% leaf litter, 5% dead wood. No evidence of recent fire	Degraded	Cattle	38 (0.2%)
Mallee/mulga complex over Spinifex	5	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	60% bare ground, 40% live vegetation, 5% leaf litter, recent fire within this habitat at Lake Way	Good	Cattle, Rabbits, Fire	419 (2.5%)
Mulga Over Calcrete	6	Calcrete platform Low Woodland B of *Acacia* spp.	80% bare ground, 20% live vegetation, 2% leaf litter, No evidence of recent fire	Completely degraded	Cattle	1,650 (10%)
Minor Drainage Line	7	*Casuarina pauper* woodland with scattered Eucalypt species over saline white/grey soils	30% bare ground, 60% live vegetation, 5% leaf litter, 2% dead wood. No evidence of recent fire	Degraded	Cattle	35 (0.2%)
Red Sand Dune	8	Mosaic: dunes Open Low Woodland B of *Eucalyptus eremicola* spp *peeneri* and *Acacia* spp over Hummock of *Triodia ? melvillei*	60% bare ground, 40% live vegetation, 5% leaf litter, 5% dead wood. No evidence of recent fire	Good	Cattle, Rabbits	152 (0.9%)
Chenopod floodplain	9	Plains Low woodland B of *Acacia* spp	40% bare ground, 60% live vegetation, 5% leaf litter, 5% dead wood. Seasonally inundated, no evidence of recent fire	Good	Cattle	120 (0.7%)
Creek line with River Red Gum and Casuarina	10	Creekline Woodland of *Eucalyptus camaldulensis* ssp *obtusa*	40% bare ground, 30% live vegetation, 20% leaf litter, 2% dead wood. No evidence of recent fire	Degraded	Cattle, Rabbits, Recreation, Dumping of rubbish	176 (1.1%)
Mulga Over Hardpan	11	Clay plains Low Woodland B of *Acacia aneura var aneura* over Open	75% bare ground, 20% live vegetation, 5% leaf litter, 5% dead wood. No	Very Good	Cattle, Rabbits,	5,789 (34.9%)

Fauna Habitat	Site No.	Vegetation Association	Habitat Assessment	Overall Condition of Fauna Habitat (after Keighery 1994)	Disturbance	Extent in Study area (ha, %)
		Tall Grass of *Eriachne mucronata* (arid form)	evidence of recent fire		Horses	
Major Drainage Line	12	Clay plains Open Woodland of *Eucalyptus camaldulensis* ssp *obtusa* Over Low Woodland B of *Acacia* spp	40% bare ground, 25% live vegetation, 30% leaf litter, 5% dead wood. No evidence of recent fire	Good	Cattle, Horses	2,274 (13.7%)
Claypan		Mixed samphire species with fringing chenopods and mulga (*Acacia aneura*)	50% bare ground, 50% live vegetation. No evidence of recent fire	Degraded	Cattle	138 (0.8%)
Acacia victoriae on Calcrete		Open shrubland of *Acacia victoriae* with scattered chenopods and very sparse to no ground cover	85% bare ground, 10% live vegetation, 5% leaf litter. No evidence of recent fire	Degraded	Cattle	39 (0.2%)
Mixed Shrubland Floodplain		Mulga over *Acacia* and *Cassia* spp.	85% bare ground, 10% live vegetation, 3% leaf litter, 2% dead wood. No evidence of recent fire	Completely Degraded	Cattle, Dumping of rubbish	793 (4.8%)
Stony Rise		Mulga over *Eremophila forresti* on stony substrate	60% bare ground, 30% live vegetation, 10% leaf litter. No evidence of recent fire	Degraded	Cattle, Horses	450 (2.7%)
Mulga over Quartz Loam		Mulga dominated low open woodland over scattered *Acacia* sp. *Cassia* sp. and *Grevillea* sp. on a loamy substrate with quartz gravel	60% bare ground, 30% live vegetation, 3% leaf litter, 2% dead wood. No evidence of recent fire	Degraded	Cattle	1,211 (7.3%)
Samphire Flats		Low heathland of halophilic species incl. *Halosarcia* sp and *Frankenia* sp.	60% bare ground, 40% live vegetation. No evidence of recent fire	Degraded	Cattle	735 (4.4%)
Salt Lake		Bare salt pan	100% bare ground, seasonally inundated	Very good	Mining (discharge of water), vehicle disturbance	668 (4.0%)

Minor Drainage Line

Less than 1% of the Study area consists of Minor Drainage Line habitat, with all of this habitat type occurring in the Centipede West study area (**Figure 18)**. Although this habitat type is present within the surrounding bioregion, its extent is typically limited (Pringle *et al*., 1994).

Minor Drainage Line habitat consisted of *Casuarina pauper* woodland with scattered *Eucalyptus* spp. over saline white/grey loam soils. A surface expression of the water table was present within this habitat, with intermittent pools of fresh/brackish water becoming fouled due to access from cattle. The understorey has been heavily grazed and hence the habitat is degraded.

This habitat is associated with higher species diversity as minor drainage lines generally contain moist, well vegetated microclimates. The relatively dense *Eucalyptus* and *Casuarina* woodland provides good vegetation cover (60%), which in conjunction with a fresh water source, provides an important breeding habitat for birds of prey. Leaf litter cover was low (5%) however other microhabitat such as logs and debris were present. This habitat type is uncommon within the Study area as water sources within the region are rare and this pool provides an important water source for bird and mammal species.

Mallee/Mulga complex Over Spinifex

Mallee/mulga over Spinifex habitat comprises 2.5 % of the Study area with the majority of this habitat type occurring within the Lake Way study area and between the Centipede East and West study areas (**Figures 18** and **19**). It consists of coppicing low open woodland of *Eucalyptus eremicola* sub sp. *peeneri* over hummock grassland of *Triodia sp*, with a scattered shrub layer of *Grevillea spp*, *Acacia* spp. and *Eremophila* spp. Similar habitat is present outside the Study area, and is likely to be well represented in the surrounding region. Although grazed by cattle, Mallee/Mulga over Spinifex was in generally good condition within the Study area.

This habitat type is vulnerable to fire, with recent burns observed adjacent to the Lake Way study area during the autumn survey. Too frequent fire is likely to reduce the potential for this habitat to support conservation significant fauna such as Mulgara (*Dasycercus cristicauda*) and Malleefowl (*Leipoa ocellata*), which both require habitat that has not been burnt for long periods of time.

Mulga Over Calcrete

Mulga over calcrete habitat is common within the Lake Way and Centipede study areas, comprising almost 10% of the entire Study area. It consists of low open *Acacia aneura* woodland with scattered *Casuarina pauper* trees over a low open scrub of *Acacia tetragonophylla* (“dead-finish” or “kurara”) and *A. victoriae* (“elegant wattle”) over very open herbs *Sclerolaena bicornis* (“goathead burr”) and open low grass of *Ereapogon caerulescens*. This habitat type is aligned with the Cunyu Land system (Pringle *et al*., 1994), which is moderately common throughout the wider landscape.

Vegetation was sparse with little to no understorey over a highly exposed substrate (**Table 8**), largely as a consequence of a long history of overgrazing. Soils were heavily compacted due to grazing also, resulting in poor drainage and rendering the habitat completely degraded.

This habitat is highly unlikely to possess high species diversity as the low vegetation cover, compacted soils and paucity of understorey provide little shelter for burrowing reptile species. The diversity of small skink species is likely to be low as there is no leaf litter to support genera such as *Lerista* spp. and *Ctenotus* spp. (Wilson and Swann, 2008). The mammal and bird diversity in this habitat is likely to be low as there is little shelter, protection from predators and a low food potential.

Claypan

This habitat forms less than 1% of the Study area, and is patchily distributed within the Lake Way and Centipede study areas (**Figures 18** and **19**). It consists of low open Samphire (*Frankenia and Halosarcia* spp.) heathland covering the claypan bed with fringing vegetation consisting of low Chenopod shrubland. The topography and compacted clay substrate offers little drainage and the claypan is likely to be seasonally inundated forming collective pools of water after periods of heavy rainfall. Claypan habitat was degraded as a result of grazing by cattle.

Claypan habitat within the Study area is unlikely to support any conservation significant fauna species.

Red Sand Dune

Red Sand Dune habitat forms 0.9% of the Study area, and is found bordering the lakeside vegetation within both Lake Way and Centipede study areas (**Figures 18** and **19**). This habitat contains *Triodia* sp. hummock grass with scattered *Acacia ligulata* and *Callitris preissi* (native pine) on a red sandy dune. As it is specifically associated with the shores of the lake, the extent of this habitat is likely to be limited within the broader landscape.

Red Sand Dune habitat has the potential to support the Mulgara (Vulnerable EPBC Act, Schedule 1 WC Act), as this species favours sandy substrates. The likelihood of the species being present within Red Sand Dune habitat in the Study area is low as it is heavily impacted by grazing, which prevents Spinifex from maturing to forms large clumps preferred by the species (van Dyck and Strahan, 2008).

Melaleuca Stands

This habitat, which comprises 0.7% of the Study area, consists of a band of low *Melaleuca xerophila* forest on red sandy clay soils, occurring as fringing vegetation between the samphire flats of Lake Way and upslope vegetation associations. Melaleuca stands appear to be limited within the surrounding region and at Lake Way, only occur sporadically around the lake's edge.

The dense nature of the canopy in Melaleuca stands provided shelter for fauna, including foraging and nesting sites for small birds. Leaf litter was also in relative abundance, providing habitat and resources for ground dwelling species. Despite this, the *Melaleuca* stands were typically degraded due to grazing by cattle and contained little understorey, reducing their capacity to support faunal assemblages.

Melaleuca Stands habitat is unlikely to support any conservation significant fauna species.

Acacia victoriae Shrubland Over Calcrete

This habitat consisted of *Acacia victoriae* Shrubland over Calcrete, forming 0.2% of the Study area. It occurs within the Lake Way study area adjacent to a drainage line (**Figure 19**) and is likely to be limited in its extent in the surrounding landscape.

Persistent overgrazing has removed the palatable shrubs and grass layer of this habitat, with compaction and topsoil erosion evident. Little understorey was present and leaf litter was confined to the areas under the remaining *Acacia* trees. Faunal diversity within this habitat type was expected to be relatively low. When in flower, the *Acacia* trees may provide an important food source for nectivorous bird species such as honeyeaters.

Acacia victoriae Shrubland over Calcrete habitat is unlikely to support any conservation significant fauna species.

Chenopod Floodplain

Chenopod floodplain occurs in the lower section of the Uramurdah Creek system, closest to Lake Way (**Figure 19**), comprising 0.7% of the Study area. It consists of a narrow drainage channel with an open heath of mixed chenopod species on dry brown clay. This habitat type occurs within the Lake Way study area. It is associated with drainage into the lake and is likely to be represented elsewhere in the broader landscape.

Shrub cover within this habitat type was relatively dense potentially providing habitat for reptiles in terms of shelter for the burrows of dragon lizards (*Agamidae*) and small skink species such as *Ctenotus* and *Lerista* species. Small bird species such as the Fairy-wrens and Thornbills forage under the protective shrub layer.

There is some potential for the Slender-billed Thornbill (*Acanthiza iredalei iredalei*) to occur within Chenopod Floodplain habitat.

Eucalypt Woodland

The Eucalypt woodland consisted of open woodland of *Eucalyptus gypsophila* over a low shrubland consisting of occasional *Acacia* species on sandy loamy red soils. This habitat type comprised 0.2% of the

Study area, occurring in the north of the Lake Way study area (**Figure 19**). It is likely to be limited in the surrounding landscape, which is dominated by *Acacia* species such as mulga (*Acacia aneura*).

Eucalyptus Woodland represents a relatively productive habitat, with deep leaf litter and a substantial canopy providing some structural diversity and shelter. Other micro habitats such as logs and branches were also present, suggesting that it may support a relatively rich faunal assemblage compared with the surrounding habitats.

As the amount of Eucalypt Woodland habitat was small (i.e. 37 ha), it is unlikely that any conservation significant fauna species reside within this habitat permanently, although several bird species may nest within it intermittently (e.g. Major Mitchell's Cockatoo *Cacatua leadbeateri*, Peregrine Falcon *Falco peregrinus*, Bush Stone Curlew *Burhinus grallarius*). No conservation significant species were recorded within this habitat during the surveys.

Mulga Woodland over Chenopod Shrubland

This habitat, comprising 0.2% of the Study area, occurring within the Lake Way study area (**Figure 19**) and may be patchily distributed throughout the broader landscape. Mulga Woodland over Chenopod habitat within the Study area is degraded as the chenopod understorey is sparse and grasses have been heavily grazed by cattle.

It is unlikely that this habitat type would support any conservation significant fauna species.

Open Mulga Woodland over Spinifex

This habitat comprised Mulga (*Acacia aneura* var *aneura*) low open woodland over hummock grassland of *Triodia melvillei* with a scattered mixed shrub layer on red sandy soil. This community ranges in structure from hummock grassland with a few scattered emergent Mulga through to open low woodland over the Study area. This habitat type occurs over ten percent of the Study area, largely within the Borefields study area (**Figure 17**), and is likely to be well represented in the broader landscape also.

Spinifex provides important shelter with a regulated temperature from harsh external conditions and a protective barrier for small native mammal species such as the Kultarr (Van Dyck and Strahan, 2008). Some gecko species (Gekkonidae) are restricted to habitats where Spinifex occurs (e.g. *Strophurus jeanae* and the Jewelled Gecko (*Strophorus elderi*). In areas where sandier soils are present (e.g. within the centre of the Lake Way Study area), this habitat type may have some potential to support the Mulgara (*Dasycercus cristicauda,* Vulnerable – EPBC Act, Schedule 1 – WC Act), although degradation from grazing and fire may reduce this potential.

Creekline with River Red Gum and Casuarina

This habitat consisted of a dry creekline supporting a River Gum (*Eucalyptus camaldulensis*) and Black Oak (*Casuarina pauper*) woodland on gravelly red soil over calcrete (**Plate 10**). This habitat type made up 1.1% of the Study area and traverses the Borefields study area (**Figure 17**).

There was little understorey which is typical of a creek bed environment, however the large River Gum trees provided a high amount of leaf litter as well as other micro habitat such as fallen woody debris.
The River Gums contained tree hollows that provide shelter for arboreal reptiles such as pythons, and nesting habitat for arboreal bat species such as the Central Long-eared Bat (*Nyctophilus major tor* [Parnaby 2009], Priority 4 Fauna).

Mixed Shrubland Floodplain

Mixed Shrubland Floodplain habitat occurs within the Borefields study area and comprises 4.8% of the overall Study area (**Figure 17**). The habitat consists of mixed open shrubland of Mulga (*Acacia aneura*), *Acacia* sp. and *Cassia* sp. This habitat is likely to occur in other low lying areas amongst mulga woodlands.

The majority of the understorey within the Mixed Shrubland Floodplain habitat had been heavily grazed and along with a paucity of leaf litter and woody debris, offers little shelter for reptile and mammal species.

It is unlikely that this habitat type would support any conservation significant fauna species.

Stony Rise

Stony rise habitat consisted of a low open woodland of Mulga over *Eremophila forrestii open shrubland* on the gradual slopes. This habitat occurs in two small areas within the Borefield study area (2.7% of overall Study area). The gradual slope within this habitat provides good drainage; however, persistent overgrazing has resulted in its degradation, with little understorey present leaving most of the ground exposed.

It is unlikely that this habitat type would support any conservation significant fauna species.

Open Mulga Woodland over Spinifex on Hardpan

This habitat consisted of Mulga *(Acacia aneura* var *aneura)* low open woodland over closed hummock grassland of *Triodia melvillei* (spinifex) with a scattered shrub layer on red sandy soils. It is well represented across all three study areas (**Figure 17, 18, 19**), comprising 35% of the overall Study area, and is common within the wider landscape.

The combination of Mulga and Spinifex, along with occasional shrubs and grasses, provides some structural diversity, which may support a range of fauna species including birds and arboreal reptiles. Further, the habitat remains in very good condition.

It is unlikely that this habitat type would support any conservation significant fauna species.

Major Drainage Line

The Major Drainage Line (13.7% of Study area) runs through the centre of the Borefields study area (**Figure 17**). It forms part of a substantial drainage system that extends to the northwest and is likely to be well represented outside the Study area.

The mature River Red Gum (*Eucalyptus camaldulensis*) and *Acacia* trees provided a substantial amount of leaf litter cover and woody debris. This habitat is likely to support a moderate faunal diversity as leaf litter provides foraging habitat for small skink species and nocturnal reptiles (such as geckos) that shelter under the bark of trees. The large Eucalypts contained tree hollows, which provide important habitat for nesting birds (Pizzey and Knight, 2007), arboreal mammals (van Dyck and Strahan 2008) and reptiles such as pythons (Wilson and Swann, 2008).

There is some potential for conservation significant species to utilise this habitat, including Major Mitchell's Cockatoo (*Cacatua leadbeateri,* Schedule 4 Fauna, WC Act) and the Bush Stone-curlew (*Burhinus grallarius*, Priority 4 Fauna), although they are unlikely to be solely reliant on it for their existence.

Mulga Over Quartz Loam

This habitat, which comprises 7.3% of the Study area, consists of Mulga dominated low open woodland with scattered *Acacia* sp. *Cassia* sp. and *Grevillea* sp. on a loamy substrate with quartz gravel. Heavy and prolonged grazing has greatly reduced the amount of understorey and live vegetation cover, rendering much of the substrate exposed. This habitat type occurs in a small section of the Borefield study area (**Figure 17**) and is well represented in the Study area surrounds (**Figure 16**).

It is unlikely that this habitat type would support any conservation significant fauna species.

Samphire Flats

Samphire flats are well represented on the margins of the salt lake in the Lake Way and Centipede study areas (**Figure 18** and **19**) and form 4.4% of the overall Study area. Samphire flats and adjacent saltbush communities associated with the Lake Way are disjunct at the regional scale and provide intermittent habitat for waterbirds, and are therefore considered at least locally significant. This includes Abercrombie Creek within the Centipede study area, which possesses similar attributes to the Lake Way samphire flats, and from a habitat perspective is considered an extension of that system (**Figure 19)**.

Samphire flats and saltbush communities can support fauna of conservation significance such as the Slender-billed Thornbill (*Acanthiza iredalei iredalei,* Vulnerable – EPBC Act), Bush Stone-curlew (*Burhinus grallarius,* Priority 4 Fauna) and Australian Bustard (*Ardeotis australis,* Priority 4 Fauna). Further, samphire

flats are particularly prone to degradation from grazing due to the high palatability of the vegetation to livestock.

Salt Lake

Salt Lake refers to the bare flat areas of Lake Way that are devoid of vegetation. This habitat comprises 4% of the Study area. The Salt Lake areas are likely to become inundated after periods of substantial rainfall, potentially supporting species of waterbird; including migratory species listed by the EPBC Act 1999 (see Section 4.3.4).

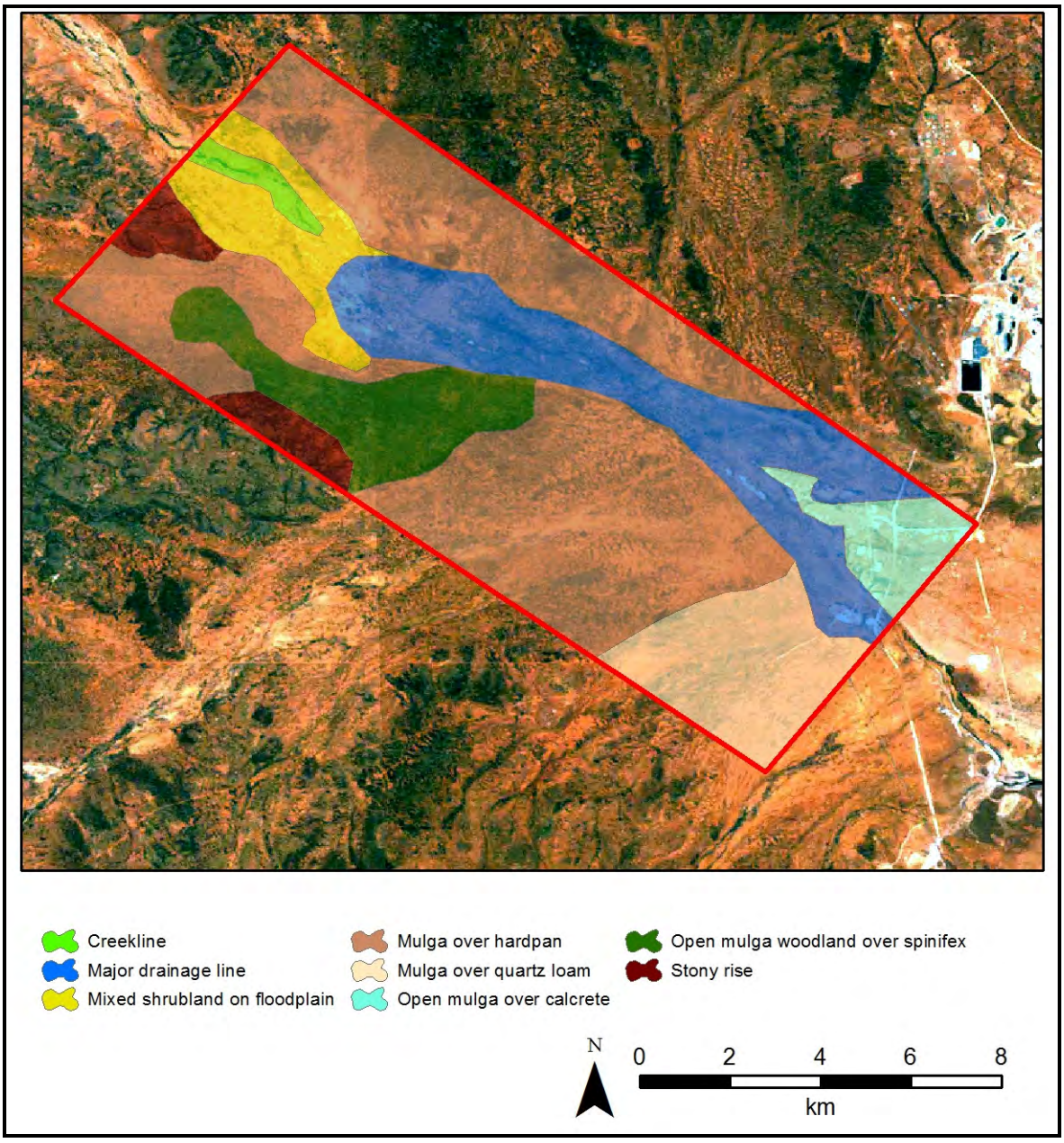

Figure 17: Borefield study area fauna habitat map

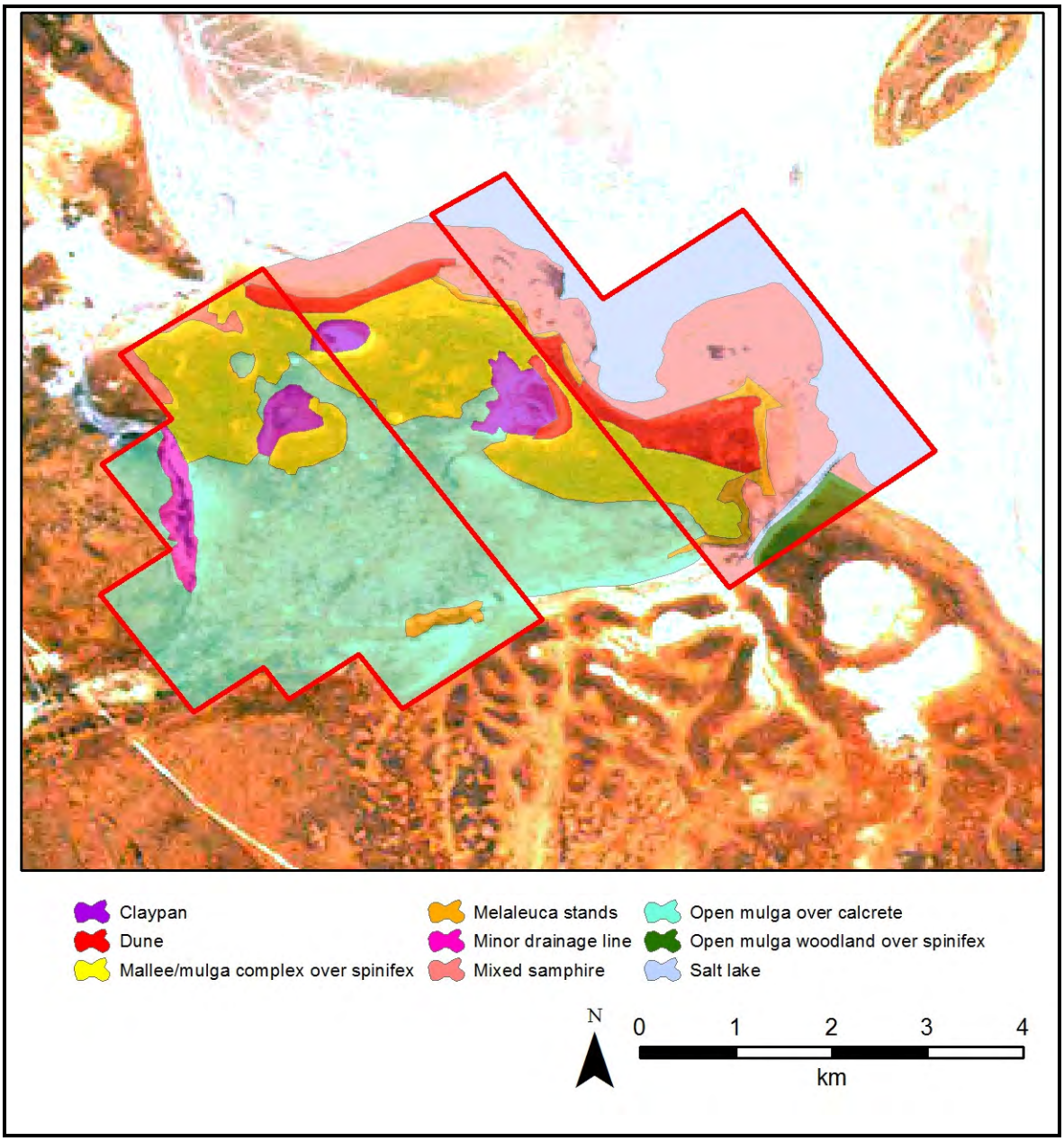

Figure 18: Centipede study area fauna habitat map

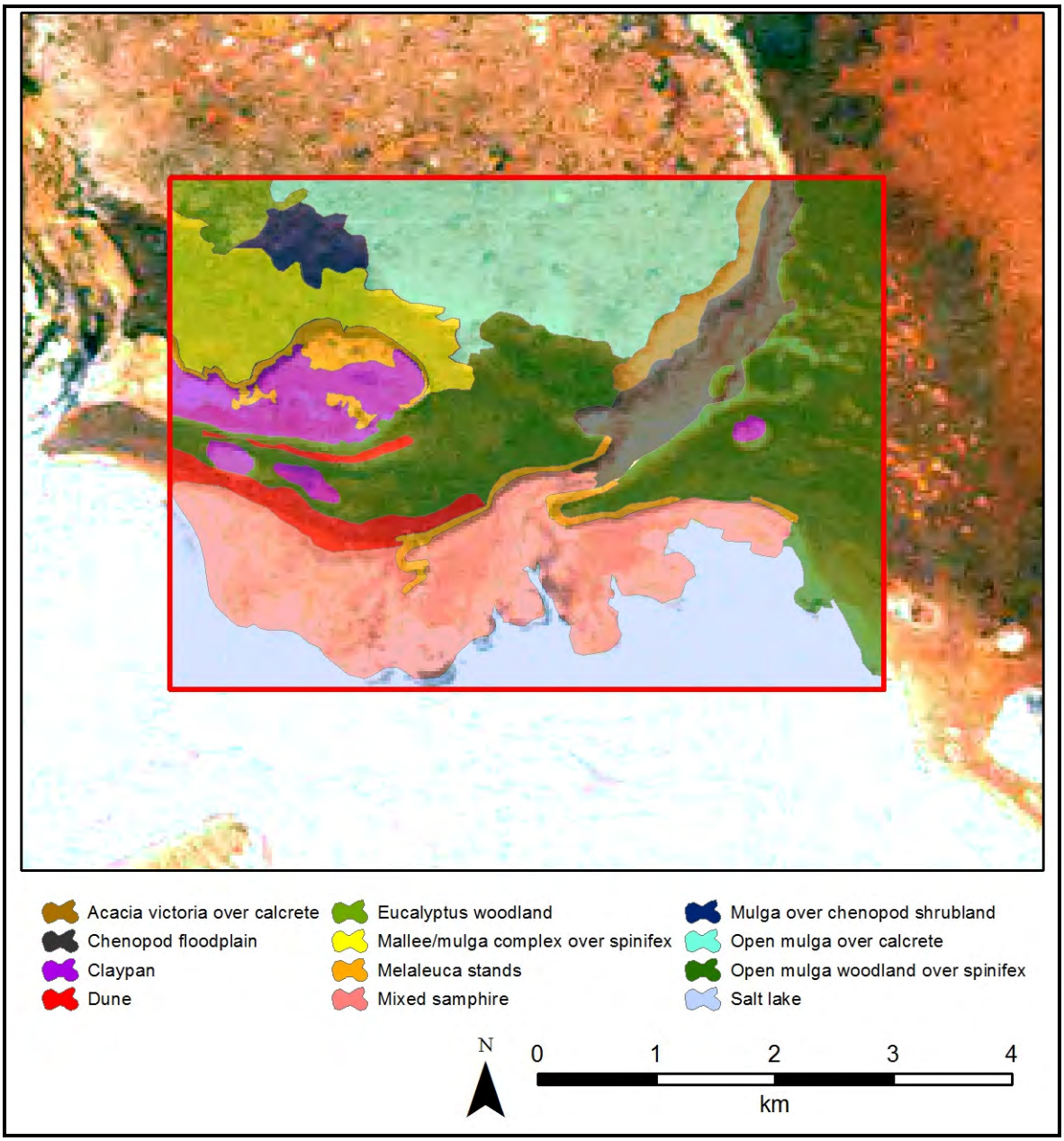

Figure 19: Lake Way study area fauna habitat map

4.2 Vertebrate Fauna Species

A summary of vertebrate fauna species recorded within the Study area and from surveys conducted within the locality, is provided in **Table 9.** A complete inventory of species recorded from within the Study area and wider surrounds is presented in **Appendix A**.

The review of database searches and previous surveys in the region determined a total of 326 terrestrial vertebrate fauna species have the potential to occur within the Study area, comprising 43 mammals (31 native and 12 introduced), 182 birds, 95 reptiles and six amphibian species (**Table 9**; **Appendix A**).

Of these species, 216 have been recorded in surveys within the Study area, consisting of 31 mammals (20 native), 75 reptiles, 105 birds and five amphibians. During the 2009 reconnaissance survey and 2010 detailed autumn survey, a total of 109 vertebrate species were recorded, comprising 21 mammals (12 native), 36 reptiles, 52 birds and no amphibians. (**Table 9**; **Appendix A**).

Table 9: Summary of vertebrate fauna species richness within the Study area and surrounds

Fauna	Previous Studies							Species Richness Recorded from Studies	Species Richness Recorded from Database Searches[1]	Total Species Richness
	Study Area				Local Surveys					
	Outback Ecology (2010)	Outback Ecology (2009)	Outback Ecology (2008)	CSIRO (1978)	Bancroft and Bamford (2004)	Outback Ecology (2002)	Bamford (2010)			
Native Mammals	12	9	13	10	N/A	-	19	28	21	31
Birds	46	21	55	85	47	22	82	156	152	182
Reptiles	35	7	33	52	N/A	9	47	83	62	95
Amphibians	-	-	-	5	N/A	1	4	6	3	6
Introduced Fauna	8	5	8	4	N/A	1	5	12	2	12
Total Native Fauna	93	37	101	152	N/A	32	152	273	238	314
Total Fauna	101	42	109	156	N/A	33	157	285	240	326

[1] Database searches include:

Department of Environment and Conservation's Threatened and Priority Fauna Database (DEC, 2009);

Department of Environment and Conservation's NatureMap Database (DEC, 2009a)

Birds Australia Birdata Search (Birds Australia, 2010)

Department of Environment, Water, Heritage and The Art's Environmental Reporting Tool (2009)

Australian Museum Collections Database Search (2009)

4.2.1 Mammals

There are 47 species of mammals known from the entire Murchison bioregion (NLWRA, 2002). Twenty mammal species no longer occur in the bioregion and are now either extinct (e.g. the Lesser Stick-nest Rat, Pig-footed Bandicoot, Crescent Nail-tail Wallaby, Long-tailed Hopping-mouse and Short-tailed Hopping-mouse) or regionally extinct (e.g., Greater Stick-nest Rat, Chuditch, Black-flanked Rock-wallaby and the Greater Bilby). Apart from the hopping-mice, all these species are critical weight range mammals with weights between 35 g and 5,500 g. That is, those species that have been most affected by environmental changes following European settlement such as fox and cat predation (Burbidge and McKenzie, 1998). The bioregion, therefore, has very high 'faunal attrition' and 'faunal contraction' indices at 0.45 and 0.4 respectively (NLWRA, 2002).

The review of database searches and previous surveys conducted within a 150 km radius of the Study area indicate that 43 mammal species (31 native) could potentially occur within the Study area (**Appendix A**).

A total of 31 mammals (20 native and 11 introduced) have previously been recorded within the Study area. A total of 21 of these mammal species (12 native) were recorded during the 2009 reconnaissance survey and 2010 detailed autumn survey by Outback Ecology (**Appendix A**).

Six species of bats were recorded within the Study area during the targeted bat component of the 2009 reconnaissance survey, Gould's Wattled Bat *(Chalinolobus gouldii*), Inland Free-tail Bat (*Mormopterus sp 3* [Adams et al 1988]), Inland Broad-nosed Bat (*Scotorepens balstoni*)*,* Inland Forest Bat (*Vespadelus baverstocki*), Inland Cave Bat (*Vespadelus finlaysoni*) and Lesser Long-eared Bat (*Nyctophilus geoffroyi*). All of these species have previously been recorded within the Study area (**Appendix A**).

No conservation significant mammal species were recorded during the 2009 and 2010 surveys.

4.2.2 Birds

A total of 182 bird species have previously been recorded, or potentially occur, within and surrounding the Study area (**Appendix A**). Of these species, 105 species have been recorded in the vicinity of Lake Way as part of vertebrate surveys, with 52 species recorded during the 2009 and 2010 surveys by Outback Ecology (**Appendix A**).

Some of these species would only be present irregularly, either as nomads or migrants occurring during their summer migration or during particular climatic conditions. Several of these species are migratory birds that would be present on Lake Way during periods of inundation (Section 4.3.4).

One migratory species listed under the EPBC Act, the Rainbow Bee-eater (*Merops ornatus*), was found to be common throughout all three study areas. This species was also previously recorded in the Study area

by Outback Ecology during the detailed spring survey conducted in October 2007. Another listed migratory species, the Sharp-tailed Sandpiper (*Calidris acuminata*), was sighted opportunistically during the detailed 2010 autumn survey within Samphire Flats habitat, in the southern portion of the Centipede study area on a single occasion.

4.2.3 Reptiles

The Murchison Bioregion is rich in reptiles with over 80 known species. The review of database searches and previous surveys conducted in the locality indicate that 95 reptile species could potentially occur within and surrounding the Study area (**Appendix A**).

A total of 36 reptile species were recorded during the 2009 reconnaissance survey and 2010 detailed autumn survey by Outback Ecology (**Appendix A**).

No conservation significant reptile species were recorded during the 2009 reconnaissance or 2010 detailed autumn survey, or in any other known surveys conducted within the Study area.

4.2.4 Amphibians

A total of six amphibian species have previously been recorded, or potentially occur, within and surrounding the Study area (**Appendix A**). Five of these were recorded in a survey conducted by CSIRO (1978) during a time of favourable rainfall. Only one species, the Desert Tree Frog (*Litoria rubella*) has been previously recorded in the vicinity of Lake Way since that time (**Appendix A**).

All six of these amphibian species have aquatic larval stages and all except the Desert Tree Frog burrow to avoid desiccation. Salt levels are likely to be too high within Lake Way itself to support frogs and if present they are more likely to be present in the water pool within the Centipede study area or the seasonally inundated claypans surrounding the salt lakes, for example the Uramurdah Claypan to the north of the Lake Way study area.

No amphibians were recorded during the 2009 reconnaissance or 2010 detailed autumn survey.

4.2.5 Fish

In such an arid environment the only species of fish with the potential to occur is the Spangled Perch *(Leiopotherapon unicolor*). This species can occur in arid areas within the Murchison bioregion. It is a very drought tolerant species that survives long periods between rainfall events probably by aestivating in wet mud or litter. This species has not been recorded within the Study area and is unlikely to occur. The most likely place for fish to survive is the small water pool located within the Centipede study area or the Uramurdah Claypan and associated creekline to the north of the Lake Way study area.

4.2.6 Introduced Vertebrate Fauna

Fourteen introduced species occur within the Murchison bioregion. Of these species, eleven have been recorded within the Study area (**Table 10**).

Table 10: Introduced species possibly occurring within the Study area

Group	Common Name	Scientific Name	Outback Ecology (2010)	Outback Ecology (2009)	Outback Ecology (2008)
Mammals	House Mouse	*Mus musculus*	X	-	X
	Dingo / Wild Dog	*Canis lupus dingo*	X	-	X
	Red Fox	*Vulpes vulpes*	X	X	X
	Cat	*Felis catus*	X	-	X
	European Rabbit	*Oryctolagus cuniculus*	X	X	X
	Donkey	*Equus asinus*	X		
	Brumby / Horse	*Equus caballus*	X	X	X
	Dromedary Camel	*Camelus dromedarius*		-	X
	European Cattle	*Bos taurus*	X	X	X
	Goat	*Capra hircus*		-	-
	Sheep	*Ovis aries*		X	-

4.3 Conservation Significant Fauna

This section provides a summary of the occurrence of conservation significant vertebrate fauna species previously recorded or potentially occurring in the Study area.

Two conservation significant fauna species listed under the EPBC Act as Migratory have been recorded within the Study area; the Rainbow Bee Eater (*Merops ornatus*) and Sharp-tailed Sandpiper (*Calidris acuminatus*). The Rainbow Bee-eater species was recorded during the 2009 reconnaissance and 2010 detailed autumn survey in all three study areas; and within the Lake Way study area during the 2007 detailed spring survey. A single Sharp-tailed Sandpiper (*Calidris acuminata*) was recorded within Samphire Flats habitat in the Centipede East study area during the 2010 detailed autumn survey.

The conservation significance of terrestrial vertebrate fauna potentially occurring, within the Study area is described in the following sections, including:

- Threatened fauna species listed under the EPBC Act, and declared threatened fauna and other specially protected fauna listed under the WC Act (Section 4.3.1).
- Priority fauna recognised by DEC (Section 4.3.2).
- Species not listed under any Acts, but considered of conservation significance due to patterns of distribution (for instance bioregional endemics) (Section 4.3.3).

- Migratory species listed under the EPBC Act and international agreements which include the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), Republ*ic of Ko*rea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals) (Section 4.3.4).

4.3.1 Threatened Fauna Species

Legislation has been developed at a Commonwealth and State level to protect fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value. At the national level, fauna are protected under the EPBC Act. Within WA, fauna can be listed under various Schedules within the WC Act. Definitions of conservation significance are presented in **Appendix C**.

No threatened fauna species listed under the EPBC Act or WC Act have been recorded within the Study area.

Ten threatened fauna species were returned via searches of databases; however, only five of these could potentially occur within the Study area (**Table 11**). These five species are examined below. The remaining six species that are unlikely to occur are listed in **Table 12** and are discussed briefly.

Table 11: Threatened species potentially occurring within the Study area

Common Name	Scientific Name	Conservation status		Record Source			
		EPBC Act	WC Act	Study Area	Local <75km	Regional >75km	Database Searches
Mammals							
Crest-tailed Mulgara	*Dasycercus cristicauda*	VU	S1		K	IK	KO
Birds							
Malleefowl	*Leipoa ocellata*	VU	S1		K	K	KOP
Slender-billed Thornbill	*Acanthiza iredalei iredalei*	VU					OP
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	-	S4				K
Peregrine Falcon	*Falco peregrinus*	-	S4				M

EPBC Act: EX Extinct, E Endangered, VU Vulnerable
WC Act: Schedule 1, S2, S3, S4
I Outback Ecology (2009). Lake Maitland Baseline Terrestrial Fauna Surveys.
K DEC (2009a) Threatened Species Search
M Birds Australia (2009)
O DEWHA (2009a) Environmental Reporting Tool
P DEWHA (2009b) Protected Matters Report

- **Mulgara (*Dasycercus cristicauda, blythi*)**

Until relatively recently the Brush-tailed Mulgara (*Dasycercus blythi*) has been considered the same species as the Crest-tailed Mulgara *(Dasycercus cristicauda*) (Van Dyck and Strahan, 2008). The Mulgara

is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act however these acts do not distinguish between species. The current distribution of each of these species is uncertain and can only be ascertained once correct identification of museum specimens has been undertaken (Van Dyck and Strahan, 2008). The Brush-tailed Mulgara is currently listed as a Priority 4 species by DEC and current estimations show that the distribution of the Brush-tailed Mulgara occurs within the region of the Study area. The Crest-tailed Mulgara is believed to have occurred in this area historically but is not likely to occur currently (van Dyck and Strahan 2008).

The Mulgara inhabits sandplains dominated by *Triodia* spp. (Halpern Glick Maunsell, 1997). The DEC Threatened and Priority Fauna Database contains records of Mulgara from Kumarina (200km N), Jundee Mine site (50 km north east), Wanjarri Nature Reserve (55km SE), Barwidgee Station (30km ESE), Mt Keith Mine Site (135km S), and Honeymoon Well (25km S) and recent records from Wiluna in 2007.

No evidence of Mulgara was recorded during this or previous surveys within the Study area. Spinifex with an overstorey of Mulga and Mallee does exist within the Study area (**Figure 18** and **Figure 19**); however, this habitat does not contain the almost pure stands of Spinifex with little overstorey that are preferred by Mulgara (Gibson and Cole, 1992; Maxwell *et al*. 1996; HGM, 1997). Additionally, the degraded nature of Spinifex habitats within the Study area (i.e. heavily grazed, recently burnt) is not conducive to supporting this species. Active searches of these sites failed to locate this species. Habitat more likely to support Mulgara exists outside the Study area in the vast Spinifex sandplains to the east of Lake Way.

Despite the fact optimal habitat does not occur for this species over the Study area, and given that this species is known to occur in the vicinity, it is possible that this species may utilise the Study area from time to time.

- **Malleefowl (*Leipoa ocellata*)**

The Malleefowl is a ground-dwelling bird that builds large and distinctive mounds of soil and litter in which it incubates its eggs. Malleefowl distribution is fragmented and scattered through semi-arid rangelands and the eastern Wheatbelt of south-western Australia (Garnett and Crowley, 2000). The known distribution of the Malleefowl occurs over the Study area (Blakers *et al*. 1984; Barrett *et al*. 2003; Marchant and Higgins, 1993), although the species is only thought to be scattered throughout the region (Benshemesh et al., 2007). The most recent recordings of Malleefowl at Wiluna are from 2007, with previous records from Yeelirrie (75 km S), Wanjarri Nature Reserve (55km SE), Earaheedy Station (150km NE), Lake Carnegie (210km NE), Mount Keith (135km S), and Yandal Station (75km SE) occurring from 1984 to 2001.

Primary habitat consists of Mallee, and semi-arid shrublands (Garnett and Crowley, 2000), with a recent survey revealing that regionally this species favour shrubby areas with heights reaching two to four metres, as opposed to open areas or woodlands (Benshemesh et al., 2007).

Targeted searches for Malleefowl mounds were conducted in the Mulga and Mallee woodland habitats across the Centipede, Borefield and Lake Way study areas. No evidence of Malleefowl or their distinctive mounds was recorded during targeted searches conducted during this or previous surveys within the Study area (Outback Ecology, 2008). Based on findings of Benshemesh et al. (2007) and Parsons (2008), it is suspected that these habitats were too open to support Malleefowl.

Too frequent fire and heavy grazing by cattle within the Study area are also likely to have compromised habitat suitability for this species. However, it is still possible that the Malleefowl could occur in low densities in the Mallee woodland and Mulga habitats across the Centipede, Lake Way and Borefield study areas (**Figures 17, 18** and **19**).

- **Slender-billed Thornbill (*Acanthiza iredalei iredalei*)**

The Slender-billed Thornbill is listed as Vulnerable under the EPBC Act. The Slender-billed Thornbill's preferred habitat is saltbush communities and samphire flats associated with salt lake systems. Although listed federally, as well as in South Australia and the Northern Territory, this species is not listed in under Western Australian legislation and it is thought that populations in northern South Australia and east of the Flinders Ranges, and possibly those that occur north-west of Lake Gairdner, are most likely to be in decline (DEWHA, 2009d).

Several active searches were undertaken for this species in the Samphire and Chenopod habitat surrounding Lake Way (Lake Way and Centipede study areas) but were not successful in detecting the species. The Study area is situated within the northeast distributional boundary for this species (Higgins and Peter, 2002), and although the habitat is degraded, there is potential for this species to occur.

- **Major Mitchell's Cockatoo (*Cacatua leadbeateri*)**

The Major Mitchell's Cockatoo is listed as Schedule 4 under the WC Act. This species occupies sparsely timbered grasslands, paddocks with trees, mulga, open scrublands, open mallee country and tree lined watercourses. The Major Mitchell's Cockatoo is a sedentary, uncommon species with a patchy distribution, although it may be locally common. Although the Study area lies outside the species distribution as identified by Johnstone and Storr, (1998), Higgins (1999) shows the Study area is on the edge of its range and a DEC threatened fauna database record exists from just east of Wiluna in 1967. This species is thought to have declined in southern farming regions (Morcombe, 2003).

The preferred habitat of this species is open woodland. The Borefield study area contains a creek line and major drainage line vegetated with *Eucalyptus camaldulensis* providing suitable habitat for this species (**Figure 17**). Major Mitchell's Cockatoo has not previously been recorded within the Study area; however, this species may use this habitat intermittently.

- **Peregrine Falcon (*Falco peregrinus*)**

The Peregrine Falcon is listed as Schedule 4 under the WC Act. It is a nomadic species that utilises a wide range of habitats across Australia, including rocky escarpments and gorges, cliffs, tree lined watercourses, open woodland and *Acacia* shrublands (Pizzey and Knight 2007). This species has a home range of approximately 20 – 30 km^2 throughout the year. The Peregrine Falcon utilises cliffs and tree hollows for breeding.

The species is highly mobile and may occur over the Study area intermittently. Large eucalypts that provide potential breeding habitat for this species occur within the Creek Line and Major Drainage Line habitats of the Borefield study area, the Minor Drainage Line habitat within the Centipede study area and in the surrounds of the Uramurdah Clay Pan to the north of Lake Way.

Table 12: Threatened fauna species considered unlikely to occur over the Study area

Common Name	Scientific Name	Conservation Status[1]		Record Source (database searches)
		EPBC Act	WC Act	
Mammals				
Burrowing Bettong	*Bettongia leseuer*	VU	S1	L
Banded Hare-Wallaby	*Lagostrophus fasciatus fasciatus*	VU	S1	K
Greater Bilby	*Macrotis lagotis*	VU	S1	L
Birds				
Princess Parrot	*Polytelis alexandrae*	VU		OP
Reptiles				
Great Desert Skink	*Egernia kintorei*	VU	S1	KOP

EPBC Act: EX Extinct, E Endangered, VU Vulnerable
WC Act: Schedule 1, S2, S3, S4
K DEC (2009a) Threatened Species Search
L DEC NatureMap Search (2009)
O DEWHA (2009a) Environmental Reporting Tool
P DEWHA (2009b) Protected Matters Report

- **Burrowing Bettong (*Bettongia lesueur*)**

This species was once widespread across mainland Australia and is the only macropod to habitually shelter in underground warrens (Van Dyck and Strahan 2008). Evidence of old bettong warrens exists within the Study area in calcrete habitats. The species is now extinct on the mainland, due largely to predation from introduced predators; however, these conspicuous warrens remain in the landscape for many years and have been found elsewhere in semi-arid and arid Australia (Noble et al. 2007). Populations of this species occur only on Bernier, Dorre and Barrow Islands (van Dyck and Strahan 2008).

- **Banded Hare-wallaby (*Lagostrophus fasciatus fasciatus*)**

This species was once common throughout what is now the Wheatbelt region of Western Australia, although fossil evidence extends much further afield (van Dyck and Strahan 2008). The species is extinct on the mainland due to predation by introduced predators and now relict populations occur only on Bernier and Dorre Islands in Shark Bay. The species is believed to prefer dense thickets of vegetation (van Dyck and Strahan 2008) and so it is unlikely that the species would have inhabited the Study area prior to their extinction.

- **Greater Bilby (*Macrotis lagotis*)**

Once found throughout arid and semi-arid regions of Australia, the Greater Bilby now remains patchily distributed in isolated populations throughout the Gibson and Great Sandy Deserts south to Warburton, the Tanami Desert, Broome, south-west Queensland, NSW and north-east of Alice Springs, the Pilbara and Dampierland Bioregions, as well as the Kimberley (DEC, 2009b; Pavey, 2006; Menkhorst and Knight, 2004). The Greater Bilby occupy a range of inland habitats including grasslands, cracking clays, desert sand plains, dunefields, hummock grassland and massive red earths with *Acacia* shrublands (van Dyck and Strahan, 2008).

The Greater Bilby once occurred in the region and a WA Museum record exists for the species north of Wiluna in 1985 (DEC 2009a). This species has since undergone a widespread population decline as a result of altered fire regimes, predation by the European Red Fox (*Vulpes vulp*es) and feral cats and grazing pressure from introduced herbivores and livestock.

The Greater Bilby no longer occurs in the Eastern Murchison subregion and is therefore not likely to be present (ANRA, 2007). Further, a comprehensive targeted search conducted within Sand Dune habitat within Lake Way and Centipede study areas failed to detect the species (**Figures 12, 13, 14**).

- **Princess Parrot (*Polytelis alexandrae*)**

The Princess Parrot is found in the central and western arid zone of Australia and is listed as Vulnerable under the EPBC Act. Large-scale movements and sporadic appearances outside the western deserts make it difficult to determine whether there has been any change in distribution or numbers. The Princess Parrot is an inhabitant of lightly wooded country of desert areas to the east of the Study area; from the Great Sandy Desert, through the Gibson Desert and into the Great Victoria Desert (Johnstone and Storr, 1998). A record from Kumarina, close to the western edge of the Little Sandy Desert, over 220 km to the north of the Study area, is included in the DEC database search. A single record also exists for Wanjarri Nature Reserve in 1964 (Higgins, 1999). However, the Study area is outside the core range of this species and furthermore suitable habitat of swales between sand dunes or savannah woodland is not present. Consequently the species is unlikely to occur.

- **Great Desert Skink (*Egernia kintorei*)**

This species is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act. The Great Desert Skink occurs on red sandplains and sand ridges supporting spinifex predominantly to the east of the Study area (Pearson *et al*. 2001). The current distribution of the Great Desert Skink consists of seven isolated populations in Australia. Three of these populations occur in the eastern interior of Western Australia in the Gibson and Great Sandy Desert regions approximately 1200 km north of Kalgoorlie at Patjarr, Lake Mackay and Rudal River National Park (DEWHA, 2009d; Pearson *et al*, 2001).

The Great Desert Skink was caught in the Wanjarri Reserve in 1964 (DEC, 2009a). However, the Study area is located at the periphery of the species' range and therefore it is unlikely that the Great Desert Skink would occur within it. The Desert Skink was not recorded during trapping or targeted searches for this species within the Study area (**Figures 12, 13 and 14**).

4.3.2 Priority Fauna Species

The DEC recognises species not listed under the WC Act but for which there is some concern, and has produced a supplementary list of 'Priority' fauna. Definitions of Priority fauna are listed in **Appendix C**.

No Priority fauna species listed by the DEC were recorded within the Study area during this survey or previous fauna surveys.

Seven Priority fauna species were returned via searches of databases; however, only four of these could potentially occur within the Study area (**Table 13**). These four species are examined below. The remaining three species that are unlikely to occur are listed in **Table 14** and are discussed briefly.

Table 13: Priority fauna species that potentially occur within the Study area

Common Name	Scientific Name	Conservation Status	Record Source			
		DEC Priority	Study Area	Local <75 km	Regional >75 km	Database Searches
Birds						
Striated Grasswren	*Amytornis striatus striatus*	P4		-		K
Australian Bustard	*Ardeotis australis*	P4		KW	KJ	KLM
Bush Stone-Curlew	*Burhinus grallarius*	P4		-	H	KM
Grey Falcon	*Falco hypoleucos*	P4		-		M

DEC Priority Species List: P1, P2, P3, P4

Outback Ecology (2008) Baseline Terrestrial Fauna Survey of Lake Way. Report produced for Toro Energy Ltd.
I Outback Ecology (2009). Lake Maitland Baseline Terrestrial Fauna Survey. Report prepared for Mega Uranium Pty Ltd.
J Ninox (1993). Vertebrate Fauna Assessment of the Proposed Bronzewing Gold Project. Unpublished Report prepared for Signet Engineering Pty Ltd.
K DEC (2009a) Threatened Species Search
L DEC (2009b) NatureMap Search
M Birds Australia (2009)

W Anecdotal observation, Toro Energy Ltd, 2009.

- **Striated Grass-wren (*Amytornis striatus striatus*)**

The Striated Grass-wren is listed as Priority 4 by DEC and occurs within restricted habitat consisting of tall, dense *Triodia* spp. hummock grasslands. The main threat to these species is altered fire regimes which affects the height and density of hummock grasslands. Previous recordings of the Striated Grasswren occurred from Wanjarri Nature Reserve in 1979 and 1987 (DEC 2009a). However this species is now believed to occur in scattered but widespread populations in the Gibson Desert and Little Sandy Desert (Higgins, *et al* 2001).

Targeted searches were conducted for this species within the Mallee and Mulga over Spinifex grasslands habitats (**Figures 12, 13, 14**); however this species was not recorded and has not been previously recorded over the Study area (Outback Ecology, 2008). The Spinifex grasslands across the Study area consist of small clumps which have been degraded due to frequent fires and grazing by cattle. Although habitat in the Study area is limited and degraded, there is some potential for this species to occur.

- **Australian Bustard (*Ardeotis australis*)**

The Australian Bustard is listed as Priority 4 by DEC and has a wide distribution across Australia. The Australian Bustard inhabits open dry woodlands of Mulga, arid scrublands and Spinifex tussock grasslands (Johnstone and Storr, 1998; Morcombe, 2003) along with grasslands and drainage areas particularly after a series of years of above average rainfall (Johnstone and Storr, 2004). The DEC Threatened and Priority Fauna Database contains eleven records of the Australian Bustard from areas including Wiluna, Wanjarri Nature Reserve (55km SE), Sandstone (165km SW) and Lake Violet (5km N).

The Australian Bustard was not formally recorded from the Study area during the surveys, although an individual was sighted between the Lake Way and Centipede study areas in late 2009 by Toro field personnel. Further, suitable habitat does occur and therefore this species has the potential to occur within the Study area, at least intermittently.

- **Bush Stone-curlew (*Burhinus grallarius*)**

The Bush Stone-curlew is classified as Priority 4 by DEC. The species has declined in the southern parts of its range, primarily owing to the destruction and degradation of its preferred woodland habitat, predation by introduced foxes and interactions with habitat loss (Johnstone and Storr 2004).. The species is found in open woodlands of Mallee and Mulga, grasslands and sandplains supporting Spinifex and forest particularly near water courses or swampy areas (Geering *et al*., 2007; Pizzey and Knight, 2007; Johnstone and Storr, 1998). The DEC Threatened and Priority Fauna Database contains eight records of the Bush-stone Curlew from areas including Wiluna, Meekatharra (170km W), Sandstone (165km SW), Mount Keith (135km S), Sir Samuel (115km S), and Peak Hill (240km NW).

Call playback for the Bush Stone-curlew was conducted within Minor Drainage Line habitat (Centipede study area), Creek Line and Major Drainage Line habitat (Borefield study area) and the Mallee Woodland habitat (Lake Way study area) during nocturnal surveys. However, the species was not recorded during this survey and has not been previously been recorded within the Study area (Outback Ecology, 2008).

Although this species has not been recorded within the Study area, it does have the potential to occur within the above mentioned habitats, which are present.

- **Grey Falcon *(Falco hypoleucos*)**

The Grey Falcon is listed as Priority 4 by the DEC and has a scattered distribution across northern and eastern Australia. This species tends to inhabit open woodland areas on coastal and riverine plains, the arid and semi-arid interior of the country and around inland ephemeral and permanent drainage systems where annual rainfall is less than 500mm (Johnstone and Storr, 1998; Morcombe, 2003; Garnett and Crowley, 2000). This species can be rare, resident or nomadic to most of the semi-arid interior of Western Australia.

The Grey Falcon prefers to nest along larger creeklines supporting River Red Gums (Morecombe, 2003). The southern distribution of the Grey Falcon is immediately to the north east of the Study area in the vicinity of Lake Carnegie (Johnstone, 1998; Marchant and Higgins, 1993). However, the species has the potential to occur as it is highly mobile and suitable nesting habitat occurs in the Creek Line habitat within the Borefield study area.

Priority fauna species that are considered unlikely to occur over the Study area are listed in **Table 14**.

Table 14: Priority fauna species considered unlikely to occur over the Study area

Common Name	Scientific Name	Priority Status	Record Source (database searches)
Birds			
Princess Parrot *(discussed in Section 4.2.1*)	*Polytelis alexandrae*	P4	OP
Thick-billed Grasswren (western ssp)	*Amytornis textilis textilis*	P4	K
White-browed Babbler (western Wheatbelt)	*Pomatostomus superciliosus ashbyi*	P4	KL

K DEC (2009a) Threatened Species Search
L DEC NatureMap Search (2009)
O DEWHA (2009a) Environmental Reporting Tool
P DEWHA (2009b) Protected Matters Report

- **Thick-billed Grasswren *(western subspecies) (Amytornis textilis textilis)***

Although identified from the DEC Database search, this species has suffered major reductions in distribution and no longer occurs in the region, with the closest population now located at Shark Bay (Higgins *et al*. 2001). The last record of this species refers to a historical sighting in Wiluna from 1974 and it is therefore considered unlikely to occur within the Study area.

- **White-browed Babbler (western Wheatbelt) (*Pomatostomus superciliosus ashbyi*)**

This DEC Priority 4 listing for the White-browed Babbler refers to the subspecies *Pomatostomus superciliosus ashbyi* from the western Wheatbelt and southwest of WA (Garnett and Crowley, 2000). A single record for this subspecies exists from Millbillillie Station, five kilometres north of the Lake Way study area, although the taxonomic validity of this record is questionable. Six White-browed Babblers were recorded at the Minor Drainage Line habitat (Centipede study area) and an additional seven were recorded in the Creek Line habitat within the Borefield study area. However, these were the common form of the species *Pomatostomus superciliosus*. The White-browed Babbler is considered to be relatively common in the Murchison Bioregion.

4.3.3 Locally and Regionally Significant Species

Other species of conservational significance include endemics, those with restricted or fragmented ranges, or those that are at the extremes limits of their known distribution.

- Spotted Mulga Snake (*Pseudechis butleri*)

The Spotted Mulga Snake is the only vertebrate fauna species known to be endemic to the Eastern Murchison subregion (Cowan, 2001). The Spotted Mulga Snake is found in Mulga woodlands and shrublands (Wilson and Swan, 2008). This species is not considered to be threatened and was not detected during the 2010 autumn detailed terrestrial fauna survey, although it is possible that it could occur within the Study area based on the presence of Mulga habitat.

4.3.4 Migratory and Marine Wading Species

Two species listed as Migratory under the EPBC Act were recorded in the Study area during this assessment, the Rainbow Bee-eater (*Merops ornatus*) and Sharp-tailed Sandpiper (*Calidris acuminata*). The Rainbow Bee-eater has been recorded within the Study area during both the 2009 reconnaissance and 2010 detailed autumn survey as well as the 2007 detailed spring survey (Outback Ecology 2008).
A single Sharp-tailed Sandpiper was observed opportunistically in the Centipede study area during the 2010 detailed autumn survey.

A search of EBPC listed “Migratory” and “Marine” species indicated 35 species could potentially occur within the Study area. However, these lists have been acknowledged as imperfect (DEWHA, pers comm. June 2010) and are currently being revised as part of a wider review on the EPBC Act (see Hawke, 2009).

The review raised the issue that "interpreting the lists to include all species from the families is nonsensical because so many of the species are not migratory." This is reflected in data searches conducted for the Study area, which returned a range of species that are either not considered migratory or marine, threatened by the project, or of conservation significance. These are as follows: Brown Goshawk (*Accipiter fasciatus*), Whistling Kite (*Haliastur sphenurus*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*), Spotted Nightjar (*Eurostopodus argus*), Pallid Cuckoo (*Cacomantis pallidus*), Black-eared Cuckoo (*Chalcites osculans*), Magpie-lark (*Grallina cyanoleuca*), Nankeen Kestrel (*Falco cenchroides*), Sacred Kingfisher (*Todiramphus sanctus*), Welcome Swallow (*Hirundo neoxena*), Tree Martin (*Petrochelidon nigricans*), Australasian Pipit (*Anthus novaeseelandiae*), Stubble Quail (*Coturnix pectoralis*), Southern Boobook Owl (*Ninox novaeseelandiae*), and Eastern Barn Owl (*Tyto javanica*). These species will not be considered further.

A list of 20 migratory and marine bird species of relevance to the Study area is presented in **Table 15** and discussed below. Two of these species, the Rainbow Bee-eater (*Merops ornatus*) and the Fork-tailed Swift (*Apus pacificus*) are migratory and may use the habitats that occur in the surrounds of Lake Way.

The other 18 species are waterbirds and may use Lake Way during periods of inundation. All 18 are listed as marine species (EPBC Act 1999), although ten of these species have been previously recorded from Lake Way or the surrounds (**Appendix A**). Further, seven of these ten species are shorebirds listed as migratory (EPBC Act 1999) and routinely move vast distances along the East Asian-Australasian Flyway, incorporating areas such as northern China, Mongolia, Siberia and Alaska (DEWHA, 2009e). The migratory shorebirds that use these inland wetlands are highly mobile, allowing them to respond to changes in conditions (DEWHA, 2009e).

Table 15: Migratory and marine species potentially occurring within the Study area

Common Name	Scientific Name	Conservation Status		Record Source			
		EPBC Act 1999 Migratory	EPBC Act 1999 Marine	Study area	Local (<75km)	Regional (>75km)	Database
Rainbow Bee-eater	*Merops ornatus*	M	-	ABC	DG	H	MOP
Fork-tailed Swift	*Apus pacificus*	M	-	-	D	-	OP
Nankeen Night Heron	*Nycticorax caledonicus*	-	MA	-	E	-	LM
Eastern Great Egret	*Ardea alba*	M	MA	-	E	-	O
Straw-necked Ibis	*Threskiornis spinicollis*	-	MA	-	E	-	M
*Common Greenshank	*Tringa nebularia*	M	MA	-	DE	-	-
*Wood Sandpiper	*Tringa glareola*	M	MA	-	DE	-	-
*Common Sandpiper	*Actitis hypoleucos*	M	MA	-	DE	-	-

Common Name	Scientific Name	Conservation Status		Record Source			
		EPBC Act 1999 Migratory	EPBC Act 1999 Marine	Study area	Local (<75km)	Regional (>75km)	Database
*Sharp-tailed Sandpiper	*Calidris acuminata*	M	MA	A	DE	-	-
*Curlew Sandpiper	*Calidris ferruginea*	M	MA	-	E	-	-
*Red-necked Stint	*Calidris ruficollis*	M	MA	-	DE	-	-
Black-winged Stilt	*Himantopus himantopus*	-	MA	-	DE	-	M
Red-necked Avocet	*Recurvirostra novaehollandiae*	-	MA	-	DE	-	M
Red-capped Plover	*Charadrius ruficapillus*	-	MA	-	DE	-	M
*Oriental Plover	*Charadrius veredus*	M	MA	-	DE	-	-
Oriental Pratincole	*Glareola maldivarum*	M	MA	-	D	-	-
Australian Pratincole	*Stiltia isabella*	-	MA	-	E	-	-
Silver Gull	*Larus novaehollandiae*	-	MA	-	E	-	-
Gull-billed Tern	*Sterna nilotica*	-	MA	-	E	-	-
Whiskered Tern	*Chlidonias hybridus*	-	MA	-	E	-	-

* Non-breeding migrants
M= Migratory species
MA= Marine Species

A Outback Ecology (2010) Terrestrial Vertebrate Fauna Assessment for the Wiluna Uranium Project.
B Outback Ecology (2009) Terrestrial Vertebrate Fauna Reconnaissance Survey for the Wiluna Uranium Project.
C Outback Ecology (2008) Baseline terrestrial Fauna Survey of Lake Way.
D CSIRO (1978) A Survey of the Vertebrate Fauna of the Lake Way Area, Mid-western Australia.
E Bancroft, W. and Bamford, M (2004). Review of the Wetland Avifauna of Lake Way.
G Bamford Consulting Ecologists (2010) Vertebrate Fauna Assessment of the Yeelirrie Project Area.
H Outback Ecology (2010) Mega Uranium Lake Maitland Project: Terrestrial Fauna Habitat Assessment.
L DEC (2009b). NatureMap
M Birds Australia (2009)
O DEWHA (2009a) Environmental Reporting Tool
P DEWHA (2009b) Protected Matters Report

Generally, inland lake habitats are only sporadically surveyed due to their ephemeral nature and tendency to be remote. Consequently, there is a distinct lack of data for vast inland areas of Australia (DEWHA, 2009e). There have been few records of waterbirds at Lake Way and like many salt lakes in inland Western Australia, Lake Way may not be utilised by waterbirds for long periods of time (Bancroft & Bamford 2004; Kingsford *et al*., 2010).

The availability of wetland habitat for waterbirds in arid Australia is largely dependent upon episodic rainfall events (Outback Ecology, 2005). Records of such inundation events at Lake Way are sparse as the lake remains dry for lengthy periods, only flooding every five to twenty years following substantial rainfall

(Outback Ecology, 2010). One such event occurred after the passage of cyclone Ilona in December 1988 and Red-Necked Avocets (*Recurvirostra novaehollandiae*), Silver Gulls (*Chroicocephalus novaehollandiae*) and Gull Billed Terns (*Gelochelidon nilotica*) responded to the flooding by nesting there in the summer of 1988/89 (N. Dunlop, unpub. data). The nesting sites were primarily located on the islands and natural causeways between the islands and the mainland within Lake Way. As these sites were connected to the mainland, the majority of the nests failed as a result of predation by Red Foxes (*Vulpes vulpes*) (N. Dunlop, unpub. data).

In recent years, Lake Way has experienced partial inundation during 2004, 2005 and also 2007 (Outback Ecology, pers comm. 2010). Many waterbirds are attracted to large inland salt lakes such as Lake Way during periods of inundation due to the hatching and growth of aquatic crustaceans such as brine shrimp (*Parartemia* sp.) and seed shrimp (Subclass Ostracoda). These crustaceans provide a primary dietary component to many waterbird species (Outback Ecology 2002, 2005). The hatching and survival of the brine shrimp and seed shrimp is salinity dependant.

Permanent accumulation of saline water, such as at the dewatering point for the Wiluna Gold mine site, does not produce ideal waterbird habitat as this water is hypersaline and above the tolerance range for most invertebrate fauna. However, during substantial filling events of the Lake, the salts would become dispersed resulting in the return to baseline levels (Outback Ecology, 2010).

A large island to the north of the existing causeway, in particular, is considered important waterbird breeding habitat due to its isolation, and the number of vegetation communities it supports that are in excellent condition (Bennett, 2002). This island is located one kilometre to the south west of the Lake Way study area.

- **Rainbow Bee-eater (*Merops ornatus*)**

The Rainbow Bee-eater occupies numerous habitats including open woodlands, with sandy loam soil, sandpits, riverbanks, road cuttings, beaches, cliffs, mangroves and rain forests (Morcombe, 2003). The Rainbow Bee-eater can occur as a resident, breeding visitor, passage migrant or winter visitor (Morcombe, 2003). This species nests in burrows dug at a slight angle in the flat ground, sandy banks and margins of roads and tracks (Johnstone and Storr, 1998). Suitable habitat for this species occurs throughout much of the Study area.

The Rainbow Bee-eater was recorded as common in all three study areas during the 2010 detailed autumn survey (**Appendix B**). In contrast, only two Rainbow Bee-eaters were recorded during a targeted search of the Creekline habitat within the Borefield study area during the 2009 reconnaissance survey. The species was also previously recorded during the 2007 survey (Outback Ecology 2008) at the Uramurdah claypan, to the north of the Lake Way study area (**Appendix A**).

- **Sharp-tailed Sandpiper (*Calidris acuminata*)**

The Sharp-tailed Sandpiper breeds in north-east Siberia and migrates south to New Guinea and Australia. Over 90% of the population occurs in Australia during the non-breeding period and many occur on ephemeral wetlands across inland Australia (Bamford et al., 2008). The distribution of Sharp-tailed Sandpipers in Australia changes markedly from year to year based on the availability of this habitat (Bamford et al., 2008).

A single Sharp-tailed Sandpiper was observed opportunistically during the 2010 detailed autumn survey in Samphire Flats habitat within the southern portion of the Centipede East study area (coordinates GDA 1994, MGA Zone 51, 237722E, 7027899S). It is likely that this species would utilize Samphire Flats and other fringing lake habitats sporadically following significant rainfall events, although it is not possible to predict the abundance of the species during these periods.

- **Fork-tailed Swift (*Apus pacificus*)**

The Fork-tailed Swift is a nomadic species that is known to follow storm fronts to forage on insects (Johnstone and Storr, 2004). As it is almost entirely an aerial species, this species is not considered to be dependent on particular terrestrial habitat types. The Fork-tailed Swift species may fly over the Study area without specifically utilising the habitats present.

Although the Fork-tailed Swift has not been recorded within the Study area and its range is patchy across Western Australia (Barrett *et al*., 2003; Pizzey and Knight 2007), it could potentially occur within the Study area.

- **Nankeen Night Heron** (***Nycticorax caledonicus***)

The Nankeen Night Heron is a species that is known to frequent well-watered areas of Western Australia, including the Swan Coastal Plain and Kimberley region. Its occurrence outside of these areas ranges from rare to common, with long-range movements of over 1000 km observed, although the frequency of these movements is unknown (Johnstone and Storr, 2004). This species is associated with river pools, lakes, swamps, tidal creeks, salt ponds and flooded samphire flats. The Nankeen Night Heron was listed in database searches and may potentially occur within the Study area, at least intermittently.

- **Eastern Great Egret (*Ardea modesta*)**

This species is associated with inland rivers and lakes that contain surface water. The Great Egret is highly mobile and can be found throughout most of the western fringes of Western Australia in coastal areas and towards the semi-arid interior (Johnstone and Storr 1998). Given that Lake Way experiences inundation on an infrequent basis, this species is only likely to visit the area in response to these inundation events.

- **Straw-necked Ibis (*Threskiornis spinicollis*)**

The Straw-necked Ibis is a common, nomadic, locally abundant species that occupies grasslands, and irrigated and cultivated pastures (Morcombe, 2003). This species is listed Marine under the EPBC Act and may occur within the Study area where intermittently when fresh water is present.

- **Common Greenshank (*Tringa nebularia*)**

The Common Greenshank visits the north-west coastline from August – June each year (Johnstone *et al.* 2000). This species has a preference for fresh and saltwater wetlands (inland and coastal) and inter-tidal mudflats (if well protected) salt ponds, samphire flats, (Johnstone *et al.* 2000, Geering *et al*. 2007). It tends to occur in low densities (Bamford et al., 2008) and is only likely to visit Lake Way and surrounds intermittently when inundation of the lake occurs.

- **Common Sandpiper (*Tringa hypoleucos*)**

The Common Sandpiper breeds over most of Eurasia then migrates to Africa, south Asia, New Guinea, Australia and occasionally New Zealand. The flyway population of this species is estimated to be 25,000-100,000 with the Australian population estimate of 3,000 (Geering *et al.* 2007). The Common Sandpiper is frequently found on rocky creeks, channels, dams, waterways in mangroves or salt marsh, intertidal mudflats and rocky or sandy beaches around coastal and inland Australia (Geering *et al.* 2007), generally occurring in low densities (Bamford et al., 2008). The Common Sandpiper is only likely to visit Lake Way when inundation of the lake occurs.

- **Curlew Sandpiper (*Calidris ferruginea*)**

The Curlew Sandpiper breeds in central and eastern Siberia then migrates to Africa, south Asia and Australasia during their non-breeding migration (Geering *et al.* 2007). In Australia, Curlew Sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. This species mainly occurs on intertidal mudflats in sheltered coastal areas of estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms (Higgins and Davies 1996). A decline in numbers of Curlew Sandpipers was recorded in Australia during the 1990s and there has been poor breeding success in recent years (Bamford et al., 2008). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Red-necked Stint (*Calidris ruficollis*)**

The Red-necked Stint is a non-breeding migrant to Australia. This species breeds in the arctic tundra in north central Siberia to western Alaska then migrates south to India, south-east Asia, Australia and New Zealand (Geering *et al.* 2007). During the non-breeding period, over 80% of the population of the Red-necked Stint occurs in Australia (Bamford et al., 2008). The Red-necked Stint is predominantly found on estuarine mudflats but can occur in inland, freshwater and brackish wetland areas (Geering *et al*. 2007). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Black-winged Stilt (*Himantopus himantopus*)**

The Black-winged Stilt occurs in the Philippines (subspecies *leucocephalus),* south through to Indonesia to Bismark Islands, Australia and New Zealand (Geering *et al.* 2007). This species is listed Marine under the EPBC Act. This species breeds mostly during spring and early summer amongst low vegetation within close proximity to the water (Geering *et al.* 2007). This species can be found in open freshwater wetlands, salt marshes, sewage farms, flooded claypans, dams, tidal estuaries and saltworks (Pizzey and Knight 2007; Geering *et al.* 2007). The combined south Asian, Australian and New Zealand population of the Black-winged Stilt is estimated to be 480,000 - 530,000 with the Australian population estimate of 300,000 (Geering *et al.* 2007). The Black-winged Stilt is only likely to visit Lake Way when inundation of the lake occurs.

- **Red-necked Avocet (*Recurvirostra novaehollandiae*)**

The Red-necked Avocet is endemic to Australia with the world/Australian population estimate of this species being 107,000 (Geering *et al.* 2007). This species can be found in both freshwater and saline wetlands, estuaries, sewage farms, claypans, and saltworks and intertidal mudflats of sheltered bays and inlets (Pizzey and Knight 2007; Geering *et al.* 2007). Breeding occurs within Australia between August and December (Pizzey and Knight 2007). Diet consists of small crustaceans, insects, molluscs and worms (Geering *et al.* 2007).

After the passage of cyclone Ilona in 1988, Red-necked Avocets were confirmed breeding at Lake Way (Bancroft and Bamford, 2004).

- **Red-capped Plover (*Charadrius ruficapillus*)**

The Red-capped Plover is endemic to Australia with the world/Australian population estimate of this species being 95,000 (Geering *et al.* 2007). This species has a preference for saline environments and can be found on the margins of sandy beaches, intertidal mudflats, saline wetlands, salt marshes and brackish lakes (Pizzey and Knight 2007; Geering *et al*. 2007). This species breeds throughout the year, but mainly during spring and summer (Geering *et al.* 2007). Diet consists of small crustaceans, insects, molluscs and worms (Geering *et al.* 2007). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Oriental Plover (*Charadrius veredus*)**

The Oriental Plover breeds in northern China and Mongolia and the bulk of the population spends the non-breeding period in northern Australia (Bamford et al., 2008). All important sites in the non-breeding period are in northern Australia (Bamford et al., 2008). This species favours dry grasslands, particularly shorter grassland areas or recently burnt areas, rarely feeding in wet habitats but may occupy mudflats or beaches

to roost when warm conditions prevail (Geering *et al.* 2007). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Australian Pratincole (*Stiltia isabella*)**

The Australian Pratincole is listed Marine under the EPBC Act. This species predominantly breeds during September-October in inland Australia then migrates to northern Australia and south-east Asia during winter (Geering *et al.* 2007). This species prefers habitats of treeless and sparely wooded plains and grasslands (Morcombe, 2003). The flyway population estimate of this species is 60,000 with the Australian population estimate 60,000 (Geering *et al.* 2007). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Silver Gull (*Larus* novaehollandiae)**

The Silver Gull is a very common marine species in coastal areas. After the passage of cyclone Ilona in 1988, Silver Gulls were confirmed breeding at Lake Way (Bancroft and Bamford, 2004).

- **Gull-billed Tern (*Sterna nilotica*)**

This species is listed Marine under the EPBC Act, yet the Gull-billed Tern is rarely found over the ocean. Instead, this species is known to inhabit freshwater swamps, tidal creeks, beaches, estuarine mudflats, flooded salt lakes, inundated samphire flats, sewage farms and dams (Johnstone and Storr 1998). The diet of the Gull-billed Tern is extremely varied, consisting mainly of small fish, reptiles, amphibians, crustaceans, insects and their larvae (Johnstone and Storr 1998). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

- **Whiskered Tern (*Chlidonias hybridus*)**

This species is listed Marine under the EPBC Act. The Whiskered Tern is a common species found throughout Australia which prefers inland shallow freshwater wetlands, floodwaters, claypans, irrigated pastures and occasionally brackish systems (Morcombe, 2003). This species may occur at Lake Way intermittently, when standing water is present after rainfall.

4.4 Short Range Endemic Invertebrate Fauna

The 2010 autumn survey yielded a total of 95 invertebrate specimens, comprising of 14 mygalomorph spiders, 34 scorpions, 6 pseudoscorpions, 6 slaters and 35 terrestrial snail specimens. Site 6 recorded the highest number of specimens (a total of 38 specimens) of all sites sampled.

Results for each targeted invertebrate group are discussed below in Sections 4.4.1 to 4.5.6. A description of the potential SRE habitat types occurring over the Study area is provided in Section 4.7.

4.4.1 Mygalomorph Spiders

A total of 14 mygalomorph specimens from five genera were collected from the Study area and surrounds during the 2010 autumn survey. The majority of male specimens were collected in the pitfall traps, while females and immature specimens tended to be collected from burrows that were found while targeted searching.

Of these specimens, a total of four putative SRE mygalomorph spiders have been identified as occurring within Study area. Dr Volker Framenau has also examined mygalomorph spiders collected during 2007 spring survey of the Study area and none were found to represent putative SRE species (Framenau & Harvey 2010; **Appendix E**).

Table 16: Mygalomorph spider specimens collected from the Study area and surrounds during the 2010 autumn survey (Sites located within the proposed impact footprint are shaded)

Family	Species	Putative SRE	Sites No.											
			1	2	3	4	6	7	8	11	A	B	C	D
Barychelidae	'indet.' sp. ^	?				1								
Barychelidae	*Mandjelia 'wanjarri'*	N		1										
Dipluridae	*Cethegus* sp. ^	N							1					
Idiopidae	*Eucyrtops* sp. ^	?				1								
Nemesiidae	*Aname* MYG176	Y			1	2								
Nemesiidae	*Aname* MYG177	Y					1							
Nemesiidae	*Aname* MYG173	Y						1						
Nemesiidae	*Aname* sp. ^	?		1	2						1			
Nemesiidae	*Kwonkan* MYG175	Y	1											

^ These specimens could not be accurately identified as specimens were either immature or female

Note: Sites 5, 9, 10 were not systematically surveyed in 2010 due to heritage constraints

Family Barychelidae

Four specimens from this family were collected during the 2010 autumn survey. Of these specimens, only one specimen could be accurately identified as the others were females or juveniles. *Mandjelia* 'wanjarri' (**Plate 21**) is not considered to represent a SRE species (Framenau & Harvey 2010; **Appendix E**).

Plate 21: *Mandjelia* 'wanjarri'

Family Dipluridae

Only one specimen from this family was collected over the two surveys. This specimen was a juvenile and could not be accurately identified beyond the genus *Cethegus*.

Family Idiopidae

One specimen from this family was collected during the 2010 autumn survey. This specimen was of a female and could not be accurately identified beyond the genus *Eucyrtops*.

Family Nemesiidae

Ten specimens of this family were collected during the 2010 autumn survey. Of these specimens, four species have been identified. Each of these species appear to represent putative SRE species and are discussed below.

***Kwonkan* MYG175**

It is possible that *Kwonkan* MYG175 represents a SRE species (Framenau & Harvey 2010; **Appendix E**). This species was represented by a single specimen from the 2010 autumn survey (**Plate 22**). The species has been previously recorded at Lake Maitland approximately 80 km to the south east of the Study area in 2007 (Framenau & Harvey 2010; **Appendix E**). The two specimens of Kwonkan MYG175 from Lake Maitland were collected from Woodlands on Calcrete Flats habitat.

Kwonkan MYG175 was collected from Site 1 within the Melaleuca Stands habitat in the Centipede West study area (**Figure 18**).

Plate 22: Kwonkan MYG175

***Aname* MYG173**

It is possible that *Aname* MYG173 represents a SRE species (Framenau & Harvey 2010; **Appendix E**). This single specimen collected during the 2010 autumn survey is the only known record of this species (Framenau & Harvey 2010; **Appendix E**) (**Plate 23**).

Aname MYG173 was collected from Site 7 within the Minor Drainage Line habitat which occurs in the Centipede West study area (**Figure 18**).

Plate 23: *Aname* MYG173

***Aname* MYG176**

It is possible that *Aname* MYG176 represents a SRE species (Framenau & Harvey 2010; **Appendix E**). The three specimens collected during the 2010 autumn survey are the only known records of this species (Framenau & Harvey 2010; **Appendix E**) (**Plate 24**).

Aname MYG176 was collected from Site 3 and Site 4. Site 3 is within the Eucalypt Woodland habitat and Site 4 is within the Mulga over Chenopod Shrubland habitat. Both of these sites occur in close proximity to each other within the north west corner of the Lake Way study area (**Figure 19**).

Plate 24: *Aname* MYG176

***Aname* MYG177**

It is possible that *Aname* MYG177 represents a SRE species (Framenau & Harvey 2010). The single specimen collected during the 2010 autumn survey is the only known record of this species (Framenau & Harvey 2010; **Appendix E**) (**Plate 25**).

Aname MYG177 was recorded at Site 6 within the Open Mulga over Calcrete habitat in the Centipede West study area (**Figure 18**).

Plate 25: *Aname* MYG177

4.4.2 Scorpions

A total of 34 scorpions from three genera were collected from the Study area and surrounds during the 2010 autumn survey (**Table 17**)

Of these specimens, *Urodacus* 'yeelirrie' has been identified as a putative SRE species (Framenau & Harvey 2010; **Appendix E**).

Family Buthidae

Thirteen specimens from two genera were collected from this family during the 2010 autumn survey. The genus *Isometroides* was represented by two specimens, however the taxonomy of this genus is poorly resolved and species identification is not possible (Framenau & Harvey 2010; **Appendix E**).

The genus *Lychas* was represented by four species: *Lychas* 'adonis', *L. annulatus, L. jonesae* and *L.* '*splendens'.* None of these species are considered to be SRE (Framenau & Harvey 2010; **Appendix E**).

Family Urodacidae

Twenty one specimens from the genus *Urodacus* were during the 2010 autumn survey. The genus *Urodacus* was represented by three species.

Urodacus 'gibson 3' and *Urodacus* 'laverton 2' are not considered to be SRE species based on current known distribution patterns and presumed habitat preferences (Framenau & Harvey 2010; **Appendix E**).

***Urodacus* 'yeelirrie'**

Thirteen specimens of *Urodacus 'yeelirrie'* (**Plate 26**) have been recorded within the Study area and surrounds; and 14 specimens have been previously collected from Yeelirrie (ecologia, 2010). *Urodacus* 'yeelirrie' was initially considered as likely to be a SRE species and populations were considered to be vulnerable as they were both known only from areas proposed for mining developments (Lake Way and Yeelirrie) (Framenau & Harvey 2010). However, since the report by Framenau & Harvey (2010), this species has been found at additional locations (E. Volschenk, personal communication, June 2010).

Urodacus 'yeelirrie' was found at eight sites, across six habitats and within all of the study areas and surrounds. Given that this species appears to be relatively common, occurs within a number of habitats and is known to occur at locations other than Lake Way, it appears that *Urodacus* 'yeelirrie' may be less likely to represent a SRE than was initially anticipated.

Table 17: Scorpion specimens collected from the Study area and surrounds during the 2010 autumn survey (sites which occur in the proposed impact footprint are shaded)

Family	Species	Putative SRE	Site No												
			1	2	3	4	5	6	7	8	11	A	B	C	D
Buthidae	*Isometroides* sp.	N								1	1				
Buthidae	*Lychas* 'adonis'	N			1										
Buthidae	*Lychas annulatus*	N								2					
Buthidae	*Lychas jonesae*	N	2	4									1		
Buthidae	*Lychas* 'splendens'	N							1						
Urodacidae	*Urodacus* 'gibson 3'	N			1					1	1				
Urodacidae	*Urodacus* 'laverton 2'	N								1					7
Urodacidae	*Urodacus* 'yeelirrie'	Y	1	1*		1	2*	3			1		2	2	

Note: Specimens identified as *Urodacus 'yeelirrie'* were originally described as *Urodacus 'lakeway 2'* (E. Volschenk, personal communication, April 2010).

Note: Sites 5, 9, 10 were not systematically surveyed in 2010 due to heritage constraints

* These specimens were recorded during the 2007 spring survey

Plate 26: *Urodacus* 'yeelirrie'

4.4.3 Pseudoscorpions

A total of six pseudoscorpions from three genera were collected from the Study area and surrounds during the 2010 autumn survey (**Table 18: Pseudoscorpion specimens collected from the Study area and surrounds** during the 2010 autumn survey (sites which occur within the proposed project footprint are shaded)
).

Family Artemnidae

The only specimen of this family collected during the 2010 autumn survey was of the genus *Oratemnus*. This specimen was immature and could not be accurately identified.

Family Olpiidae

Five specimens from two genera were collected from this family during the 2010 autumn survey. One specimen was immature and could not be accurately identified.

Indolpium sp. does not appear to be a SRE species as extremely similar specimens have been collected from other regions of Wester Australia (Framenau & Harvey 2010; **Appendix E**).

***Beierolpium* 'sp. 8/2'**

It is possible that *Beierolpium* 'sp. 8/2' represents a SRE species, however a systematic review of this genus has not been completed (Framenau & Harvey 2010; **Appendix E**). One specimen of this species was collected at Site 2 in the Mulga/Mallee complex over Spinifex habitat within the Centipede East study area (**Figure 18**).

Table 18: Pseudoscorpion specimens collected from the Study area and surrounds during the 2010 autumn survey (sites which occur within the proposed project footprint are shaded)

Family	Species	Putative SRE	Sites No.											
			1	2	3	4	6	7	8	11	A	B	C	D
Artemnidae	*Oratemnus* sp.^	N				1								
Olpiidae	'indet'^	N				1								
Olpiidae	*Beierolpium* 'sp. 8/2'	Unknown		1										
Olpiidae	*Indolpium* sp.	N					1		1					1

^ These specimens could not be accurately identified as specimens collected were immature

Note: Sites 5, 9, 10 were not systematically surveyed in 2010 due to heritage constraints

4.4.4 Myriapods

No millipedes were found during the surveys over the Study area.

4.4.5 Terrestrial Isopods

Six specimens from two genera within the family Armadillidae were collected during the 2010 autumn Survey. These specimens were found to represent two species; *Buddelundia* sp. and *Spherillo* sp. 2. *Buddelundia* sp. was recorded from Site 5 and Site C; and *Spherillo* sp. 2 was recorded from Site A. Neither of these species is believed to represent SRE species (**Appendix F**).

4.4.6 Terrestrial Molluscs

Thirty five specimens of terrestrial snails from the genus *Pupoides* were collected from the Study area and surrounds during the 2010 autumn survey (**Table 19**).

Family Pupillidae

All specimens collected over the two surveys were found to belong to the genus *Pupoides*. The specimens most closely resemble *Pupoides beltianus* and are unlikely to represent a SRE species (Slack-Smith & Whisson 2010; **Appendix G**).

Table 19: Terrestrial mollusc specimens collected from the Study area and surrounds during the 2010 autumn survey (sites which occur within the proposed project footprint are shaded)

Family	Species	Putative SRE	Sites											
			1	2	3	4	6	7	8	11	A	B	C	D
Pupillidae	*Pupoides* sp.^	N			1									
	Pupoides sp. cf. *P. beltianus*	N				2	33				9			

^ These specimens could not be accurately identified as only juvenile specimens were collected

Note: Sites 5, 9, 10 were not systematically surveyed in 2010 due to heritage constraints

4.4.7 Potential SRE Habitat

The general characteristics of typical SRE habitat are described in Section 3.5 and a general description of the landscape features of the region is provided in Section 2.1. Of the 19 broad fauna habitats identified as occurring within the Study area, seven are considered to have moderate to high potential as SRE habitat on the basis of: Isolated Habitats or Sheltered/Microhabitats Habitats (**Table 20**). The distribution of these habitats within the study areas are shown in **Figure 20 - Figure 23**. Descriptions of these habitats with reference to their suitability to support SRE species and connectivity and extensiveness in the landscape are provided below.

Minor Drainage Line

Minor Drainage Line habitat has high potential to support SRE species as it is sheltered and moist environment compared to the surrounding landscape; and is a habitat isolate as no similar habitat occurs in the area surrounding Lake Way. Shelter is provided by scattered *Eucalyptus* spp. and tall dense *Casuarina pauper* trees which also contribute substantial quantities of leaf litter typically found within this habitat. A further source of moisture originates from the water table, which is located at a shallow depth below the surface (approximately 1.0 m). The possible disturbance from flooding and from what appeared to be the build up of salts on the soils crust, may limit the potential for this habitat to support SRE species in some areas.

This habitat occurs in the south east section of the Centipede West study area along Abercrombie Creek (**Figure 20**).

Melaleuca Stands

The Melaleuca Stands have high potential to support SRE species as the Melaleuca grow in a narrow band (often no more than 30 m wide) fringing Lake Way. As a consequence, this habitat is naturally fragmented around Lake Way and also isolated from similar habitat which might occur at other salt lake systems.
This habitat was present at both the Lake Way and Centipede study areas (**Figure 18** and **19**).

Chenopod floodplain

The Chenopod Floodplain habitat has high potential to support SRE species as it represents a collection point for water, which contributes to a moister environment capable of supporting a variety of low shrubs. Although the amount of leaf litter is low, the heavy clay soils are appropriate for burrowing species, with several ‘mud plug’ mygalomorph spider burrows observed from this habitat during the October 2007 survey (Outback Ecology, 2008). This habitat occurs in the eastern section of the Lake Way study area and extends upstream (north) outside the Lake Way study area (**Figure 21**). This flood plain is considered isolated in the landscape due to both its vegetation composition and soil structure.

Major Drainage Line

The Major Drainage Line habitat has moderate potential to support SRE species. This habitat occurs where the West Creek fans out, supporting moderately dense patches of River Red Gums. These trees provide shelter and contribute leaf litter that are likely to support detritivorous invertebrates and their predators. The red clay soils of this habitat also appear to be appropriate for burrowing invertebrate species. This habitat occurs across a large portion of the Borefields study area, and appears to be relatively uncommon and disconnected from similar habitat in the landscape surrounding Lake Way (**Figure** 22).

Mallee/Mulga complex over Spinifex

The Mallee/Mulga complex over Spinifex habitat has a moderate potential to support SRE species. This complex tends to form mosaics in association with the deep red sands that occur to the north and west of Lake Way. These associations differ in complexity from the vast Mulga over Spinifex sandplains which occurs to the east of Lake Way. The deep red sands within the Mallee/Mulga complex provide a suitable habitat for mygalomorph spiders as the substrate is easy to dig and cool moist conditions occur within 25 cm of the surface. Additionally, the Mulga and Mallee trees contribute leaf litter that would be suitable as habitat and food for invertebrate species. This habitat occurs in the Centipede and Lake Way study areas (**Figure 20**; **Figure 21**).

Mulga over Chenopod Shrubplain

The Mulga over Chenopod Shrubplain habitat has a moderate potential to support SRE species as this habitat is uncommon and patchy in the landscape. The topography of this habitat facilitates accumulation of water after rainfall from the surrounds. Soils are of dense clays suitable for burrowing invertebrates, however much of the vegetation was sparse and leaf litter cover was low. This habitat occurs in the north west corner of the Lake Way study area (**Figure 21**).

Eucalypt Woodland

The Eucalypt Woodland habitat has a relatively low potential to support SRE species. Although Eucalypt woodlands on red-brown soils tend to be uncommon in the landscape, the conditions prevailing within this habitat provide only moderate shelter. This habitat occurs as a small pocket that occurs in the north west corner of the Lake Way study area (**Figure 21**).

Table 20: Potential SRE habitats within the Study area

Potential SRE Habitats	Study area(s)	Is the habitat isolated in the landscape?	Is the habitat sheltered or does it form a microhabitat?	Potential to support SRE Species	Putative SRE species recorded
Minor Drainage Line	Centipede	Yes	Yes	High	*Aname* 'MYG 173'
Melaleuca Stands	Lake Way Centipede	Yes	Yes	High	*Kwonkan* 'MYG 175' *Urodacus* 'yeelirrie'
Chenopod Floodplain	Lake Way	Yes	Yes	High	No
Major Drainage Line	Borefield	Moderately	Moderately	Moderate	No
Mallee/Mulga Complex over Spinifex	Lake Way Centipede	Moderately	Moderately	Moderate	*Urodacus* 'yeelirrie'
Mulga over Chenopod Shrubplain	Lake Way	Moderately	Moderately	Moderate	*Aname* 'MYG 176' *Urodacus* 'yeelirrie'
Eucalypt Woodland	Lake Way	Moderately	Moderately	Moderate	*Aname* 'MYG 176'

Note: The following habitats were not surveyed during autumn 2010 due to heritage constraints: Chenopod Floodplain; Major Drainage Line

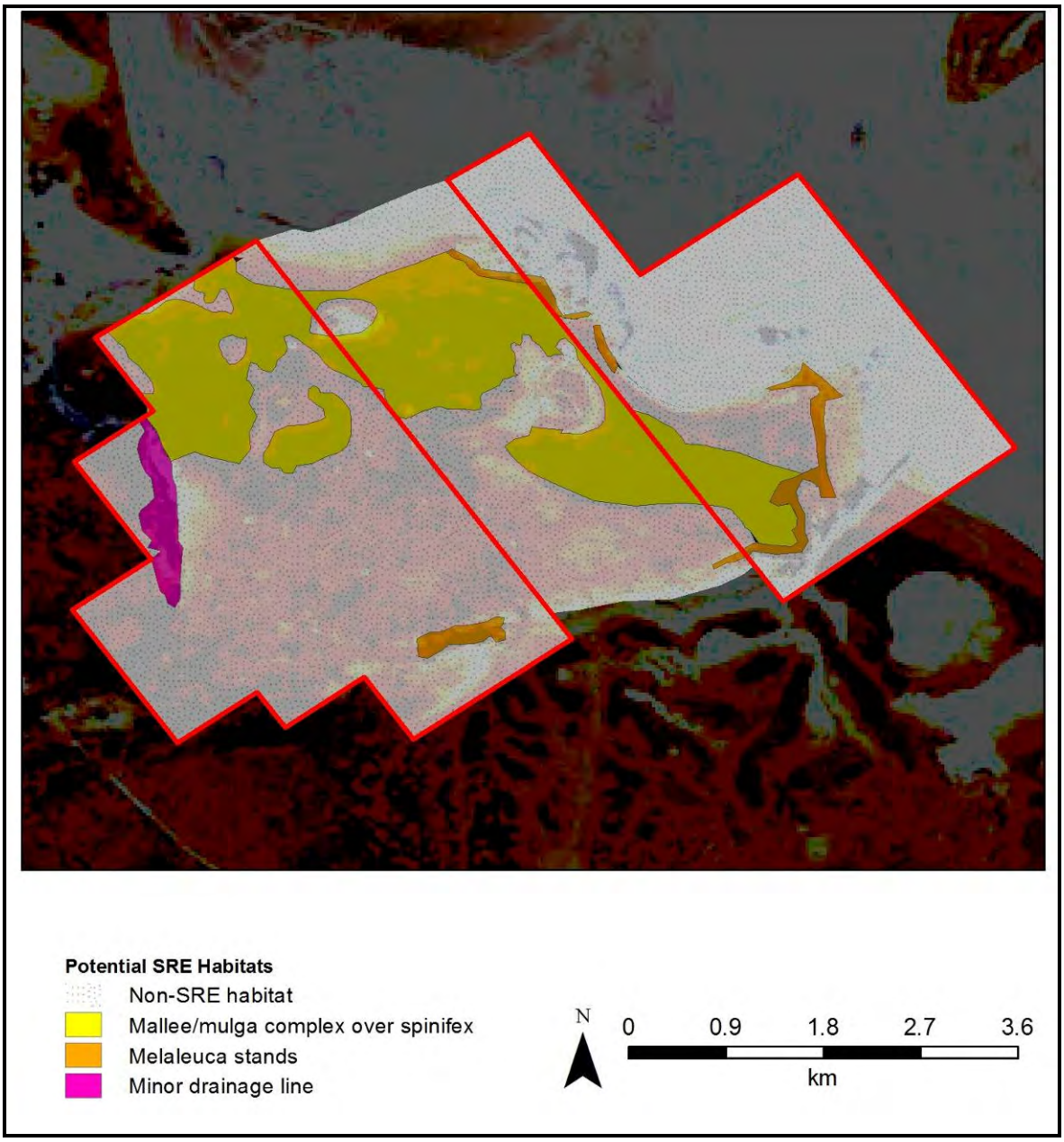

Figure 20: Potential SRE habitat occurring within the Centipede study area

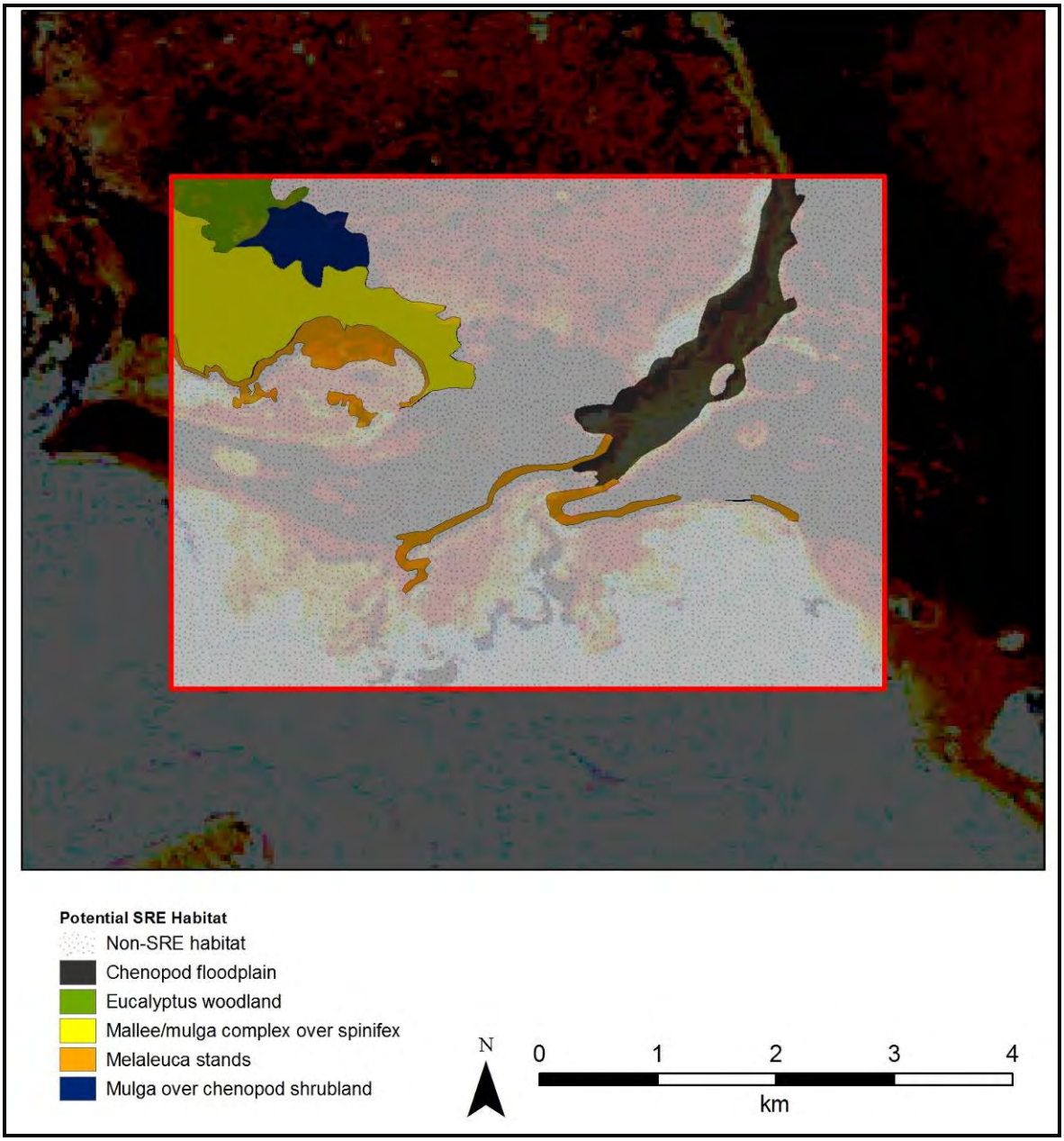

Figure 21: Potential SRE habitat occurring within the Lake Way study area

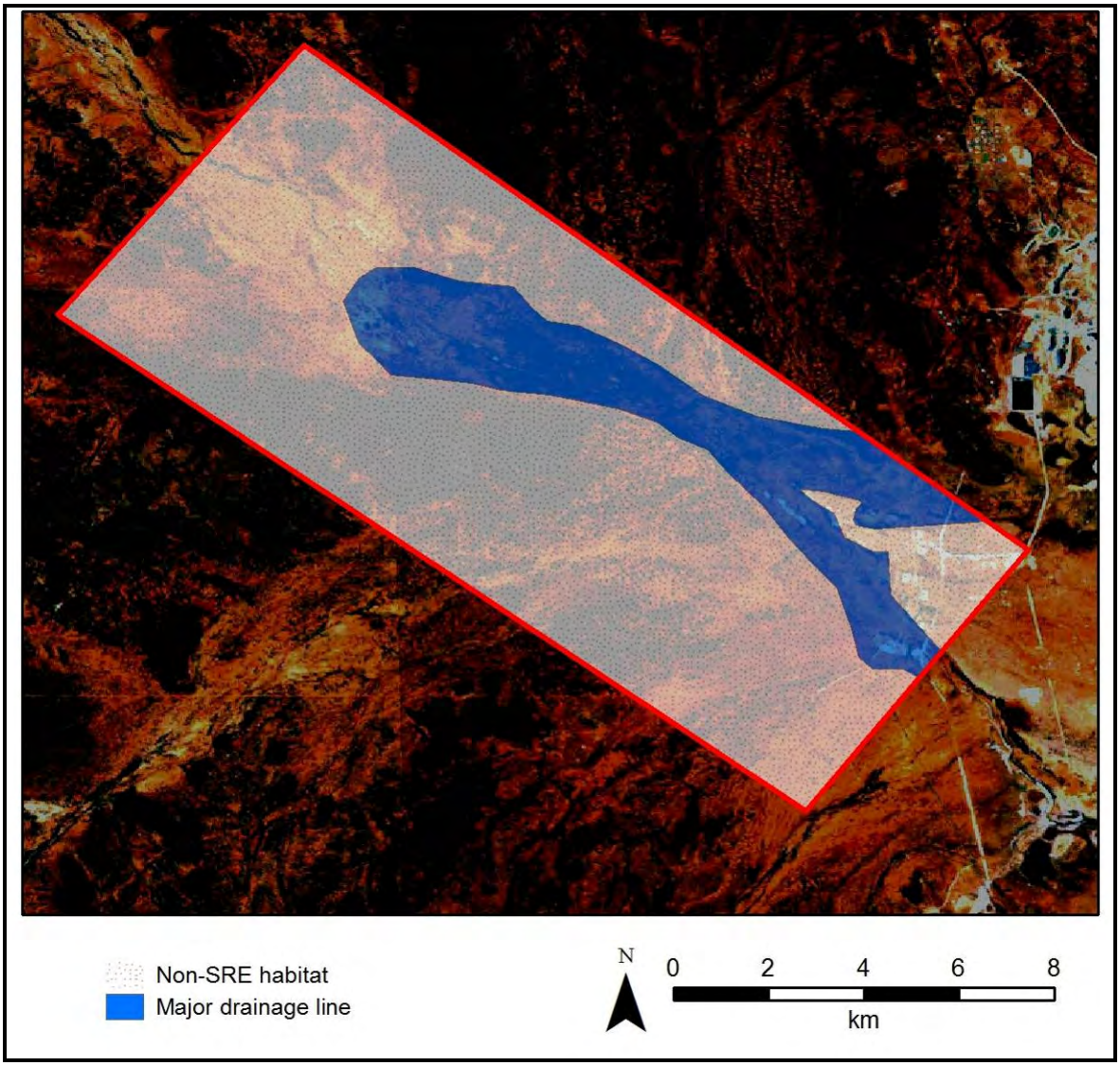

Figure 22: Potential SRE habitat occurring within the Borefields study area

4.5 Sampling Adequacy

Species accumulation curves give an indication of the sampling adequacy of trapping for a survey. When a curve approaches an asymptote it suggests that sampling effort has been sufficient to adequately collect the species comprising the faunal assemblage at the location(s) sampled. The value at which the curve asymptotes also represents an approximate measure of the total species complement at that location. It must be noted that the use of species accumulation curves assumes that the survey methods and timing are capable of recording all species present at a site, whereas this is not likely to be the case. In terms of timing, the number of species detected is often greater in warm weather or following periods of substantial rainfall (Spence-Bailey *et al.* 2010). Further, there may be some species that are inherently difficult to detect owing to their cryptic or migratory nature (MacKenzie, 2005).

Species accumulation curves for this assessment were calculated using systematic trapping data for herpetofauna and mammals, and timed census surveys for bird species. The curve tended to asymptote after around five days for mammals, although species richness was very low overall. The curve approached an asymptote after six days for birds, with a less pronounced asymptote evident for reptiles/amphibians after seven days. This data suggest that survey effort was sufficient to sample much of the fauna present within the Study area during autumn 2010, although it is likely that additional survey in different seasons (e.g. spring or after substantial rainfall) may increase the total number of species recorded.

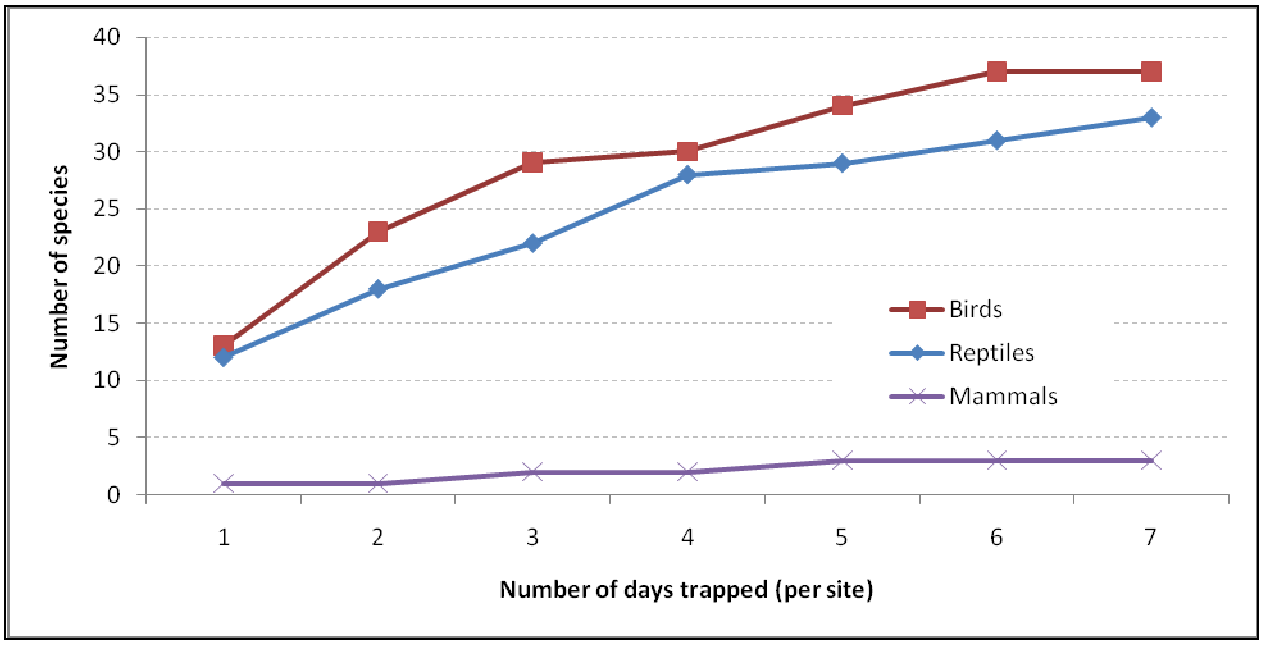

Figure 23: Species accumulation curve for the detailed 2010 autumn survey

4.6 Limitations and Constraints

A number of factors can influence the design and intensity of a fauna survey. The EPA (2004) lists possible limitations and constraints that can impinge on the adequacy of fauna surveys. These are assessed in

Table 21. All fauna surveys are limited to some degree by time and seasonal factors and in an ideal situation several surveys would be undertaken over a number of years encompassing different seasons. Nevertheless, all the factors identified by the EPA (2004) were considered.

Table 21: Summary of potential fauna survey constraints

Aspect	Constraint? Yes/No	Comment Regarding 2009 and 2010 surveys
Competency/experience of consultants	No	Members of the survey team were fauna specialists whom have many years experience undertaking fauna surveys of this kind in Western Australia.
Scope	No	All broad vertebrate fauna and terrestrial SRE invertebrate fauna habitats were assessed using established and standardised sampling techniques. All previous survey work over the Study area and surrounds was reviewed. Bat survey work was analysed by Bat Call WA (2008, 2009). Invertebrate specimens were identified by specialists of the WAM.
Proportion of fauna identified	No	A total of 109 vertebrate fauna species were recorded during this survey, which constitutes approximately 50% of the total number of species recorded in previous studies conducted throughout the wider area. Further survey effort after periods of substantial rainfall may increase the number of species recorded, particularly for waterbirds.
Information sources (e.g. historic or recent)	No	Relatively well surveyed region, predominantly regional surveys and those undertaken for mining operations. Recent surveys have been undertaken in relatively close proximity to the Study area.
Proportion of task achieved, and further work which might be needed	Yes	The vertebrate fauna assemblages and potential impact of the Project on vertebrate fauna and habitat has been demonstrated within this assessment. Further invertebrate SRE work may be required to determine the distribution of the mygalomorph spider *Kwonkan* 175 within and outside proposed impact footprints. The identification of *Urodacus*_'Lake Way 1' is to be completed by Erich Volschenk and further survey work may be required if this species is found to be a SRE. Although the dry pitfall trapping methods utilised for the collection of SRE invertebrate fauna in this survey align with Guidance Statement No. 20, the low numbers of specimens, particularly mygalomorph spiders (3 new species represented by single specimens) suggests that the understanding of diversity within the Study area may be largely incomplete. Wet pitfall trapping (recently endorsed by Brad Durrant of the DEC) is a more thorough method of sampling mygalomorph spiders as trapping effort can be extended up to six weeks which increases the number of trap nights and increases the probability of coinciding with appropriate weather conditions for capturing these cryptic species. The implementation of a wet pitfall trapping program for the Wiluna Project is likely to provide a more thorough understanding of SRE invertebrate diversity and contribute to a better understanding of the regional distributions of these species within and outside project footprints.
Timing / weather / season / cycle	Partial	Timing, weather, and seasonality of survey were appropriate for vertebrates with the exception of waterbirds. Surveying occurred during a protracted dry period for the region, which may have led to the lack of waterbirds observed. Targeted survey of lacustrine ecosystems for waterbirds after significant rain would likely yield better results for these species. This has occurred in previous surveys, notably that of CSIRO (1978).
Disturbances	No	The Study area and surrounds have been substantially disturbed by grazing of cattle, and to a lesser extent by mining operations. It should be noted that the level of disturbance within the Study area is typical of the wider region.

Aspect	Constraint? Yes/No	Comment Regarding 2009 and 2010 surveys
Intensity	No	The Study area has been sampled over two seasons (spring 2007 and autumn 2010). With reference to this survey (2009 reconnaissance and 2010 autumn detailed survey) a total of 2912 trap-nights and a total of 50.7 person hours spent undertaking bird census, active hand searching, targeted searching and spotlighting searching, which is considered adequate intensity. It is considered that further survey effort would not have resulted in a substantial increase in species diversity (See **Figure 23**).
Completeness	Yes	The survey was complete as most major habitats were systematically surveyed in 2010 (some exceptions due to heritage constraints). Those habitats that could not be surveyed in 2010 had been target searched previously in 2007 and 2009. These habitats are not believed to support conservation significant species.
Resources	No	Resources were adequate to carry out the survey satisfactorily. Survey participants were competent in identification of species and habitat encountered during the survey. A total of 62 person days were needed to complete the 2009 reconnaissance and 2010 detailed autumn survey.
Remoteness / access problems	No	Although access was limited for some areas of the Study area due to heritage constraints, these areas had been accessed and assessed previously in 2007 and 2009. Additionally, suitable replication of most habitats was available outside the heritage areas for fauna assessments in 2010.
Availability of contextual information	No	A wealth of information is available for the IBRA subregion including, NatureMap, DEC lists, National Land and Water Resources Audit, as well as regional fauna surveys.

5. IMPACT ASSESSMENT

This section assesses the potential impacts of the proposed Project on terrestrial fauna and habitat. The primary objectives of this section are to describe the relevant threatening processes associated with the proposed Project (Section 5.1), and to examine the likely impact of these threatening processes on fauna habitat (Section 5.2) and assemblages (Section 5.3), vertebrate fauna species of conservation significance (Section 5.4) and short range endemic invertebrate species (Section 5.5).

5.1 Threatening Processes

Threatening processes relevant to the Murchison Bioregion have been identified by the Australian Natural Resources Audit (DEWHA 2007) and include grazing pressure, changed hydrology, feral animals (especially goats, foxes and rabbits), changed fire regimes, pollution, pathogens and increased vegetation fragmentation. Threatening processes specifically associated with the Project are categorised as either direct or indirect impacts:

Direct impacts of the Project include:

- habitat removal/modification;
- collision with vehicles.

Indirect impacts of the Project include:

- noise and vibration;
- changes to surface hydrology;
- light;
- introduced flora; and
- introduced fauna.

These are discussed in detail below.

5.1.1 Habitat Removal/Modification

The development of the Project will result in the removal of approximately 1,300 ha of habitat via land clearance (Toro Energy Ltd, 2010). Site preparation will consist of the progressive clearing of vegetation and topsoil prior to mining and processing activities. Vegetation and topsoil will be stockpiled separately to ensure maximum reuse of these resources in subsequent rehabilitation (Toro Energy Ltd, 2010).

Clearing of vegetation is an unavoidable part of the Project development, and represents the most direct impact on the habitats and fauna assemblages present within the Study area. Clearing of vegetation can be conducted in a manner that minimises impact by progressively clearing over time to allow animals to disperse to other suitable areas, and also by retaining corridors or linkages so that individuals can move

between remaining habitat patches. SRE invertebrate fauna species typically have poor powers of dispersal and are more likely to be directly impacted by clearing activities.

No permanent water source is present at the Study area; however, the proposed works would be located on or adjacent to Lake Way, where the water table is close to the surface (Toro Energy Ltd, 2010). Dewatering of mining pits may involve the creation of artificial water bodies via pumping of groundwater from the pits to evaporation ponds (Toro Energy Ltd, 2010) or to pit voids. Additional artificial waterbodies including process water dams and turkey's nests may also be created as part of the project. These may present a minor entrapment risk for vertebrate mammal species such as kangaroos (e.g. *Macropus robustus, M. Rufus*); however, the establishment of fauna egress areas would likely alleviate this threat.

Permanent accumulation of saline water, such as at the dewatering point for the Wiluna Gold mine site does not produce suitable waterbird habitat as this water would be hypersaline and above the tolerance range for the invertebrate fauna that form the basis of their diet (Bamford et al., 2008). Further, there are ephemeral water bodies nearby that support a greater abundance and diversity of aquatic fauna, which represents a more important food source for waterbirds (e.g. Lake Violet, Uramurdah Claypan, Outback Ecology, 2005).

5.1.2 Collision with Vehicles

Vehicle collisions represent a relatively minor impact on fauna assemblages as incidents typically only involve individuals and are unlikely to have any lasting impact on a population. However, collisions with vehicles can be directly addressed by reducing the speed at which vehicles travel and also by erecting fences in strategic areas where fauna are known to cross major transport routes (e.g. where transport corridors traverse Major Drainage Line habitat).

Any incidents that result in the injury or death of conservation significant species should be reported to the DEC and specimens should be retained (i.e. stored in a freezer) for further examination by DEC or the Western Australian Museum.

5.1.3 Noise and Vibration

The development of the Project is likely to generate constant noise and vibration due to machinery, processing plant, power plant, heavy and light vehicles and the general presence of people. The effects of noise on wildlife have been well studied, although responses vary depending on the species and on the age and sex of the individual animal (for comprehensive summaries see (Larkin et al. 1996); and (Radle 2007)).

General responses to noise across a wide variety of animal species range from interruptions in feeding and resting behaviour to complete abandonment of an area. Noise may lead to reduced population densities in small mammals, nest failure and decreased population densities in birds (Slabbekoorn and Ripmeester

2008) and abandoning of roost sites and a reduced hunting efficiency in bats due to disturbance of their echolocation system. Constant levels of noise also interfere with species' communication and is known as acoustic interference (Parris and Schneider 2009). Species which may be especially at risk of disturbed communication are those that use calls to communicate over larger distances such as the Bush Stone-curlew, which is listed Priority 4.

5.1.4 Changes to surface hydrology

The Project is likely to result in changes to surface hydrology which may indirectly impact habitats outside of clearing zones. Drainage control structures may divert natural water flow away from areas that normally receive water which may reduce the quality of the habitat and the health of vegetation occurring within these areas. Alternatively, drainage control structures may increase sediment loading or cause temporary flooding of habitat adjacent to the mining areas. Alterations to surface water hydrology should be limited where practicable.

5.1.5 Light

The Project is likely to result in an increase in exposure of fauna to artificial light. Artificial light from mining activities may have detrimental effects on resident bird, mammal and reptile species, as it may interfere with biological and behavioural activities that are governed by the length of day or photoperiod, including reproduction, dormancy, foraging and migration (Bradshaw and Holzapfel 2007, Le Corre et al. 2002). Bird *et al*. (2004) found that nocturnal mice exposed to artificial light exploited fewer food patches compared to mice exposed to areas of less light, while nocturnal frogs exposed to artificial light have been known to suspend normal feeding and reproductive behaviour (Harder, 2002).

Light pollution has also been shown to interfere with timing of songbird choruses, potentially leading to reduction in breeding success or survival (Miller, 2006). Excessive light is likely to have an adverse effect on the natural foraging behaviour of bats, which are attracted to artificial light sources. To reduce the impact of artificial light on faunal communities particularly during night-time hours, lights should be designed to illuminate designated areas such as pathways and roads, rather than poorly designed lights that illuminate the night sky. Further, care should be taken to ensure that transport and haul routes are designed to avoid inadvertent illumination of important habitat features such as hollow-bearing woodlands, watersources or drainage lines.

5.1.6 Introduced Plants

Environmental weeds may be brought in by mobile mining equipment. Weed invasion is widely recognised as having a negative impact on fauna species as it can fundamentally alter the composition and structure of vegetation communities (Cowie and Werner 1993, Gordon 1998). Invasion by non-native species typically results in declines in native plant species richness, but the response of fauna may be more complicated with individual invasions potentially resulting in increase, decrease or no-change scenarios for different assemblages (Grice, 2006). For example, both Smyth et al. (2009) and Binks et al. (2005) found

that even at low densities, Buffel Grass (*Cenchrus ciliaris*) affected the composition of ground vegetation, birds and ant fauna, leading to declines in some species. It is therefore important to implement management strategies to reduce the occurrence and spread of weeds during mining operations.

5.1.7 Introduced Fauna

Introduced fauna (both herbivorous and predatory) cause fundamental changes to ecosystems, and have lead to the decline and extinction of many species in Australia (Abbott 2002, Burbidge and McKenzie 1989, Ford et al. 2001, Short and Smith 1994). Additionally, predation of native fauna by the fox and feral cat is listed as a key threatening process under the EPBC Act.

Eleven introduced fauna species have been recorded in the Study area or within the region, as determined by database and literature searches, including the House Mouse (*Mus musculus*), Wild Dog (*Canis lupus dingo*), Feral Cat (*Felis catus*), Red Fox (*Vulpes vulpes*), European Rabbit (*Oryctolagus cuniculus*), Horse (*Equus caballus*), Donkey (*Equus asinus*), Dromedary Camel (*Camelus dromedarius*), Goat (*Capra hircus*), *Sheep* (*Ovis aries*) and European Cattle (*Bos Taurus*). While several introduced herbivores are domesticated within the Study area (European Cattle, Horse), other species are considered to be feral animals. Together, these introduced herbivores have been responsible for the widespread degradation of much of semi-arid Australia due to overgrazing (Morton 1990).

Development of the Project may provide additional resources or habitat (e.g. via an accommodation village, rubbish tips, food disposal areas) that may support a greater abundance of feral animals than previously recorded, which in turn may adversely impact on populations of native fauna. It is suggested that monitoring and control of feral animals be conducted, in cooperation with surrounding land managers. Management measures to prevent and control the increase of feral species numbers and the attraction of any new feral species include proper hygiene practices, appropriate disposal of wastes and control programs.

5.2 Impacts on Fauna Habitats

Loss of habitat is listed as a key threatening process under the EPBC Act. Vegetation clearing and removal of soil is a necessary part of the Project development and it is likely that sedentary fauna currently residing within areas to be cleared would be lost and more mobile fauna would be displaced; however, most of the 19 habitats present over the Study area are widely represented throughout the region and so there is opportunity for displaced fauna to seek refuge in surrounding habitat outside the disturbance area. The extent of each habitat type expected to be removed is summarised in **Table 22** and **Figure 24** and **Figure 25** below. It should be noted that these figures are approximate as the position of additional infrastructure is currently unknown. This includes:

- Access and haul roads to and from mining areas;
- A water pipeline from West Creek to the plant, which is likely to follow the Goldfields Highway or old Goldfields Hwy (i.e. will lie largely within existing disturbed ground); and

- Accommodation areas
    - the temporary construction camp will probably be within the “Centipede West” Study area
    - the permanent camp location has not been decided and may lie outside the Study areas surveyed within this assessment.

The location of these infrastructure feautures will take environmental constraints into consideration. Access and haul roads are expected to follow existing tracks as much as possible.

Table 22: Extent of habitat expected to be removed for the development of the Project

Broad Fauna Habitat	Extent within Study area, ha	Extent to be impacted, ha (%)
Melaleuca Stands	118 (0.7%)	92 (78%)
Open Mulga Woodland over Spinifex	1,728 (10.4%)	199 (11.5%)
Eucalypt Woodland	37 (0.2%)	-
Mulga woodland over chenopod shrubland	38 (0.2%)	-
Mallee/mulga complex over Spinifex	419 (2.5%)	105 (25.1%)
Mulga over calcrete	1,650 (10%)	59 (3.6%)
Minor drainage line	35 (0.2%)	-
Red sand dune	152 (0.9%)	119 (78.3%)
Chenopod floodplain	120 (0.7%)	53 (44.2%)
Creek line with River Red Gum and Casuarina	176 (1.1%)	-
Open Mulga Woodland over Spinifex on Hardpan	5,789 (34.9%)	-
Major drainage line	2,274 (13.7%)	-
Claypan	138 (0.8%)	69 (50%)
Acacia victoriae on calcrete	39 (0.2%)	-
Mixed shrubland floodplain	793 (4.8%)	-
Stony rise	450 (2.7%)	-
Mulga over quartz loam	1,221 (7.3%)	-
Samphire flats	735 (4.4%)	499 (67.9%)
Salt lake	667 (4.0%)	126 (18.9%)
Total	**16,569 (100%)**	**1,321 (8%)**

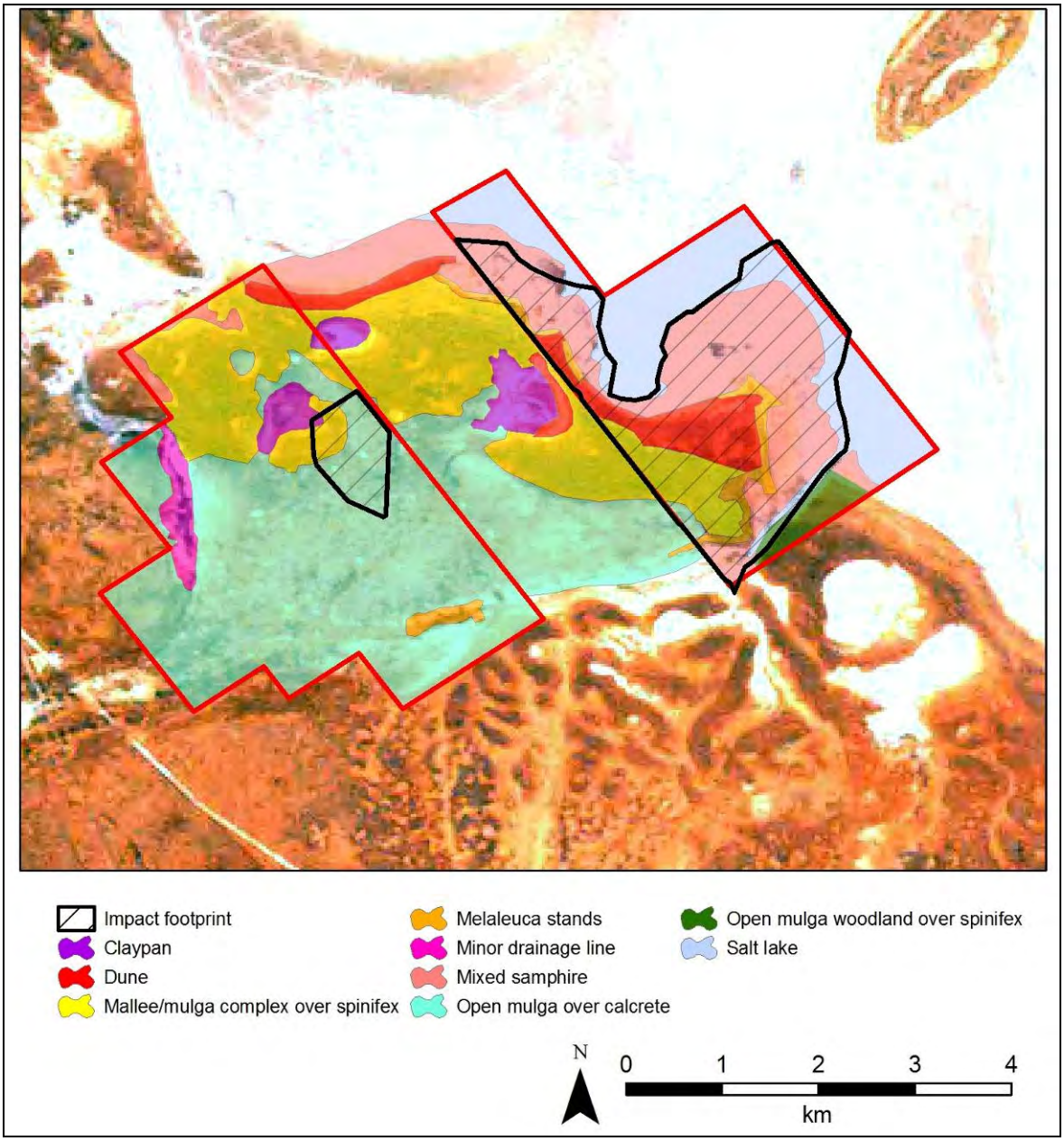

Figure 24: Proposed impact areas within the Centipede Study area

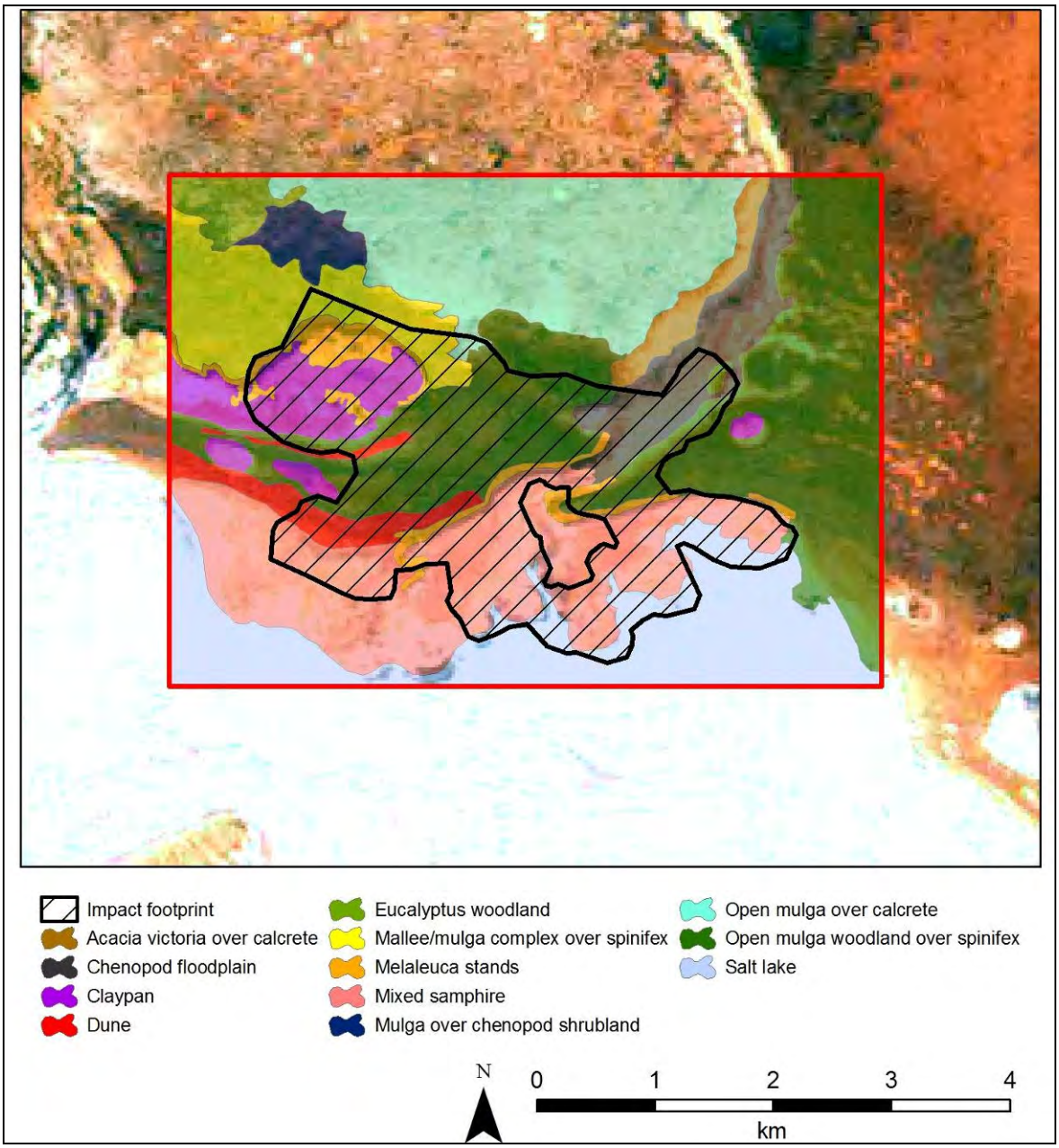

Figure 25: Proposed impact areas within the Lake Way Study area

Habitats of limited regional extent that occur within proposed impact footprint include Melaleuca Stands, Red Sand Dune, Claypan, Mallee/Mulga Complex over Spinifex and Chenopod Flood Plain. Of these, the Mallee/Mulga Complex over Spinifex and the Chenopod Flood Plain are relatively well represented outside of the proposed disturbance footprint with 25 and 44% of their local extent likely to be impacted by project implementation. 78% of both Melaleuca Stands and Red Sand Dune are likely to be impacted within the Study area as part of the Project, which represents a substantial local impact to these habitats. It is likely that Red Sand Dune habitat is present elsewhere within the region; however, Melaleuca Stands occur sporadically around the margins of Lake Way and consist of small, isolated patches. Removal of any of

these patches increases the degree of isolation of the remaining patches, potentially inhibiting habitat-dependent fauna from moving between them.

The Project may result in the medium-term loss of habitat for some species dependant on samphire or chenopod shrublands, as these slow-growing habitats cannot be easily re-created by revegetation. However, habitat removal or modification is not likely to significant impact vertebrate fauna within these habitats over the long term as the vertebrate fauna assemblage recorded within them is similar to other regional sites.

It should be noted that the majority of the fauna habitats within the Study area were degraded due to cattle grazing. During the detailed 2010 autumn survey, it was also noted that Mallee/Mulga Complex over Spinifex had experienced a recent fire, and it is likely that the wider landscape is fire prone also. Implementation of habitat management guidelines outlined in Outback Ecology (2005), including management of grazing and fire is likely to reduce potential impacts of the proposed Project on vertebrate fauna. Where appropriate, livestock (cattle) and other introduced herbivores (e.g. camels. donkeys, horses) should be excluded from habitat to allow effective regeneration. Attempts should also be made to reduce the scale and intensity of wild fires in order to retain a range of fire ages within different fauna habitats.

5.3 Impacts on Terrestrial Vertebrate Faunal Assemblages

Faunal assemblages most likely to be impacted by the Project are those dependent on specific habitats or those with restricted ranges. The majority of fauna species observed or expected to occur within areas that will be impacted by project implementation are found elsewhere within the East Murchison sub-bioregion (**Appendix A**). Consequently, the impacts detailed above are not likely to significantly affect fauna assemblages in the Study area.

The component of the bird fauna specifically associated with Lake Way (i.e. migratory waterbirds and waders) is not likely to be impacted by the Project. Twenty migratory or marine species (as listed in the EPBC Act 1999) may potentially occur at Lake Way with nine of these being waders and waterbirds listed as migratory species. These species would most likely utilise the Lake Way playa in times of inundation as well as claypans and creeklines draining into Lake Way. These areas are not included as a migratory shorebird site of international importance in Australia (Bamford et al, 2008). Further, Lake Way is not considered nationally important habitat for migratory shorebirds as it does not support more than 15 species, more than 2000 individuals, or more than 0.1% of the flyway population for any species. However, habitats associated with the lake system (e.g. Salt Lake, Mixed Samphire, Melaleuca Stands) are considered significant at a local scale and clearing or disturbing substantial areas (> 50 ha) of these habitats is likely to impact faunal assemblages at a local scale.

Impacts to fauna assemblages may be reduced by considering the timing of the proposed works. For example nesting birds and their young may be directly impacted by habitat clearance but this potential impact could be reduced by scheduling clearing activities to occur outside of nesting or breeding periods.

5.4 Impacts on Terrestrial Vertebrate Fauna Species of Conservation Significance

The likely impact of the Project on conservation significant species from a local and a regional perspective were ranked using the following categories **(Table 23):**

- **Negligible -** No discernible effect on species;
- **Minimal -** No population decline expected;
- **Low -** Short-term population decline expected within Project area (recovery expected after end of the Project) and no perceived threat to the overall conservation status of the species;
- **Moderate -** Permanent population decline with no perceived threat to the overall conservation status of species;
- **High -** Permanent population decline expected, posing threats to the conservation status of the species; and
- **Extreme -** Taxon extinction possible or likely

Table 23: Impacts on conservation significant species and suggested management actions

Species	Conservation[1] Significance			Localised Impact on Species	Regional Impact on Species	Suggested Management Actions
	EPBC Act	WC Act	DEC Priority			
Mulgara (*Dasycercus cristicauda*)	VU	S1	-	**Minimal** • Not recorded within Study area. Targeted searches were undertaken; however evidence of this species was not identified. • Suitable habitat for this species does occur in the Study area; however it is of poor quality as it does not contain the 'pure' unburnt stands of Spinifex with little overstorey that are preferred by Mulgara. Additionally, the degraded nature of Spinifex habitats within the Study area (i.e. heavily grazed, recently burnt) is not conducive to supporting this species. • Habitat more likely to support Mulgara exists outside the Study area in the vast Spinifex sandplains to the east of Lake Way.	**Minimal:** • DEC threatened and Priority fauna database records indicate that the Mulgara has been recorded from Kumarina (200km N), Jundee Mine site (50 km north east), Wanjarri Nature Reserve (55km SE), Barwidgee Station (30km ESE), Mt Keith Mine Site (135km S), and Honeymoon Well (25km S) and recent records from Wiluna in 2007 (DEC, 2009).	• Minimise destruction of Red Sand Dune spinifex habitat and implement fire management where possible. • Implement feral animal control and monitor feral predators. • Educate mine site personnel and contractors with respect to the conservation status of the Mulgara. • Report sightings of this species to DEC.
Malleefowl (*Leipoa ocellata*)	VU	S1		**Negligible** • Not recorded within the Study area. Targeted searches were undertaken however evidence of this species was not identified. • Suitable habitat within Study area is marginal at best	**Negligible** • Recent recordings of Malleefowl at Wiluna are from 2007, with previous regional records from Yeelirrie (75 km S), Wanjarri Nature Reserve (55km SE), Earaheedy Station (150km NE), Lake Carnegie (210km NE), Mount Keith (135km S), and Yandal Station (75km SE) occurring from 1984 to 2001.	• Minimise destruction of habitat that possess a substantial canopy and leaf litter layer and a sandy substrate (e.g. dense stands of Mulga). • Implement feral animal control and monitor feral predators. • Educate mine site personnel and contractors with respect to the conservation status of the Malleefowl and report location of any mounds to DEC and Malleefowl Preservation Group.

Slender-billed Thornbill (*Acanthiza iredalei iredalei*)	VU	S1		**Minimal** • Not recorded within the Study area. Targeted searches were undertaken however evidence of this species was not identified. • Suitable habitat present within the Study area, although highly degraded from grazing by livestock.	**Negligible** • No regional records have been recorded for this species by DEC (2009).	• Minimise disturbance to Chenopod and Samphire Flat habitats fringing Lake Way. • Implement feral animal control and monitor feral predators. • Report any sightings of this species to DEC.
Major Mitchell's Cockatoo (*Cacatua leadbeateri*)		S4		**Negligible** • Species has not been recorded within the Study area. • Study area is on the edge of this species distribution range. • Wide-ranging species that is not likely to be reliant on habitat within the Study area. • Impact to suitable habitat for this species form the Project (Major Drainage Line with *Eucalyptus camaldulensis*) is expected to be negligible.	**Negligible** • Most recent record on DEC database is 1967 at Melrose (E of Wiluna). • The loss of breeding habitat for this species as a result of the Project from a regional perspective is considered to be negligible.	• Minimise destruction of substantial *Eucalypt* trees with hollows wherever possible. • Report any sightings of this species to DEC.
Peregrine Falcon (*Falco peregrinus*)	-	S4	-	**Minimal** • This species has not been recorded within the Study area. • Potential loss of nesting habitat; however suitable nesting habitat within the Study area (Large Eucalypts) is marginal and unlikely to be impacted by the Project.	**Negligible** • The loss of breeding habitat for this species as a result of the Project from a regional perspective is considered to be negligible. • Habitat for this species is widely represented throughout the region.	• Minimise destruction of substantial *Eucalypt* trees with hollows wherever possible. • Report any sightings of this species to DEC.
Striated Grasswren (*Amytornis striatus striatus*)			P4	**Negligible** • Not recorded within the Study area. • Habitat required by this species for nesting (tall dense spinifex), is lacking in the Study area due to impacts of livestock and fire.	**Negligible** • Previous records from Wanjarri Nature Reserve in 1979 and 1987 (DEC 2009) • Habitat is not likely to be suitable for this species in the surrounding region.	• Minimise destruction of spinifex habitat, and reduce intensity of grazing and frequency of fires within these habitats. • Report any sightings of this species to DEC.

Australian Bustard (*Ardeotis australis*)			P4	**Minimal** • The species is likely to occur within the Study area regularly in low numbers. Toro Energy field staff observed one individual between Centipede and Lake Way in 2009. • Has the potential to occur in a wide range of habitats within the Study; Similar and suitable habitat for this species occurs immediate outside the Project impact footprint.	**Negligible** • The DEC Threatened and Priority Fauna Database contains eleven records of the Australian Bustard from areas including Wiluna, Wanjarri Nature Reserve (55km SE), Sandstone (165km SW) and Lake Violet (5km N).Increased likelihood of introduced predators and road kill. • Suitable habitat for this species occurs in the Study area and surrounds; however loss of habitat for this species as a result of the Project from a regional perspective is considered to be negligible.	• Educate mine site personnel and contractors with respect to the conservation status of the Australian Bustard. • Implement measures to reduce accidental deaths and road kill. • Report sightings of this species to DEC.
Bush Stone-curlew (Burhinus grallarius)	-	-	P4	**Minimal** • This species has not been recorded in the Study area. • Suitable habitat does exist for this species in the Study area.	**Minimal** • The DEC Threatened and Priority Fauna Database contains eight records of the Bush-stone Curlew from areas including Wiluna, Meekatharra (170km W), Sandstone (165km SW), Mount Keith (135km S), Sir Samuel (115km S), and Peak Hill (240km NW). • Increased likelihood of introduced predators and road kill. • Suitable habitat for this species occurs in the Study area and surrounds; however loss of habitat for this species as a result of the Project from a regional perspective is considered to be negligible.	• Educate mine site personnel and contractors with respect to the conservation status of the Bush Stone-curlew. • Implement measures to reduce accidental deaths and road kill. • Report sightings of this species to DEC.
Grey Falcon (Falco hypoleucos)	-	-	P4	**Negligible** • This species has not been recorded in the Study area. • Wide-ranging species that is not likely to be reliant on habitat within the Study area.	**Negligible** • Species occupies a wide range of habitats and is nomadic across Australia. • Loss of habitat for this species as a result of the Project from a regional perspective is considered to be negligible.	• No significant impacts foreseen. • Report sightings of this species to DEC.

Rainbow Bee-eater (Merops ornatus)	M			**Minimal:** • Species reported as common throughout all study area. • Species is widespread and occupies a variety of habitats. • There will be potential loss of habitat for this species at a local scale; however suitable habitat for this species is well represented outside the Study area.	**Negligible:** • Widespread species that occupies a variety of habitats. • Loss of habitat for this species as a result of the Project from a regional perspective is considered to be negligible.	• None
Migratory Water Birds	M			**Minimal:** • Only one migratory water bird recorded, the Sharp-tailed Sandpiper (*Calidris acuminata*). • Migratory water birds may utilise Lake Way on a sporadic basis (i.e. after rainfall, during times of inundation). • Species are highly mobile and unlikely to be wholly reliant on habitat within the Study area. • Suitable habitat for these species represented in the surrounding area.	**Negligible:** • Lake Way is not listed as a wetland of national or international significance.	• Minimise disturbance to Chenopod and Samphire Flat habitats fringing Lake Way • Educate mine site personnel and contractors with respect to the conservation status of the Migratory water birds that may occur in the area, preferred habitat and likelihood of occurrence following Lake inundation. • Report sightings of Migratory species to the DEC.

[1] EPBC Act: EX Extinct, E Endangered, VU Vulnerable
WC Act: Schedule 1, S2, S3, S4
DEC Priority Species List: P1, P2, P3, P4

5.5 Impacts on SRE Invertebrate Fauna

5.5.1 Putative SRE Species

A total of five putative SRE species were identified from the 2010 autumn survey. The potential impacts of the Project on these species and the habitats in which they occur are provided in **Table 24**. The locations in which these species have been recorded within the study areas are shown in **Figures 26-28**. Three of these species, the mygalomorph spiders *Kwonkan* MYG175 and *Aname* MYG177 and scorpion *Urodacus* 'yeelirrie', were collected within the Project impact footprint; however specimens of MYG175 and *Urodacus* 'yeelirrie' were also collected outside the impact footprint. MYG177 was collected from calcrete habitat inside the footprint only, although this habitat is widespread within the study area, and so it is likely that this species occurs elsewhere. Potential impacts of the Project on these three species are discussed below. The remaining three mygalomorph spider species *Aname* MYG173, *Aname* MYG176 and *Aname* MYG177 have only been recorded outside the Project impact footprint (**Table 24**).

- ***Kwonkan* MYG175**

Kwonkan MYG175 is known to occur within the Centipede East Project impact footprint (**Figure 26**) and from outside the proposed Lake Maitland project footprint, approximately 90 km to the south east of the Study area. This species has been recorded from Melaleuca Stands occurring at Lake Way and Woodlands on Calcrete Flats habitat at Lake Maitland, suggesting the species is not restricted to one habitat type.

As this species is not restricted to habitat within the Project impact footprint and is known to occur outside the impact footprint, it appears unlikely that it will be substantially impacted by the Project.

- ***Aname* MYG177**

Aname MYG177 is known to occur within the Centipede East Project impact footprint (**Figure 26**); the only known record of this species. This species was collected from Mulga on Calcrete habitat within the study area, which was found to be both widespread and completely degraded (**Table 8**). Consequently, this species is likely to occur in similar habitat outside the project impact footprint. Therefore, it appears unlikely that it will be substantially impacted by the Project.

- ***Urodacus* 'yeelirrie'**

A total of 13 specimens have been recorded from eight sites within the Lake Way Study area and immediate vicinity during the 2007 spring survey and 2010 autumn survey; three sites within the impact footprint and five sites outside the impact footprint (**Figure 28**). The species has been recorded from six different habitat types from the Lake Way area including Melaleuca Stands, Open Mulga Woodland over Spinifex, Mulga Woodland over Chenopod Shrubland, Mallee/mulga complex over Spinifex, Mulga over Calcrete and Mulga over Hardpan.

Additionally, 14 specimens of this species have been recorded from the Yeelirrie project area, located 70 km south west of the Study area. The species has been recorded from four habitats at this project, comprising Mallee sandplain with Spinifex Grassland, *Eucalyptus gypsophilla* woodland, *Melaleuca xerophila* and *Acacia* sp. shrubland.

As the species has been recorded from a wide variety of habitats, some which are not restricted within the landscape, it appears unlikely that this species would be restricted in its distribution. Additionally, this species was found in a variety of habitats that are not restricted to the Project impact footprint. It is therefore unlikely that this species would be substantially impacted as a result of disturbance to habitats within the Project footprint.

5.5.2 SRE Habitat

Habitats which are considered as moderate or high potential to support SRE species that occur within the proposed project footprints include the Melaleuca Stands, Chenopod Flood Plain and the Mallee/Mulga complex over Spinifex habitats. Although no putative SRE species have been recorded exclusively from within these habitats, the discontinuous nature of these habitats in the landscape mean that removal of large areas of these habitats could potentially impact upon unrecorded SRE species.

Table 24: Putative SRE species and potential impacts of the Project

Putative SRE species	Study area	Do record(s) occur within project impact footprint?	Do record(s) occur outside project impact footprint?	Habitat type	Is the habitat restricted in the landscape?	Does the habitat occur over project impact footprint?	Does the habitat occur outside the project impact footprint?
Aname MYG176	Lake Way	No	Yes	Eucalypt Woodland	Moderate	No	Yes
				Mulga over chenopod shrubplain	Moderate	No	Yes
Aname MYG177	Centipede West	Yes	No	Mulga over Calcrete	No	Yes	Yes
Aname MYG173	Centipede West	No	Yes	Minor Drainage Line	Yes	No	Yes
Kwonkan MYG175	Centipede East	Yes	Yes	Melaleuca Stands	Yes	Yes	Limited
Urodacus 'yeelirrie'	All four study areas and surrounds	Yes	Yes	Melaleuca Stands, Open Mulga Woodland over Spinifex, Mulga Woodland over Chenopod Shrubland, Mallee/mulga complex over Spinifex, Mulga over Calcrete and Mulga over Hardpan.	Some habitats are restricted but others are extensive	Yes	Extensive

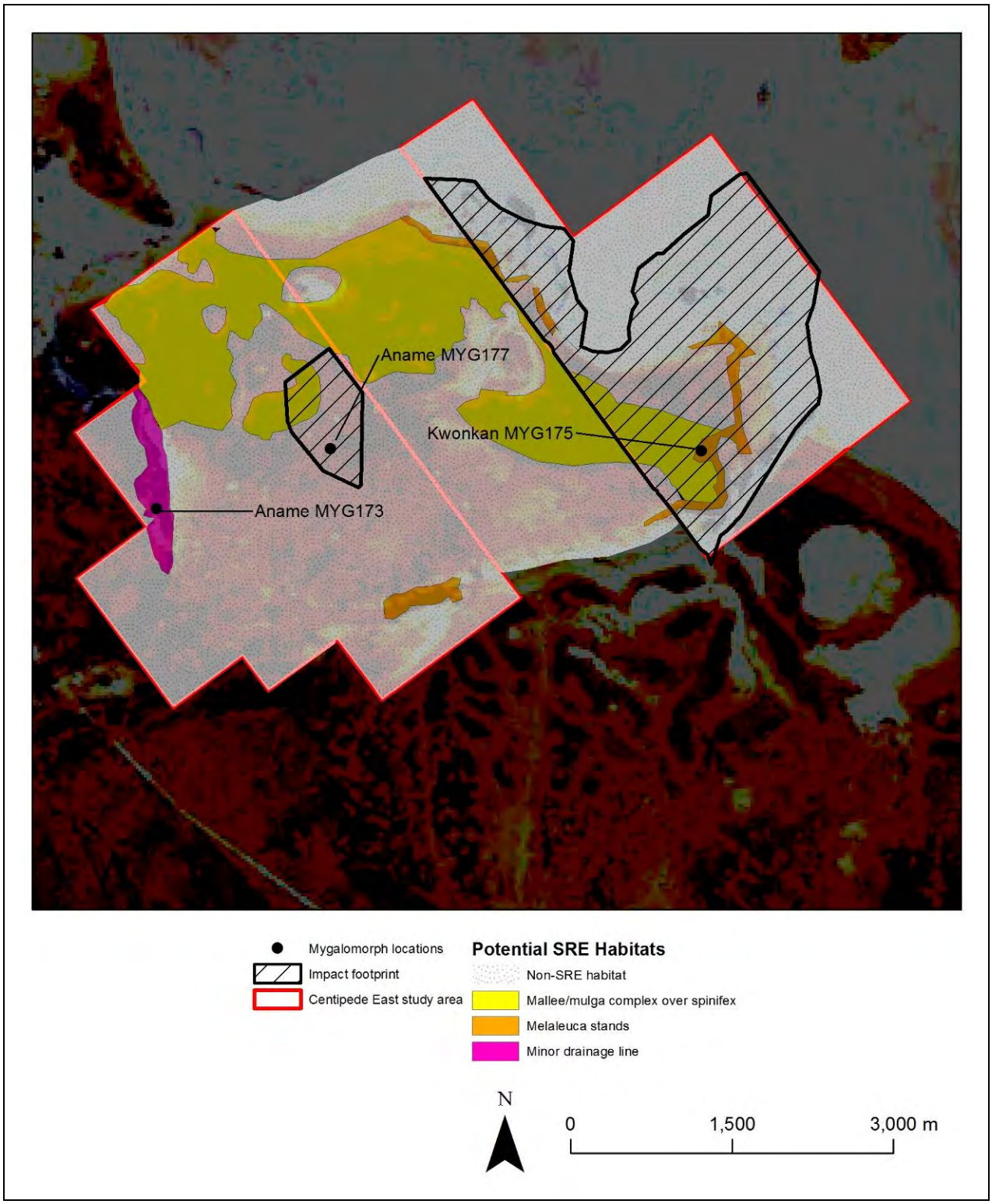

Figure 26: Records of putative SRE mygalomorph species within the Centipede study area

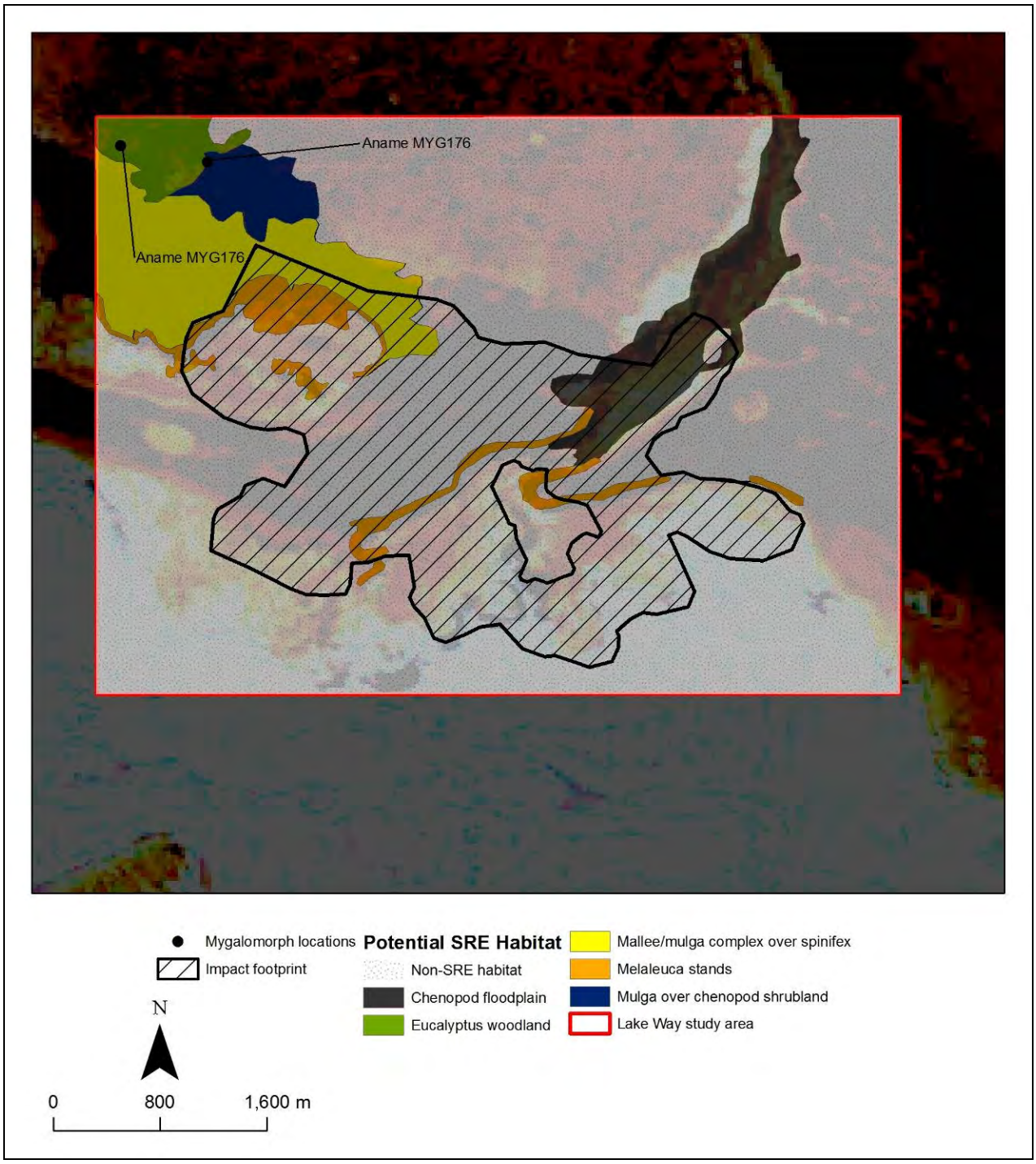

Figure 27: Records of putative SRE mygalomorph species at the Lake Way study area

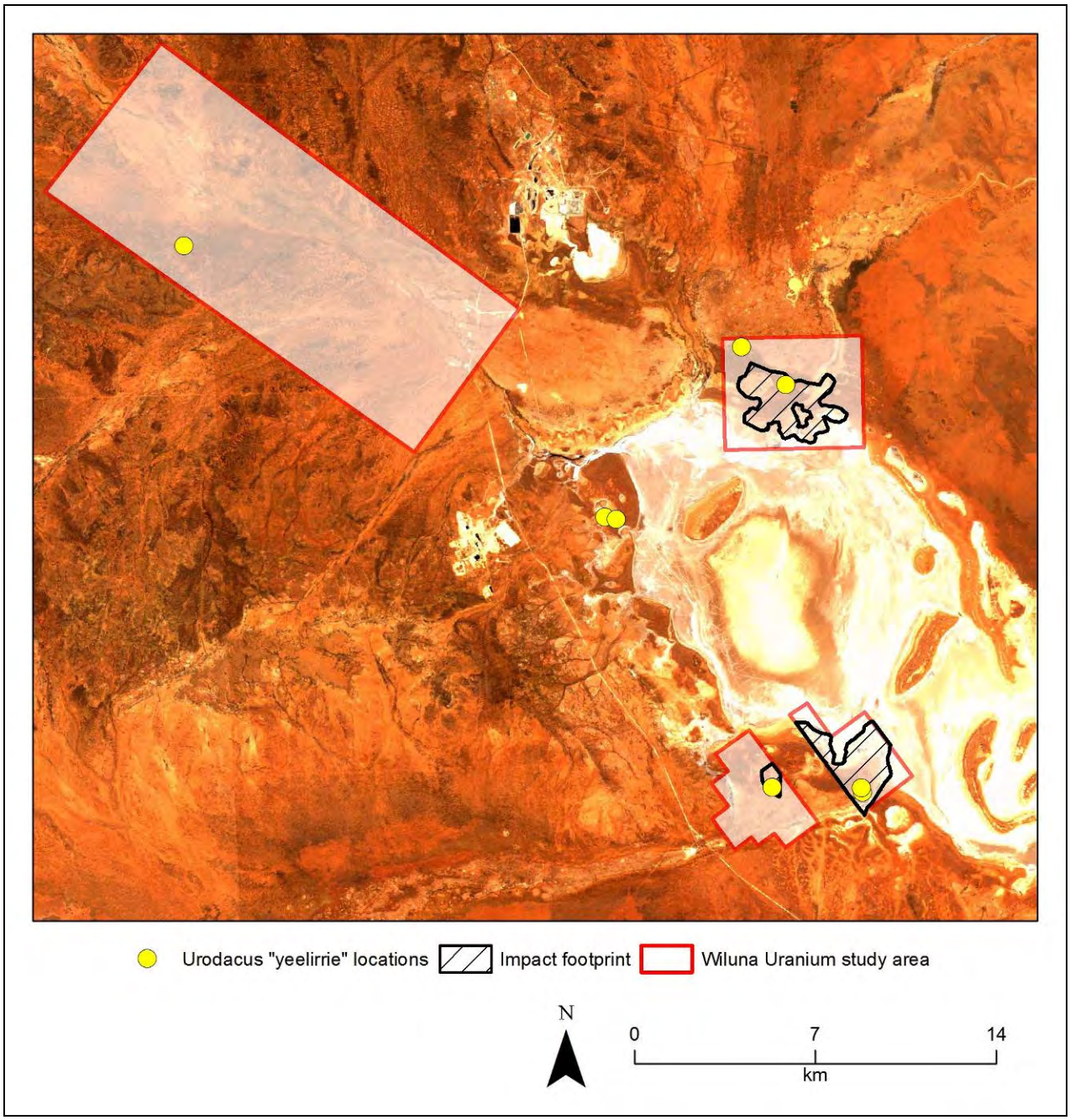

Figure 28: Records of Urodacus “yeelirrie” within and outside the Study area

6. CONCLUSIONS

6.1 Terrestrial Vertebrate Fauna

Two surveys were undertaken within the Study area as part of this terrestrial fauna assessment: a summer reconnaissance survey from 30 November to 4 December 2009; and a detailed autumn survey from 3 to 15 of March 2010.

Systematic and targeted sampling was undertaken in the twelve broad fauna habitats identified in the Study area, comprising Melaleuca Stands, Open Mulga Woodland over Spinifex, Eucalypt Woodland, Mulga Woodland over Chenopod Shrubland, Mallee/Mulga Complex over Spinifex, Mulga over Calcrete, Minor Drainage Line, Red Sand Dune, Chenopod Floodplain, Creek Line with River Red Gum, Open Mulga Woodland over Spinifex on Hardpan, and Major Drainage Line. Eight systematic sites were surveyed via trapping techniques, active hand searching, spotlighting searches and fixed time avifauna censusing. Trapping methods included the use of pitfall, Elliott, funnel and cage traps. In addition, 14 targeted survey sites were searched for signs of conservation significant species utilising the Study area.

A total of 216 vertebrate fauna species have been recorded in the Study area and immediate surrounds, comprising 31 mammals (20 native), 75 reptiles, 105 birds and five amphibians. During the 2009 reconnaissance survey and 2010 detailed autumn survey, a total of 109 vertebrate species were recorded, comprising 21 mammals (12 native), 36 reptiles, 52 birds and no amphibians. The vertebrate fauna assemblage recorded within the Study area is expected to be similar to other regional sites within the Eastern Murchison.

No threatened fauna species listed under the EPBC Act or WC Act, or Priority fauna species listed by the DEC were recorded during these surveys nor have been previously recorded in the Study area. Two conservation significant fauna species listed under the EPBC Act as Migratory were recorded during these surveys; the Rainbow Bee Eater (*Merops ornatus*) and Sharp-tailed Sandpiper (*Calidris acuminata*).

In addition to the above, 20 conservation significant fauna species could potentially occur within the Study area, comprising:

- Five species listed under the EPBC Act and WC Act: the Mulgara (*Dasycercus cristicauda* - Vulnerable and Schedule 1), Malleefowl (*Leipoa ocellata* - Vulnerable and Schedule 1), Slender-billed Thornbill (*Acanthiza iredalei iredalei* – Vulnerable), Major Mitchell's Cockatoo (*Cacatua leadbeateri* - Schedule 4) and Peregrine Falcon (*Falco peregrinus* - Schedule 4);
- Four priority species listed under the WA DEC Priority Species List: the Australian Bustard (*Ardeotis australis* - P4), Bush Stone-curlew (*Burhinus grallarius* - P4), the Grey Falcon (*Falco hypoleucos* - P4) and the Striated Grasswren (*Amytornis striatus striatus* – P4); and
- Nine species listed as Migratory under the EPBC Act: the Fork-tailed Swift (*Apus pacificus pacificus*), Eastern Great Egret (*Ardea alba*), Common Greenshank (*Tringa nebularia*), Wood Sandpiper (*Tringa*

glareola), Common Sandpiper (*Actitis hypoleucos*), Curlew Sandpiper (*Calidris ferruginea*), Red-necked Stint (*Calidris ruficollis*), Oriental Plover (*Charadrius veredus*) and Oriental Pratincole (*Glareola maldivarum*).

Significant vertebrate fauna habitats at the local scale that occur within the Study area include Samphire Flats and adjacent saltbush communities associated with Lake Way, and Melaleuca Stands along the edge of Lake Way. Clearing substantial areas of these habitats is likely to impact faunal assemblages at a localised scale. However, vertebrate habitats that occur within the Study area are generally widely represented in the surrounding region.

The Project will impact vertebrate faunal assemblages on a local scale through direct loss of fauna during land clearing, loss of habitat and indirect impacts. The Project is unlikely to have a significant impact on any fauna species, including any conservation significant fauna species, due to the presence of similar habitat in close proximity to the Study area.

6.2 Short Range Endemic Invertebrate Fauna

These fauna surveys provide a systematic assessment of targeted invertebrate groups which have the potential for short-range endemism within the Study area and surrounds.

The detailed SRE survey conducted in autumn 2010 yielded a total of 95 invertebrate specimens from the targeted SRE groups, comprising 14 mygalomorph spiders, 34 scorpions, 6 pseudoscorpions, 6 slaters and 35 terrestrial snail specimens.

Based on current scientific knowledge, five invertebrate species have been identified as putative SRE species from within the Study area. Of these species, *Aname* MYG177, *Kwonkan* MYG175 and *Urodacus* 'yeelirrie' have been recorded from within the Project footprint. Although *Aname* MYG177 was not recorded outside the project footprint, it was recorded from a habitat that is widespread within the study area. The remaining two species recorded within the project footprint were recorded outside this footprint also. *Urodacus* 'yeelirrie' was recorded in the local surrounds and both species were recorded at regional sites.

Habitats which have a moderate to high potential to support SRE species that occur within the proposed Project impact footprint include Melaleuca Stands, Chenopod Flood Plain and the Mallee/Mulga complex over Spinifex habitats. The Melaleuca Stands habitat, which is a fringing habitat that has a patchy distribution around Lake Way, does not appear to be well represented outside the Project impact footprint. The Chenopod Flood Plain and the Mallee/Mulga complex over Spinifex habitats are moderately to well represented at a local scale outside the Project impact footprint.

With consideration to survey findings and the habitat assessment, no putatative SRE invertebrate fauna species are restricted in their known occurrence to the proposed Project impact footprint.

7. STUDY TEAM

The Toro Wiluna Uranium Project terrestrial fauna assessment was conducted by

Miss Sonja Creese	B. Sc Hons (Conservation Biology) -	Zoologist
Mr Paul Bolton	B. Sc Hons (Marine Biology/Zoology)	Zoologist
Mr David Steane	B.Sc. (Hons) (Animal Science)	Zoologist
Dr Blair Parsons	PhD, B. Sc Hons (Biol. and Env. Science)	Zoologist
Trinity File	B. App Sc Hons (Environmental Science).	Principal Scientist

All AnaBat data was analysed by bat specialist Mr Robert Bullen from Bat Call WA.

The 2010 detailed autumn survey were conducted under the following Licence issued by DEC:

Licence to Take Fauna for Scientific Purposes (Regulation 17) – Licence No: SF007304

Date of issue: 24/02/2010

Valid from: 03/03/2010

Date of expiry: 01/05/2010

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Appendix A

Vertebrate Species Recorded or Potentially Occurring in the Study Area and Surrounds

Mammal Species Recorded within the Study area and surrounds

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Bovidae																				
*Bos taurus**	European Cattle				X	X	X					X	X							
*Capra hircus**	Feral Goat											X		X						
*Ovis aries**	Sheep					X							X	X						
Camelidae																				
*Camelus dromedarius**	Dromedary Camel						X				X	X		X						
Canidae																				
*Canis lupus dingo**	Dingo / Wild Dog				X		X				X	X	X					X		
*Vulpes vulpes**	Red Fox				X	X	X	X			X		X	X						
Dasyuridae																				
Antechinomys laniger	Kultarr							X						X		X				
Dasycercus blythi	Brush-tailed Mulgara			P4							X				X					
Dasycercus cristicauda	Crest-tailed Mulgara	VU	S1										X		X				X	
Ningaui ridei	Wongai Ningaui				X		X	X			X		X			X				
Sminthopsis crassicaudata	Fat-tailed Dunnart				X															
Sminthopsis hirtipes	Hairy-footed Dunnart										X					X				
Sminthopsis macroura	Stripe-faced Dunnart				X						X		X			X				
Sminthopsis ooldea	Ooldea Dunnart							X			X		X							
Emballonuridae																				
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat										X									
Taphozous hilli	Hill's Sheathtail Bat						X				X		X							
Equidae																				

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
*Equus caballus**	Horse				X	X	X													
*Equus asinus**	Donkey				X															
Felidae																				
*Felis catus**	Feral Cat				X		X	X			X		X	X						
Leporidae																				
*Oryctolagus cuniculus**	European Rabbit				X	X	X	X			X	X	X	X						
Macropodidae																				
Lagostrophus fasciatus fasciatus	Banded Hare-wallaby	VU	S1												X					
Macropus fuliginosus	Western Grey Kangaroo							X				X								
Macropus rufus	Red Kangaroo				X	X	X	X			X	X	X	X		X				
Macropus robustus erubescens	Euro				X	X	X				X	X	X	X		X				
Molossidae																				
Mormopterus beccarii	Beccari's Freetail Bat															X				
Mormopterus planiceps ('sp. 3')	Southern Freetail Bat				X	X	X				X		X							
Austronomus australis	White-striped Freetail Bat						X	X			X		X			X				
Muridae																				
*Mus domesticus**	House Mouse						X									X				
*Mus musculus**	House Mouse				X			X		X			X							
Notomys alexis	Spinifex Hopping-mouse						X				X		X			X				
Pseudomys desertor	Desert Mouse												X			X				
Pseudomys hermannsburgensis	Sandy Inland Mouse						X	X					X			X				
Potoroidae																				
Bettongia lesueur subsp. graii	Burrowing Bettong															X				

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Bettongia lesueur subsp. lesueur	Shark Bay Burrowing Bettong		S1													X				
Tachyglossidae																				
Tachyglossus aculeatus	Echidna				X	X	X	X			X	X	X	X						
Thylacomydae																				
Macrotis lagotis	Bilby	VU	S1													X				
Vespertilionidae																				
Chalinolobus gouldii	Gould's Wattled Bat				X	X	X	X			X		X			X				
Myotis lucifugus	Little Brown Bat							X												
Nyctophilus geoffroyi	Lesser longeared Bat				X	X	X				X		X			X				
Nyctophilus major tor	Inland Greater Long-eared Bat										X									
Scotorepens balstoni	Inland Broadnosed Bat				X	X	X				X		X			X				
Vespadelus baverstocki	Inland Forest Bat				X	X					X									
Vespadelus finlaysoni	Finlayson's Cave Bat				X	X	X				X		X			X				

Bird Species Recorded within the Study area and surrounds

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Acanthizidae																				
Acanthiza apicalis	Inland Thornbill				X		X	X			X					X	X	X		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				X		X	X		X	X			X			X			
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	VU																	X	X
Acanthiza robustirostris	Slaty-backed Thornbill				X		X			X	X		X	X		X	X			
Acanthiza uropygialis	Chestnut-rumped Thornbill				X	X	X	X		X	X	X	X	X			X	X		
Aphelocephala leucopsis castaneiventris	Southern Whiteface										X			X		X	X	X		
Gerygone fusca	Western Gerygone							X			X	X					X			
Smicrornis brevirostris	Weebill				X		X	X			X	X	X				X			
Accipitridae																				
Accipiter cirrhocephalus	Collared Sparrowhawk						X	X			X		X				X			
Accipiter fasciatus	Brown Goshawk	Ma				X		X						X			X			
Aquila audax	Wedge-tailed Eagle				X	X	X	X		X	X	X	X	X			X			
Circus aeruginosus	Western-marsh Harrier							X												
Circus assimilis	Spotted Harrier							X			X					X	X			
Elanus axillaris	Black-shouldered Kite							X					X				X			
Haliastur sphenurus	Whistling Kite	Ma			X	X	X	X			X						X			
Hamirostra melanosternon	Black-breasted Buzzard				X	X	X										X			
Hieraaetus morphnoides	Little Eagle					X	X	X			X		X				X			
Lophoictinia isura	Square-tailed Kite				X												X			
Milvus migrans	Black Kite						X	X					X				X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Aegothelidae																				
Aegotheles cristatus	Australian Owlet-nightjar				X	X	X	X			X		X				X			
Anatidae																				
Anas gracilis	Grey Teal								X			X					X			
Anas rhynchotis	Australasian Shoveler								X								X			
Anas superciliosa	Pacific Black Duck								X								X			
Aythya australis	Hardhead								X											
Biziura lobata	Musk Duck								X											
Chenonetta jubata	Australian Wood Duck							X	X								X			
Cygnus atratus	Black Swan								X							X	X			
Malacorhynchus membranaceus	Pink-eared Duck								X			X					X			
Tadorna tadornoides	Australian Shelduck					X		X	X		X						X			
Anhingidae																				
Anhinga novaehollandiae	Australasian Darter																X			
Anhinga melanogaster	Darter								X											
Apodidae																				
Apus pacificus	Fork-tailed Swift	M						X											X	X
Ardeidae																				
Ardea pacifica	White-necked Heron							X	X							X	X			
Egretta/Ardea novaehollandiae	White-faced Heron								X					X			X			
Ardea alba	Great Egret	M							X										X	
Nycticorax caledonicus	Rufous Night Heron								X							X	X			
Artamidae																				

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Artamus cinereus	Black-faced Woodswallow				X		X			X	X	X	X	X			X			
Artamus cyanopterus	Dusky Woodswallow																X			
Artamus minor	Little Woodswallow																X			
Artamus personatus	Masked Woodswallow										X			X			X			
Burhinidae																				
Burhinus grallarius	Bush Stone-curlew			P4							X		X		X		X			
Campephagidae																				
Coracina maxima	Ground Cuckoo-shrike							X			X	X		X			X			
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Ma			X		X	X		X	X	X	X	X			X			
Lalage sueurii	White-winged Triller							X		X	X	X	X				X			
Caprimulgidae																				
Eurostopodus argus	Spotted Nightjar	Ma					X	X			X		X	X		X	X			
Casuaridae																				
Dromaius novaehollandiae	Emu						X			X	X	X	X	X			X			
Charadriidae																				
Charadrius australis									X											
Charadrius ruficapillus	Red-capped Plover	Ma						X	X								X			
Charadrius veredus	Oriental Plover	M						X	X											
Elseyornis melanops	Black-fronted Dotterel							X	X				X				X			
Erythrogonys cinctus								X	X											
Vanellus tricolor	Banded Lapwing				X		X		X		X	X					X			
Cinclosomatidae																				
Psophodes occidentalis	Chiming Wedgebill				X		X						X				X	X		

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Cinclosoma castaneothorax marginatum	Chestnut-breasted Quail-thrush										X			X		X	X	X		
Cinclosoma castanotum	Chestnut Quail-thrush												X				X	X		
Climacteridae																				
Climacteris affinis	White-browed Treecreeper							X						X			X			
Columbidae																				
Geopelia cuneata	Diamond Dove											X	X	X			X			
Geophaps plumifera	Spinifex Pigeon																X			
Ocyphaps lophotes	Crested Pigeon				X	X	X	X		X	X	X	X	X		X				
Phaps chalcoptera	Common Bronzewing				X		X	X			X	X	X	X						
Corvidae																				
Corvus bennetti	Little Crow				X	X	X			X	X		X	X			X			
Corvus coronoides	Australian Raven											X					X			
Corvus orru	Torresian Crow										X			X			X			
Cracticidae																				
Cracticus torquatus	Grey Butcherbird				X		X				X		X	X			X			
Cracticus nigrogularis	Pied Butcherbird				X	X	X			X	X	X	X	X			X			
Gymnorhina/Cracticus tibicen	Australian Magpie				X		X				X		X			X	X			
Strepera versicolor	Grey Currawong						X				X			X			X			
Cuculidae																				
Cacomantis/ Cuculus pallidus	Pallid Cuckoo	Ma			X			X			X						X			
Chalcites basalis	Horsfield's Bronze-Cuckoo										X						X			
Chalcites osculans	Black-eared Cuckoo	Ma															X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Dicaeidae																				
Dicaeum hirundinaceum	Mistletoebird							X			X						X			
Dicruridae																				
Grallina cyanoleuca	Magpie-lark	Ma					X	X			X	X	X	X			X			
Rhipidura fuligionsa	Grey Fantail										X						X			
Rhipidura leucophrys	Willie Wagtail				X	X	X	X		X	X	X	X	X			X			
Estrildidae																				
Lonchura castaneothorax	Chestnut-breasted Mannikin															X				
Falconidae																				
Falco berigora	Brown Falcon					X	X	X		X	X		X	X			X			
Falco cenchroides	Nankeen Kestrel	Ma			X		X	X		X	X		X	X			X			
Falco hypoleucos	Grey Falcon			P4													X			
Falco longipennis	Australian Hobby						X	X			X	X	X			X	X			
Falco peregrinus	Peregrine Falcon	S4									X						X			
Falco subniger	Black Falcon																X			
Glareolidae																				
Glareola maldivarum	Oriental Pratincole	M						X												
Stiltia isabella	Australian Pratincole								X											
Halcyonidae																				
Todiramphus pyrrhopygia	Red-backed Kingfisher				X			X			X			X			X			
Todiramphus sanctus	Sacred Kingfisher	Ma						X									X			
Hirundinidae																				
Cheramoeca leucosterna	White-backed Swallow							X		X	X		X				X	X		

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Hirundo neoxena	Welcome Swallow	Ma					X	X			X		X	X			X			
Petrochelidon/ Hirundo nigricans	Tree Martin	Ma			X		X	X			X						X			
Petrochelidon/Hirundo ariel	Fairy Martin										X						X			
Laridae																				
Larus novaehollandiae	Silver Gull								X											
Sterna nilotica	Gull-billed Tern								X											
Sterna hybria	Whiskered Tern								X											
Maluridae																				
Amytornis striatus	Striated Grasswren																X			
Amytornis striatus striatus	Striated Grasswren			P4											X					
Amytornis textilis textilis	Thick-billed Grasswren (western ssp)			P4											X					
Malurus lamberti	Variegated Fairy-wren				X		X	X			X		X				X			
Malurus leucopterus	White-winged Fairy-wren				X	X	X	X		X	X	X	X				X	X		
Malurus splendens	Splendid Fairy-wren				X		X				X		X	X		X	X			
Megapodiidae																				
Leipoa ocellata	Malleefowl	VU	S1								X				X				X	X
Meliphagidae																				
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				X		X	X		X	X		X	X			X			
Anthochaera carunculata	Red Wattlebird																X			
Certhionyx variegatus	Pied Honeyeater							X									X	X		
Epthianura albifrons	White-fronted Chat																X			
Epthianura aurifrons	Orange Chat							X								X	X	X		
Epthianura tricolor	Crimson Chat							X			X		X	X			X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Erythrogonys cinctus	Red-kneed Dotterel				X												X			
Lichenostomus keartlandi	Grey-headed Honeyeater						X						X				X			
Lichenostomus leucotis	White-eared Honeyeater						X													
Lichenostomus ornatus	Yellow-plumed Honeyeater						X						X							
Lichenostomus penicillatus	White-plumed Honeyeater				X	X	X	X			X		X				X			
Lichenostomus plumulus	Grey-fronted Honeyeater												X				X			
Lichenostomus virescens	Singing Honeyeater				X	X	X	X		X	X	X	X	X			X	X		
Lichmera indistincta	Brown Honeyeater						X				X		X				X			
Manorina flavigula	Yellow-throated Miner				X	X	X	X		X	X	X	X	X			X			
Purnella/Phylidonyris albifrons	White-fronted Honeyeater				X			X			X						X	X		
Phylidonyris novaehollandiae	New Holland Honeyeater																	X		
Sugomel/Certhionyx niger	Black Honeyeater																X			
Meropidae																				
Merops ornatus	Rainbow Bee-eater	M			X	X	X	X			X	X					X		X	X
Motacillidae																				
Anthus novaeseelandiae	Australasian Pipit	Ma						X		X	X		X				X			
Neosittidae																				
Daphoenositta chrysoptera	Varied Sittella										X	X					X	X		
Otididae																				
Ardeotis australis	Australian Bustard			P4							X			X	X	X	X			
Pachycephalidae																				
Colluricincla harmonica	Grey Shrike-thrush						X	X			X	X	X	X			X			
Oreoica gutturalis gutturalis	Crested Bellbird (southern)			P4													X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Oreoica gutturalis pallescens	Crested Bellbird (central)				X			X			X		X	X		X				
Pachycephala rufiventris	Rufous Whistler				X		X	X		X	X	X	X	X			X			
Pardalotidae																				
Calamanthus campestris	Rufous Fieldwren																X			
Calamanthus fuliginosus	Striated Fieldwren							X										X		
Pardalotus rubricatus	Red-browed Pardalote																X			
Pardalotus striatus murchisoni	Striated Pardalote										X					X	X			
Pyrrholaemus brunneus	Redthroat				X	X	X	X			X		X				X	X		
Passeridae																				
Taeniopygia guttata castanotis	Zebra Finch				X		X	X			X	X	X	X		X	X			
Pelecanidae																				
Pelecanus conspicillatus	Australian Pelican	Ma							X								X			
Petroicidae																				
Melanodryas cucullata	Hooded Robin							X			X			X			X			
Microeca fascinans	Jacky Winter				X						X									
Petroica goodenovii	Red-capped Robin				X			X			X		X	X			X			
Phalacrocoracidae																				
Phalacrocorax melanoleucos	Little Pied Cormorant								X								X			
Phalacrocorax sulcirostris	Little Black Cormorant								X								X			
Phasianidae																				
Coturnix pectoralis	Stubble Quail	Ma															X			
Podargidae																				
Podargus strigoides	Tawny Frogmouth						X	X			X		X				X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Podicipedidae																				
Poliocephalus poliocephalus	Hoary-headed Grebe								X							X	X			
Tachybaptus novaehollandiae	Australasian Grebe								X								X			
Pomastostomidae																				
Pomatostomus superciliosus	White-browed Babbler					X		X			X	X	X	X		X	X			
Pomatostomus superciliosus ashbyi	White-browed Babbler (western)			P4											X	X				
Pomatostomus temporalis	Grey-crowned Babbler				X		X	X			X						X			
Psittacidae																				
Cacatua leadbeateri	Major Mitchell's Cockatoo		S4												X					
Melopsittacus undulatus	Budgerigar							X			X		X	X			X			
Neophema bourkii	Bourke's Parrot													X		X	X			
Neophema elegans	Elegant Parrot										X									
Nymphicus hollandicus	Cockatiel							X			X		X	X			X			
Barnardius zonarius subsp. zonarius	Port Lincoln Parrot					X	X									X	X			
Barnardius zonarius	Australian Ringneck				X			X		X	X	X	X	X						
Polytelis alexandrae	Princess Parrot	VU																	X	X
Psephotus varius	Mulga Parrot				X		X	X			X		X	X			X			
Eolophus roseicapillus	Galah				X		X	X			X	X	X	X		X				
Cacatua sanguinea	Little Corella												X				X			
Ptilonorhynchidae																				
Chlamydera guttata	Western Bowerbird						X	X			X		X	X		X	X			
Rallidae																				

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Gallinula tenebrosa	Dusky Moorhen								X											
Porzana fluminea	Australian Spotted Crake								X											
Gallirallus philippensis	Buff-banded Rail								X											
Porzana pusilla	Baillon's Crake								X											
Fulica atra	Eurasian Coot								X								X			
Tribonyx/Gallinula ventralis	Black-tailed Native-hen								X								X			
Recurvirostridae																				
Cladorhynchus leucocephalus	Banded Stilt							X	X								X			
Himantopus himantopus	Black-winged Stilt	Ma						X	X								X			
Recurvirostra novaehollandiae	Red-necked Avocet	Ma						X	X								X			
Scolopacidae																				
Tringa nebularia	Common Greenshank	M						X	X											
Tringa glareola	Wood Sandpiper	M						X	X											
Tringa hypoleucos	Common Sandpiper	M						X	X											
Calidris ruficollis	Red-necked Stint	M						X	X											
Calidris acuminata	Sharp-tailed Sandpiper	M			X			X	X											
Calidris alba	Sanderling	M						X												
Calidris subminuta	Long-toed Stint	M						X												
Calidris ferruginea	Curlew Sandpiper	M							X											
Strigidae																				
Ninox novaeseelandiae	Southern Boobook	Ma					X	X			X						X			
Sylviidae																				
Cincloramphus cruralis	Brown Songlark							X						X			X			

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Cincloramphus mathewsi	Rufous Songlark							X						X			X			
Cisticola exilis	Golden-headed Cisticola															X				
Cisticola juncidis	Zitting Cisticola															X				
Megalurus timoriensis	Tawny Grassbird															X				
Threskiornithidae																				
Platalea regia	Royal Spoonbill								X											
Platalea flavipes	Yellow-billed Spoonbill								X											
Threskiornis spinicollis	Straw-necked Ibis	Ma							X								X			
Turnicidae																				
Turnix velox	Little Button-quail																X			
Tyto javanica	Eastern Barn Owl	Ma															X			

Reptile Species Recorded within the Study area and surrounds

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Agamidae																				
Tympanocryptis cephalus	Pebble Dragon							X								X				
Caimanops amphiboluroides	Mulga Dragon							X				X								
Ctenophorus caudicinctus subsp. mensarum	Ring-tailed Dragon							X			X					X		X		
Ctenophorus isolepis	Central Military Dragon				X		X	X			X		X	X		X				
Ctenophorus maculatus	Spotted Dragon																			
Ctenophorus nuchalis	Central Netted Dragon				X		X			X	X	X	X							
Ctenophorus pictus	Painted Dragon							X												
Ctenophorus salinarum	Claypan Dragon						X						X			X				
Ctenophorus scutulatus	Lozenged-marked Dragon				X			X			X		X			X		X		
Ctenophorus reticulatus	Western-netted Dragon							X				X		X		X				
Lophognathus longirostris	Long-nosed Dragon				X	X	X	X								X				
Moloch horridus	Thorny Devil						X	X			X		X			X				
Pogona minor minor	Bearded Dragon						X	X			X		X	X				X		
Pogona minor minima	Dwarf Bearded Dragon									X										
Scincidae																				
Tiliqua multifasciata	Central Blue-tongue							X			X		X			X				
Tiliqua occipitalis	Western Bluetongue							X			X					X				
Cryptoblepharus boutonii								X												
Cryptoblepharus buchananii	Fence Skink										X									
Cryptoblepharus carnabyi							X													

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Cryptoblepharus plagiocephalus	Fence Skink						X				X		X							
Liopholis (Egernia) kintorei	Great Desert Skink	VU	S1												X				X	X
Egernia depressa	Pygmy Spiny-tailed Skink				X			X			X	X	X			X		X		
Liopholis (Egernia) inornata	Desert Skink							X			X									
Liopholis (Egernia) striata	Night Skink										X									
Eremiascincus richardsonii	Broad-banded Sand Swimmer							X			X		X			X				
Ctenotus calurus																X				
Ctenotus atlas	Southern Mallee Skink					X	X						X							
Ctenotus grandis											X		X							
Ctenotus hanloni											X									
Ctenotus helenae					X			X			X		X							
Ctenotus leonhardii							X	X		X	X		X			X				
Ctenotus pantherinus ocellifer	Leopard Ctenotus				X		X	X			X		X			X				
Ctenotus quattuordecimlineatus					X		X	X								X				
Ctenotus schomburgkii							X				X		X			X				
Ctenotus severus					X								X							
Ctenotus ariadnae											X					X				
Ctenotus uber subsp. uber																X				
Lerista bipes					X		X	X					X							
Lerista desertorum					X		X	X			X		X			X		X		
Lerista muelleri					X		X	X		X			X					X		
Lerista nichollsi								X												
Lerista rhodenoides											X									

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Menetia greyii	Common Dwarf Skink				X		X	X		X	X		X			X				
Morethia butleri					X		X	X			X					X				
Diplodactylinae																				
Diplodactylus elderi	Jewelled Gecko							X												
Diplodactylus pulcher								X			X		X			X				
Diplodactylus conspicillatus	Fat-tailed Gecko				X		X	X			X		X			X		X		
Lucasium damaeum	Beaded Gecko				X															
Lucasium stenodactylum	Sandplain Gecko				X	X	X					X	X							
Diplodactylus granariensis subsp. rex	Western Stone Gecko				X	X					X					X				
Diplodactylus squarrosus	Mottled Ground Gecko																			
Diplodactylus vittatus	Eastern Stone Gecko							X												
Nephrurus laevissimus	Smooth Knob-tailed Gecko				X		X	X								X				
Nephrurus wheeleri wheeleri	Banded Knob-tailed Gecko				X		X						X			X				
Nephrurus milii	Barking Gecko															X				
Nephrurus vertebralis					X						X	X	X							
Rhynchoedura ornata	Beaked Gecko				X		X	X			X		X			X				
Strophurus strophurus	Spiny-tailed Gecko				X		X	X			X					X				
Strophurus wellingtonae											X					X				
Strophurus elderi					X					X	X		X							
Gekkoninae																				
Gehyra purpurascens	Purplish Dtella					X	X			X			X							
Gehyra punctata	Spotted Dtella							X										X		
Gehyra variegata	Variegated Gecko				X		X	X		X	X	X	X			X		X		

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Heteronotia binoei	Bynoe's Gecko				X	X	X	X			X		X			X		X		
Pygopidaidae																				
Delma butleri	Butler's Delma						X				X					X				
Delma nasuta								X			X		X			X				
Aprasia picturata	Black-headed Worm Lizard															X				
Lialis burtonis	Burton's Snake Lizard							X			X		X			X				
Pygopus nigriceps	Hooded Scaly-foot				X		X				X					X				
Typhlopidae																				
Ramphotyphlops bituberculatus								X										X		
Ramphotyphlops hamatus					X											X				
Ramphotyphlops waitii																X				
Boidae																				
Antaresia childreni	Children's python							X												
Antaresia perthensis	Pygmy Python															X				
Elapidae																				
Brachyurophis approximans	North-westerm Shovel-nosed Snake				X											X				
Brachyurophis fasciolata subsp. fasciolata																X				
Demansia psammophis subsp. cupreiceps	Yellow-faced Whipsnake				X											X				
Demansia psammophis subsp. reticulata								X		X										
Pseudechis australis	Mulga / King Brown Snake							X												
Pseudonaja modesta	Ringed Brown Snake				X			X			X					X		X		
Pseudonaja nuchalis	Gwardar							X			X					X		X		

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Parasuta monachus	Monk Snake				X								X			X				
Simoselaps bertholdi	Jan's Banded Snake				X						X	X				X				
Simoselaps semifasciatus	Half-girdled Snake							X										X		
Suta monachus	Hooded Snake							X										X		
Suta fasciata	Rosen's Snake							X								X				
Varanidae																				
Varanus eremius	Desert Pygmy Monitor							X			X		X							
Varanus giganteus	Perentie				X			X			X									
Varanus gouldii	Gould's Sand Monitor				X	X	X	X			X	X	X					X		
Varanus caudolineatus	Strpie-tailed Goanna							X			X	X				X				
Varanus brevicauda	Short-tailed Pygmy Monitor															X				
Varanus tristis subsp. tristis	Racehorse Monitor															X				
Varanus panoptes rubidus	Yellow-spotted Monitor						X				X		X	X		X				
Typhlopidae																				
Ramphotyphlops hamatus							X													
Cheluidae																				
Chelodina steindachneri	Steindachner's Turtle						X	X					X			X		X		

Amphibian Species Recorded within the Study area and surrounds

Scientific Name	Common Name	Conservation Status			Study Area				Local surveys (<75km)			Regional Surveys (>75km)			Database Searches					
		EPBC Act	WC Act	DEC Priority	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Hylidae																				
Litoria rubella	Desert Tree Frog							X		X	X					X				
Cyclorana maini	Main's Frog							X			X									
Cyclorana platycephala	Water-holding Frog							X			X					X				
Limnodynastidae																				
Limnodynastes spenceri	Spencer's Burrowing Frog							X												
Neobatrachus wilsmorei	Plonking Frog							X								X				
Myobatrachidae																				
Pseudophryne occidentalis	Western Toadlet										X									

Source Data	Code
Outback Ecology (2010) Wiluna Uranium Terrestrial Fauna Habitat Assessment. Outback Ecology Services, Perth, Western Australia.	A
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Bancroft, W. and Bamford, M (2004). Review of the Wetland Avifauna of Lake Way. M.J. & A.R. Bamford, Consulting Ecologists, Kingsley, Western Australia.	E
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Outback Ecology (2010) Mega Uranium Lake Maitland Project: Terrestrial Fauna Habitat Assessment. Outback Ecology Services, Perth, Western Australia.	G
(Outback Ecology, 2008). Lake Maitland Baseline Terrestrial Fauna Surveys. Outback Ecology Services, Perth, Western Australia.	H
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DEC (2009a) Threatened and Priority Fauna Database.	K
DEC (2009b). NatureMap.	L
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OZCAM (2009). Australia's Fauna - Online Zoological Collection of Australian Museums.	N
DEWHA (2009a). Environmental Reporting Tool.	O
DEWHA (2009b). Protected Matters Report.	P

Appendix B
Abundance of Vertebrate Species Recorded During the 2010 Autumn Survey

Scientific Name	Common Name	Conservation Status		Site								Total
		EPBC Act	WC Act	1	2	3	4	6	7	8	11	
Mammals												
BOVIDAE												
*Bos taurus**	European Cattle			X	X	X	X	X	X	X	X	
CANIDAE												
Canis lupus dingo/familiaris	Dingo/Common Dog			X	X	X	X		X	X	X	
*Vulpes vulpes**	Fox				X							
DASYURIDAE												
Ningaui ridei	Wongai Ningaui						1			4	2	7
Sminthopsis crassicaudata	Fat-tailed Dunnart									1		1
Sminthopsis macroura	Stripe-faced Dunnart				1				1			2
EQUIDAE												
Equus asinus	Donkey											
Equus caballus	Horse											
FELIDAE												
*Felis catus**	Cat											
LEPORIDAE												
Oryctolagus cuniculus	Rabbit			X	X			X	X			
MACROPODIDAE												
Macropus robustus	Euro			X		X	X	X	X	X	X	
MURIDAE												
Notomys alexis	Spinifex Hopping-mouse											
TACHYGLOSSIDAE												
Tachyglossus aculeatus	Short-beaked Echidna				X					X		
Birds												
ACCIPITRIDAE												
Haliastur sphenurus	Whistling Kite								1			1
Hamirostra melanosternon	Black-breasted Buzzard									1		1
ARTAMIDAE												
Artamus cinereus	Black-faced Woodswallow							2			1	3
Cracticus nigrogularis	Pied Butcherbird				2	1	1			2	3	9
Cracticus torquatus	Grey Butcherbird					4	2			1	6	13
Gymnorhina tibicen	Australian Magpie				2	1	1				1	5

Scientific Name	Common Name	Conservation Status		Site								Total
		EPBC Act	WC Act	1	2	3	4	6	7	8	11	
CACATUIDAE												
Eolophus roseicapilla	Galah						1					1
COLUMBIDAE												
Ocyphaps lophotes	Crested Pigeon							4				4
Phaps chalcoptera	Common Bronzewing							1				1
CORVIDAE												
Corvus bennetti	Little Crow								1			1
CUCULIDAE												
Cuculus pallidus	Pallid Cuckoo			2				2				4
ESTRILDIDAE												
Taeniopygia guttata	Zebra Finch							5			1	6
FALCONIDAE												
Falco cenchroides	Nankeen Kestrel									1		1
HALCYONIDAE												
Todiramphus pyrrhopygius	Red-backed Kingfisher				1							1
HIRUNDINIDAE												
Hirundo nigricans	Tree Martin					1						1
MALURIDAE												
Malurus lamberti	Variegated Fairy-wren					2		1				3
Malurus leucopterus leuconotus	White-winged Fairy-wren									1		1
Malurus splendens	Splendid Fairy-wren					1						1
MELIPHAGIDAE												
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					1	2					3
Epthianura tricolor	Crimson Chat							1				1
Lichenostomus pencillatus	White-plumed Honeyeater					6	1					7
Lichenostomus virescens	Singing Honeyeater			3	1		3		3	3		13
Manorina flavigula	Yellow-throated Miner			1		4						5
Phylidonyris albifrons	White-fronted Honeyeater					1						1
MEROPIDAE												
Merops ornatus	Rainbow Bee-eater	M		2		6	2		4	1	1	16
PACHYCEPHALIDAE												
Oreoica gutteralis	Crested Bellbird									1		1
Pachycephala rufiventris	Rufous Whistler			2		1			2		2	7

Scientific Name	Common Name	Conservation Status		Site								Total
		EPBC Act	WC Act	1	2	3	4	6	7	8	11	
ACANTHIZIDAE												
Acanthiza apicalis	Inland Thornbill					3		4		1		8
Acanthiza chrysorrhoa	Yellow-rumped Thornbill					1	1			2		4
Acanthiza robustirostris	Slaty-backed Thornbill			3					2			5
Acanthiza uropygialis	Chestnut-rumped Thornbill			3	2	3	3	7	1	3	5	27
Pyrrholaemus brunneus	Redthroat			1				2	2			5
Smicrornis brevirostris	Weebill			4		7	4	2	4		3	24
PETROICIDAE												
Microeca fascinans	Jacky Winter			1		1			1			3
Petroica goodenovii	Red-capped Robin					1		4	1		3	9
POMATOSTOMIDAE												
Pomatostomus temporalis	Grey-crowned Babbler					1						1
RHIPIDURA												
Rhipidura leucophrys	Willie Wagtail					2		1		4		7
Reptiles												
AGAMIDAE												
Ctenophorus isolepis isolepis	Military Dragon									1		1
Ctenophorus scutulatus	Lozenge-marked Dragon						2					2
ELAPIDAE												
Brachyurophis approximans	North Western Shovel-nosed Snake					1	3	1				5
Demansia psammophis	Yellow faced Whip Snake					1						1
Parasuta monachus	Monk Snake							1	2	2		5
Simoselaps bertholdi	Jan's Banded Snake					1						1
GEKKONIDAE												
Diplodactylus conspicillatus	Fat-tailed Diplodactylus						2	2				4
Diplodactylus granariensis(?)	Wheat-belt Stone Gecko										1	1
Gehyra variegata	Tree Dtella					1	1	4	7	2	1	16
Heteronotia binoei	Bynoe's Gecko							3	1			4
Lucasium damaeum	Beaded Gecko					1						1
Lucasium stendactylum	Sand Plain Gecko									1		1
Nephrurus laevissimus	Pale Knob-tailed Gecko									2		2
Nephrurus vertebralis	Midline Knob-tail							1				1
Nephrurus wheeleri	Banded Knob-tailed Gecko						1					1

Scientific Name	Common Name	Conservation Status		Site								Total
		EPBC Act	WC Act	1	2	3	4	6	7	8	11	
Rhynchoedura ornata	Beaked Gecko			1	3			4		2	1	11
Strophurus elderi	Jewelled Gecko										1	1
Strophurus strophorus	Western Spiny-tailed Gecko									1		1
PYGOPIDAE												
Pygopus nigriceps	Western Hooded Scaly Foot					2					1	3
SCINCIDAE												
Ctenotus helenae	Clay-soil Ctenotus				1							1
Ctenotus pantherinus	Leopard Ctenotus										2	2
Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus									1		1
Ctenotus severus	Stern Ctenotus				1		1			3		5
Egernia depressa	Pygymy Spiny-tailed Skink							1				1
Lerista bipes	North-western Sandslider									20		20
Lerista desertorum	Central Deserts Robust Slider					3		1				4
Lerista muelleri(?)	Wood Mulch-slider					15	3	2	1		5	26
Menetia greyii	Common Dwarf Skink				2	1			3		4	10
Morethia butleri	Woodland Morethia Skink			1								1
TYPHLOPIDAE												
Ramphotyphlops hamatus	Pale-headed Blind Snake						1	1				2
Ramphotypholops sp	WAM Field No LW04					1						1
VARANIDAE												
Varanus gouldii	Sand Goanna			2				1				3

Appendix C

Summary Table Describing Conservation Status

Status	Code	Description
Categories used in EPBC Act Protected Matters Report		
Endangered	EN	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	VU	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Migratory	M	Species migrate to, over and within Australia and its external territories.
Marine	Ma	Species naturally occur within marine areas within Australia and its external territories.
Schedules of the Western Australian Wildlife Conservation Act 1950		
Schedule 1	S1	Fauna that is rare or likely to become extinct.
Schedule 2	S2	Fauna that is presumed to be extinct.
Schedule 3	S3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds.
Schedule 4	S4	Fauna that is in need of special protection, otherwise than for the reasons mentioned above
Priority Fauna Codes used by the Western Australian DEC		
Priority 1 Taxa with few, poorly known populations on threatened lands.	P1	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2 Taxa with few, poorly known populations on conservation lands.	P2	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3 Taxa with several, poorly known populations, some on conservation lands	P3	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4 Taxa in need of monitoring	P4	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5 Taxa in need of monitoring	P5	Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix D

Preservation and Lodgement of Specimens: Arachnids and Myriapods. Version 4 (WAM 2010)

Preservation and Lodgement of Specimens
Arachnids and Myriapods

Version 4 (January 2010)

Preservation

All specimens are to be **fixed in ethanol** as rapidly as possible after collection.

Small specimens (e.g. pseudoscorpions, schizomids) preferably to be fixed in 100% ethanol. Otherwise 75% ethanol is fine.

As we may need well-preserved tissue for future DNA analysis, large specimens (e.g. scorpions, trap-door spiders) should be preserved as follows:

- Remove third left leg at point of specimen death using clean, small scissors (wash the scissors in water, and dry with clean paper towel between each specimen).
- Place leg in 100% ethanol in 2 ml Cryotube with screw cap (available from Interpath Service Pty Ltd, Melbourne).
- Preserve remainder of specimen in tube or jar (see below) in 75% ethanol.
- Include Cryotube in same jar as specimen.

Each container should contain a **unique coded identifier** that we can quote when supplying identifications.

Each container should contain a small printed label specifying the concentration of the ethanol (e.g. "100% ETOH" or "75% ETOH").

Storage

Specimens should be stored in suitable glass containers. **Plastic is not suitable as they deteriorate over time**. We have tested SAMCO glass vials (available e.g. at "Biolab" (http://www.selbybiolab.com.au/aushome.asp) or the Australian Entomological Supplies (http://www.entosupplies.com.au/?path=1_1_14_144) in respect to the detioration of the plastic lids, other makes should not be used!

- Smaller specimens should be stored in SAMCO "Specimen Tubes Soda Glass Poly Stopper" vials with push-in type caps, size ca. 50x19mm.
- Other vial sizes of SAMCO vials are available for different sized animals (see above suppliers).
- Larger specimens should be in small glass jars.

Keep specimens in cool place, ideally in a refrigerator.

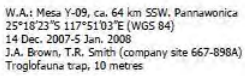
Labels
Each vial should contain a small, neatly trimmed printed label (max. size ca. 35mm x 10mm) with the following specifications:

- Arial 4.5 font
- Locality information should include: 1) the state (e.g. "WA:"); 2) a **reference to place listed on the Australian gazetteer** (http://www.ga.gov.au/map/names/). **Please do not use your internal project locality**! We use the information on the label to database specimens and it should be informative for future locality searches independent of your project!
- Use Latitudes and Longitudes (DD°MM'SS") **NOT UTMs or decimal degrees**. Seconds can be up to two digits after the comma. Specify the datum (e.g. WGS84, GDA94)
- Dates with month spelled out (abbreviated), **not as a numeral** and year NOT abbreviated (2008, NOT: '08)
- Collector data could also include your unique coded identifier (also possible on different label)
- Trapping method
- Habitat
- **Do not include an identification on the locality label**, as this identification might have to be corrected.

For example:

W.A.: Mesa Y-09, ca. 64 km SSW. Pannawonica
25°18'23"S 117°51'03"E (WGS 84)
14 Dec. 2007-5 Jan. 2008
J.A. Brown, T.R. Smith (company site 667-898A)
Troglofauna trap, 10 metres

In its final size this label looks as follows (it should not exceed 35mm width and five lines height (ca. 10mm)):

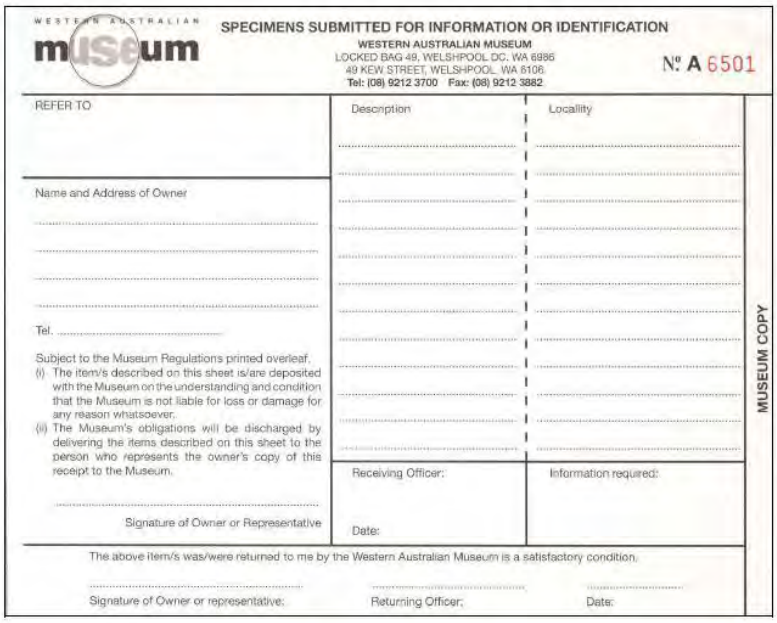


If the vial is suspected of containing multiple species, **ensure that sufficient labels are included** so that when we transfer specimens to new vials, we have enough labels.

Labels should be printed on uncoated, acid-free "Tablex System Board, 250 GSM" cut to A4 sheets (210 x 297mm). Available from Spicers Stationery, Bassendean (ph: 9279 6860) or e.g. see: http://www.edpaper.com.au/fine-paper/detail.php?range=259. The labels should be printed on a laser printer and baked in an oven @100°C for 20-30 minutes to fix the printing onto the card. Final fixation is achieved when the initially matt printing becomes glossy. Don't burn the paper, it should stay white! **Regular cardboard or paper (e.g. as available at OfficeWorks) is not suitable for long-term storage in ethanol!!**

Delivery

- Specimens should be delivered to the Western Australian Museum after an appointment is made with staff members.
- **Always ask for a receipt for the delivery of your specimens** on the following form, which is available from the reception or a staff member:



WESTERN AUSTRALIAN museum

SPECIMENS SUBMITTED FOR INFORMATION OR IDENTIFICATION

WESTERN AUSTRALIAN MUSEUM
LOCKED BAG 49, WELSHPOOL DC, WA 6986
49 KEW STREET, WELSHPOOL, WA 6106
Tel: (08) 9212 3700 Fax: (08) 9212 3882

Nº A 6501

REFER TO

Name and Address of Owner

Tel.

Subject to the Museum Regulations printed overleaf,
(i) The item/s described on this sheet is/are deposited with the Museum on the understanding and condition that the Museum is not liable for loss or damage for any reason whatsoever.
(ii) The Museum's obligations will be discharged by delivering the items described on this sheet to the person who represents the owner's copy of this receipt to the Museum.

Signature of Owner or Representative

Description

Locality

Receiving Officer:

Date:

Information required:

MUSEUM COPY

The above item/s was/were returned to me by the Western Australian Museum is a satisfactory condition.

Signature of Owner or representative:

Returning Officer:

Date:

- A **printed copy of the relevant locality data** should be supplied with the specimens, along with the name, address, telephone and email address of the company representative. An **electronic copy of the spreadsheet** containing the relevant data should be emailed to the Museum. We are currently (January 2010) developing an Excel spreadsheet template for providing electronic data to the WAM. Please inquiry if this spreadsheet is available before sending your data.

As we have an unprecedented amount of material to deal with, specimens will be returned without identification if not delivered to above specifications, in particular in relation to:

1) storage container (e.g. if not delivered in SAMCO vials) and;

2) labelling (e.g. labels not printed and cooked according to above format or not on Tablex Board).

Please help us to serve you faster by following these simple guidelines!

Prepared by Mark Harvey, Julianne Waldock and Volker Framenau

Appendix E

Short-Range Endemic Invertebrate Fauna of Lake Way and Lake Maitland, Western Australia (2007 & 2010)

(Framenau & Harvey 2010)

Report by Western Australian Museum (WAM133) - 1

The Short-Range Endemic Invertebrate Fauna of Lake Way and Lake Maitland, Western Australia (2007 & 2010)

Report to Outback Ecology

1 September 2010

Volker W. Framenau and Mark S. Harvey

Department of Terrestrial Zoology, Western Australian Museum,
Locked Bag 49, Welshpool DC, Western Australia 6986, Australia

Summary

The samples from Lake Way, 15km SSW of Wiluna, submitted to the Western Australian Museum on the 15th April 2010 (accession no. A6739) included mygalomorph spiders (Barychelidae: *Mandjelia*; Dipluridae: *Cethegus*; Idiopidae: *Eucyrtops*; Nemesiidae: *Aname*, *Kwonkan*), pseudoscorpions in two families (Atemnidae: *Oratemnus*; Olpiidae: *Beierolpium*, *Indolpium*) and scorpions in the families Buthidae (*Isometroides*, *Lychas*) and Urodacidae (*Urodacus*). A collection of mygalomorph spiders collected in 2007 at Lake Way and Lake Maitland received through Barbara Main (University of Western Australia) in August 2010 included members of the families Barychelidae (*Idiommata*, *Synothele*), Ctenizidae (*Conothele*) and Nemesiidae (*Aname*, *Kwonkan*).

Putative short-range endemics include:

- ***Aname*** **`MYG173`** (Nemesiidae): currently only known from a single male from the survey at Lake Way (2010).
- ***Aname*** **`MYG176` & `MYG177`** (Nemesiidae): two similar 'red-headed *Aname*', but distinctly different to other species in this group; currently only known from the Lake Way collection (2010).
- ***Kwonkan*** **`MYG175`** (Nemesiidae): large species of *Kwonkan*; found during the surveys in 2007 (Lake Maitland) and 2010 (Lake Way).
- ***Kwonkan*** **`MYG194`** (Nemesiidae): large species of *Kwonkan*, distinctly different to *Kwonkan* `MYG175` by colouration and genital morphology. Only known from the single male collected at Lake Maitland (2007)
- ***Urodacus*** **`yeelirrie`** (Urodacidae): currently known from Yeelirrie and Lake Way only and therefore considered a short-range endemic; vulnerable as both sites are proposed for mining developments.

Short-Range Endemism

The terrestrial invertebrate fauna of inland Australia contains a plethora of species, and just the arthropods were recently estimated to consist of more than 250,000 species (Yeates *et al.* 2004; Chapman 2009). The vast majority of these are found within the Insecta and Arachnida, although significant numbers of millipedes are to be expected. For many years, the prospect of including invertebrates in assessments of biological systems subject to alteration proved daunting and were largely ignored as being too diverse and too difficult to comprehend to satisfy the rapid turn-around needed for environmental surveys.

In a recent publication, the issue of Short-Range Endemism in the Australian invertebrate fauna was examined (Harvey 2002), and series of major groups were nominated as having a very high proportion of individual species that satisfied a certain set of criteria. The main criterion nominated for inclusion as a Short-Range Endemic (SRE) was that the species had a naturally small range of less than 10,000 km^2. Harvey (2002) found that those species possessed a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

The Western Australian fauna contains a number of SRE taxa, including millipedes, land snails, trap-door spiders, some pseudoscorpions, slaters, and onychophorans and these represent focal groups in Environmental Impact Assessment studies in the state (EPA 2009). The south coast region is relatively well known compared with other regions of the state (Framenau *et al.* 2008), but there are many poorly known species and gaps in our understanding of the distributions of many species.

Methods

Terrestrial invertebrates (mygalomorph spiders, pseudoscorpions, and scorpions) that were collected by *Outback Ecology* at Lake Way, 15km SSW of Wiluna in 2010, were submitted to the Western Australian Museum on 15th April 2010 and were examined using Leica dissecting microscopes (MZ6, MZ16). Additional material from Lake Way and Lake Maitland collected by *Outback Ecology* staff in 2007 was received through Barbara Main (University of Western Australia). This material was critically reviewed and compared with the material collected in 2010.

ARANEAE (spiders)

Infraorder Mygalomorphae (Trapdoor Spiders)

Mygalomorph ("trapdoor") spiders belong to one of the focal groups in surveys of short-range endemic taxa (Harvey 2002). Many mygalomorph spiders show low dispersal capabilities, may be restricted to relictual habitats, and have long life cycles with low fecundity. A number of mygalomorph spiders, e.g. *Aganippe castellum*, *Idiosoma nigrum*, *Kwonkan eboracum*, *Moggidgea tingle*, are listed on Schedule 1 ("Fauna that is rare or likely to become extinct" of the Wildlife Conservation (Specially Protected Fauna) Notice 2008 of the Western Australian Government. The Western Australian mygalomorph fauna is vast and, despite long-term and ongoing research by Drs Barbara Main (University of Western Australia) and Robert Raven (Queensland Museum), remains taxonomically poorly known for many families and genera (e.g. Barychelidae: *Idiommata*; Idiopidae: *Aganippe*; Nemesiidae: *Aname*, *Chenistonia*, *Kwonkan*).
The best taxonomic features to distinguish mygalomorph spiders are found within the genitalia of males. Females or juveniles may be indistinguishable, although burrow morphology may allow identification to species level in some cases (B.Y. Main, personal communication). The Western Australian Museum has recently initiated a reference collection of male mygalomorph morphospecies to facilitate an assessment of distribution patterns of these spiders. This collection is assembled in cooperation with Dr Barbara Main and will eventually be consolidated with her collection at the University of Western Australia. Mygalomorph morphospecies are consecutively numbered ("MYG001", "MYG002" etc.) to allow a comparison of taxa between different surveys.

Family Barychelidae

Members of the Barychelidae, the "Brush-footed Trapdoor Spiders" are cryptic spiders. Their burrow often lacks the firm and thick door of the Idiopidae or the extensive web of the Dipluridae (Raven 1994).

***Mandjelia* `wanjarri` (family Barychelidae)**

The genus *Mandjelia* currently includes 19 Australian species, but only two are known from Western Australia (Raven 1994). An undescribed species, *Mandjelia* `*wanjarri*` (R. Raven, ms name) from near Wiluna and Leinster was recently discovered in the collection of the Western Australian Museum. It was subsequently also reported from the Mt Keith minesite and Lorna Glen Station. A single male of *Mandjelia* `wanjarri` was collected at Lake Way during the Outback Ecology surveys (Appendix 1). Whilst this species is currently known from a limited range, it is here not considered a short-range endemic pending further collections from the region.

***Idiommata* sp. (juv.) (family Barychelidae)**

The genus *Idiommata* includes large to very large Brush-footed Trapdoor Spiders and includes four Australian species of which one, *I. blackwalli*, is known from Western Australia. The genus is taxonomically poorly known and was not treated in Raven's (1994) revision of the Barychelidae. It is currently impossible to say if the immature specimen from Lake Way (Appendix 2) represents a short-range endemic species.

***Synothele meadhunteri* Raven, 1994 (family Barychelidae)**

The genus *Synothele* is presumably widespread throughout Western and South Australia and a number of species are currently described from Western Australia, some of them with narrow known distributions (Raven 1994). *Synothele meadhunteri* has been collected in Western Australia and South Australia; it is not a short-range endemic species.

Family Ctenizidae

***Conothele* sp.**

Members of the genus *Conothele*, the only Australian genus within the Ctenizidae, are found across much of arid and semi-arid Western Australia, where they generally dig burrows in soil which are sealed with a tight-fitting lid that is usually very difficult to find.

The taxonomic status of the Western Australian fauna is very uncertain, with the entire fauna representing unnamed species. The precise distributions of each species is unknown, and much taxonomic work on this genus is required before the status of individual populations can be ascertained. It is currently impossible to say if the specimens from Lake Way (2007) (Appendix 2) represent short-range endemic species.

Family Dipluridae

Members of the mygalomorph spider family Dipluridae are represented in Western Australia mainly by the genus *Cethegus*. Diplurids are known as curtain-web spiders due to the shape of their webs, which consist of numerous strands of silk hanging across the entrance of their burrows. They are usually constructed at the base of trees or against logs.

***Cethegus* sp. (family Dipluridae)**

The genus *Cethegus* is represented in Western Australia by one named species, *C. fugax* Simon (Main 1960; Raven 1981), and several unnamed species. The Western Australian Museum has records from many different regions of the state. The status and distribution of these species are not well understood and detailed taxonomic work is needed to understand the Western Australian fauna. Male specimens are required for accurate species identification, but the Lake Way collection consists of a juvenile (Appendix 1). It is unlikely that this specimen represent a short-range endemic species.

Family Idiopidae

The mygalomorph spider family Idiopidae includes a number of genera in Western Australia, including *Anidiops*, *Gaius*, *Arbanitis*, *Euoplos*, *Blakistonia*, *Cataxia*, *Eucyrtops*, *Idiosoma* and *Misgolas* (Main 1985; Raven and Wishart 2005). They comprise the 'typical' trap door spiders, i.e. those species that usually close the burrow with a hinged door. Spiders of this family are abundant, in particular in relatively stable habitats in temperate to tropical regions (Main 1985).

***Eucyrtops* sp. (juv.) (Idiopidae)**

A single juvenile idiopid specimen, possibly representing the genus *Eucyrtops*, was recovered from Lake Way (2010) (Appendix 1). Males carry the distinguishing morphological features in mygalomorph spiders and it is therefore impossible to comment on the conservation status of this species.

Specimens of *Eucyrtops* listed in a report by Barbara Main to *Outback Ecology* (17 April 2008) were not received and could not be compared with the juvenile from the 2010 survey.

***Aganippe* sp. A (Idiopidae)**

A juvenile *Aganippe* was reported by Barbara Main to *Outback Ecology* (17 April 2008) from Lake Way (site NLW05). This specimen was not received and could not be sighted. However, without the examination of males it remains impossible to ascertain distribution and conservation status of this species.

***Aganippe* sp. (*A. "occidentalis group"*) (Idiopidae)**

A female *Aganippe*, possible from the *A. occidentalis*-group, was listed in a report by Barbara Main to *Outback Ecology* (17 April 2008) from Lake Way (site NLW09). This specimen was not received and could not be sighted. However, without the examination of males it remains impossible to ascertain distribution and conservation status of this species.

Family Nemesiidae

Members of the mygalomorph spider family Nemesiidae are represented in Western Australia by several genera, including *Aname*, *Chenistonia*, *Yilgarnia*, *Stanwellia*, *Teyl*, *Kwonkan* and *Swolnpes* (Main and Framenau 2009). They usually dig burrows in the soil, and do not cover their burrow entrances with lids.

Genus *Aname*

The genus *Aname* is very well represented in the Western Australian fauna by eight named and numerous unnamed species. The Western Australian Museum has records from many different regions of the state, but only a small proportion of males in the collection have been incorporated in our reference database. Distribution and conservation status of many species are not well understood and detailed taxonomic work is needed to understand the Western Australian fauna.

***Aname* `MYG173` (Nemesiidae)**

A single male of *Aname* `MYG173` was recovered at Lake Way (Appendix 1). This is a large and comparatively dark species and similar species are present in the reference collection of the Western Australian Museum. However, the genital morphology of this species is unique and it is currently not known from anywhere else in Western Australia. It is possible, that *Aname* `MYG173` represents a short-range endemic species.

***Aname* `MYG176` & `MYG177` (Nemesiidae)**

In comparison to *Aname* `MYG173`, both *Aname* `MYG176` and *Aname* `MYG177` are smaller and very different in colouration, with a light brown/yellow carapace and dark red cephalic region. These 'red-headed' *Aname* are very common in the northern parts of Western Australia and were the most common group of the genus in the recent DEC Pilbara survey. Recent molecular analyses suggest that this complex consists of a number of very closely related species with narrow ranges (F. Harvey, M. Rix, unpublished data). Species in this group are very difficult to distinguished based on male morphology. However, the two species from Lake Way differ considerably in genital morphology from those spiders collected in the Pilbara. Currently, these spiders are not present in the reference collection of the Western Australian Museum and it is possible that both, *Aname* `MYG176` and *Aname* `MYG177` represent short-range endemic species.

***Aname* sp. B (female) *armigera* group (Nemesiidae)**

The *Aname armigera*-group includes comparative large and pale spiders, different to the species listed above (*Aname* MYG173, 176, 177). A number of females and a juvenile were collected from Lake Maitland (2007) (Appendix 2), however, examination of mature males is required to ascertain the distribution and conservation status of this species. Based on our current knowledge of the group it is unlike that spiders of the *Aname armigera*-group represent short-range endemic species.

***Aname* sp. B (Nemesiidae)**

Females of an "*Aname* sp. B" were reported by Barbara Main from Lake Maitland. We cannot confirm these to be mature females as they did not have any sign of developed spermathecae. These speciemens could be juveniles of *Aname* `MYG176`, `MYG177` or the *Aname armigera*-group.

Kwonkan `MYG175` & `MYG194` (Nemesiidae)

The genus *Kwonkan* is restricted to Western Australia and currently includes six named species (Main 1977; Main 1983). All of these are currently known from their type specimens only. *Kwonkan eboracum* from the York region is listed on Schedule 1 ("Fauna that is rare or likely to become extinct") of the Wildlife Conservation (Specially Protected Fauna) Notice 2008. *Kwonkan* includes those nemesiid spiders that have spines on their pedal tarsi.

The collection from Lake Way (2010) included a single species of *Kwonkan* ('MYG175') that was also reported by Barbara Main as "*Kwonkan* sp. B". from lake Maitland. The species is currently only known from these two localities and it remains possible that it represents a short-range endemic species. Kwonkan `MYG194` was reported as "*Kwonkan sp. A*." by Barbara Main. In contrast to B. Main, we consider this species distinctly different to *Kwonkan* `MYG175` based on colouration, leg spination and genital morphology. Kwonkan `MYG194` is currently only known from collection at Lake Maitland (2007) (Appendix 2) and it is possible that it represents a short-range endemic species.

PSEUDOSCORPIONS

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats. The material from Lake Way included members of the families Atemnidae and Olpiidae (Appendix 1).

Family Atemnidae

***Oratemnus* sp. (family Atemnidae)**

A single juvenile of *Oratemnus* was collected during the survey near Lake Way (Appendix 1). Atemnids are frequently found under bark of trees in Western Australia, but the systematics of the group, particularly of the genus *Oratemnus*, is uncertain and the taxonomy of individual species unclear. However, based upon current evidence, it seems that most species will eventually be found to be widely distributed. For this reason, we do not believe that this represents a short-range endemic species.

Family Olpiidae

***Beierolpium* 'sp. 8/2' (family Olpiidae)**

Beierolpium 'sp. 8/2' was collected at a single site near Lake Way (Appendix 1) The systematic status of members of this genus has not been fully assessed. At present it is not possible to firmly establish the identity of these species until a complete systematic revision of the Western Australian members of *Beierolpium* is undertaken. It is possible that these specimens represent short-range endemic species, but a full taxonomic revision of the genus *Beierolpium* in Western Australia is necessary to confirm their status.

***Indolpium* sp. (family Olpiidae)**

Three specimens of this pseudoscorpion genus were collected at during the survey at Lake Way Station (Appendix 1). The specimens comprise a single species and extremely similar specimens have been collected from other regions of Western Australia, suggesting that only a single species is involved. Based on our current levels of knowledge, it appears that this species is not a short-range endemic species.

SCORPIONS

***Isometroides* (family Buthidae)**

Two specimens of the scorpion genus *Isometroides* were collected at Lake Way (Appendix 1). The genus is fairly diverse throughout the arid and semi-arid centre of Australia and also commonly collected throughout Western Australia. However, its taxonomy is poorly resolved and species identification is not possible (E. Volschenk personal communication). *Isometroides* is unlikely to include short-range endemic species.

***Lychas* (family Buthidae)**

Species of *Lychas* are abundant across all of mainland Australia (Koch 1977), as well as adjacent parts of south-eastern Asia. All species are generally quite small with slender pedipalps and mottled colouration. Four species were collected during the recent surveys at Lake Way (Appendix 1).

***Lychas `adonis`* Volschenk, ms name (family Buthidae)**

A single male of *Lychas `adonis`* was found at Lake Way (Appendix 1). This species is common throughout Western Australia with numerous specimens in the collection of the Western Australian Museum. It is not a short-range endemic species.

***Lychas `splendens`* Volschenk, ms name (family Buthidae)**

This scorpion species is widespread across southern Western Australia, and is found throughout much of the WA Wheatbelt. It is typically known from different semi-arid habitats. It is not a short-range endemic species.

***Lychas annulatus* (family Buthidae)**

Two specimens of *L. annulatus* were found at Lake Way (Appendix 1). This species is common throughout Western Australia with more than 350 records in the collection of the Western Australian Museum. It is not a short-range endemic species.

***Lychas jonesae* (family Buthidae)**

Lychas jonesae is widely distributed across Australia including the more arid areas of Western Australia. Numerous colour forms of this species exist. It is not a short-range endemic species.

***Urodacus* (family Urodacidae)**

The scorpion genus *Urodacus* is endemic to mainland Australia where 20 named species (Koch 1977; Volschenk *et al.* 2000) and at least 70 new species (E. Volschenk, unpublished data) occur. The Western Australian fauna is extremely diverse with high numbers of new species and, although numerous short range endemic species are known, others are more widespread with relatively wide distributions.

***Urodacus `gibson3`* Volschenk, name (family Urodacidae)**

Urodacus `gibson3` has been collected from several locations to date. This species is known from the Laverton area as well as the vicinity of Mt. Gibson. Based on its currently known distribution pattern in combination with its presumed habitat preferences, this species is not considered a short-range endemic (E. Volschenk, personal communication).

***Urodacus* `laverton2`**

Urodacus `laverton2` has a similar distribution as *Urodacus `gibson3`* and similar criteria for its conservation status apply. It is currently not considered a short-range endemic based on its collection records and presumed habitat preferences (E. Volschenk, personal communication).

***Urodacus* `yeelirrie`**

Urodacus `yeelirrie` is a member of a species complex containing some 20–30 morphospecies previously lumped in *Urodacus armatus*. Most of these species are known from only a handful of specimen and therefore their distribution patterns remain poorly known. The species

identified here as *Urodacus `yeelirrie`* is only known from survey efforts at Yeelirrie and nearby Lake Way (E. Volschenk, personal communication). *Urodacus `yeelirrie`* is likely to be a short-range endemic species and populations might be vulnerable as they are currently only known from areas proposed for mining developments.

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Appendix 1. Location data of SRE survey from Lake Way (2010)

REGNO	FLDNO	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	MALE	FEMALE	JUV
101219	2-2E	Araneae	Barychelidae	*Mandjelia*	*`wanjarri`*	26°50`33"S	120°21`47"S	1	0	0
101220	4-4D	Araneae	Barychelidae	*`indet.`*	`sp. (juv.)`	26°41`11"S	120°19`12"S	0	0	1
101221	5-5I	Araneae	Dipluridae	*Cethegus*	`sp. (juv.)`	26°41`11"S	120°19`12"S	0	0	1
101222	4-4D	Araneae	Idiopidae	*Eucyrtops*	`sp. (fem.)`	26°41`11"S	120°19`12"S	0	1	0
101214	7-7B	Araneae	Nemesiidae	*Aname*	`MYG173`	26°50`42"S	120°18`43"S	1	0	0
101211	4-4E	Araneae	Nemesiidae	*Aname*	`MYG176`	26°41`11"S	120°19`12"S	1	0	0
101212	4-4A	Araneae	Nemesiidae	*Aname*	`MYG176`	26°41`11"S	120°19`12"S	1	0	0
101213	3-3E	Araneae	Nemesiidae	*Aname*	`MYG176`	26°41`07"S	120°18`51"S	1	0	0
101210	6-6C	Araneae	Nemesiidae	*Aname*	`MYG177`	26°50`25"S	120°19`42"S	1	0	0
101215	SRE2-SRE2A	Araneae	Nemesiidae	*Aname*	`sp. (fem.)`	26°41`05"S	120°18`01"S	0	1	0
101218	2-2C	Araneae	Nemesiidae	*Aname*	`sp. (fem.)`	26°50`33"S	120°21`47"S	0	1	0
101216	3-3C	Araneae	Nemesiidae	*Aname*	`sp. (juv.)`	26°41`07"S	120°18`51"S	0	0	1
101217	3-3A	Araneae	Nemesiidae	*Aname*	`sp. (juv.)`	26°41`07"S	120°18`51"S	0	0	1
101209	1-1D	Araneae	Nemesiidae	*Kwonkan*	`MYG175`	26°50`28"S	120°21`47"S	1	0	0
101259	4-4H	Pseudoscorpiones	Atemnidae	*Oratemnus*		26°41`11"S	120°19`12"S	0	0	1
101260	4-4I	Pseudoscorpiones	Olpiidae	*`indet.`*		26°41`11"S	120°19`12"S	0	0	1
101257	2-2C	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/2`	26°50`33"S	120°21`47"S	0	1	0
101258	SRE6-SRE6H	Pseudoscorpiones	Olpiidae	*Indolpium*		26°42`55"S	120°22`41"S	0	0	1
101261	5-5K	Pseudoscorpiones	Olpiidae	*Indolpium*		26°41`11"S	120°19`12"S	0	0	1
101262	6-6F	Pseudoscorpiones	Olpiidae	*Indolpium*		26°50`25"S	120°19`42"S	0	0	1
101255	5-5E	Scorpiones	Buthidae	*Isometroides*		26°41`11"S	120°19`12"S	0	0	1
101256	11-11C	Scorpiones	Buthidae	*Isometroides*		26°38`49"S	120°06`16"S	1	0	0
101228	3-3B	Scorpiones	Buthidae	*Lychas*	*`adonis`*	26°41`07"S	120°18`51"S	1	0	0
101231	7-7A	Scorpiones	Buthidae	*Lychas*	*`splendens`*	26°50`42"S	120°18`43"S	1	0	0
101223	5-5B	Scorpiones	Buthidae	*Lychas*	*annulatus*	26°41`11"S	120°19`12"S	0	0	0
101232	5-5D	Scorpiones	Buthidae	*Lychas*	*annulatus*	26°41`11"S	120°19`12"S	0	1	0
101224	1-1B	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`28"S	120°21`47"S	0	1	0
101225	SRE3-SRE3B	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°43`44"S	120°15`44"S	1	0	0
101226	2-2F	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`33"S	120°21`47"S	1	0	0

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101227	1-1C	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`28"S	120°21`47"S	0	1	0
101229	2-2A	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`33"S	120°21`47"S	1	0	0
101230	2-2B	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`33"S	120°21`47"S	1	0	0
101233	2-2D	Scorpiones	Buthidae	*Lychas*	*jonesae*	26°50`33"S	120°21`47"S	1	0	0
101235	3-3D	Scorpiones	Urodacidae	*Urodacus*	*`gibson 3`*	26°41`07"S	120°18`51"S	0	0	1
101251	5-5H	Scorpiones	Urodacidae	*Urodacus*	*`gibson 3`*	26°41`11"S	120°19`12"S	0	0	0
101253	11-11B	Scorpiones	Urodacidae	*Urodacus*	*`gibson 3`*	26°38`49"S	120°06`16"S	1	0	0
101240	SRE6-SRE6G	Scorpiones	Urodacidae	*Urodacus*	*`laverton2?`*	26°42`55"S	120°22`41"S	0	0	1
101246	SRE6-SRE6E	Scorpiones	Urodacidae	*Urodacus*	*`laverton2?`*	26°42`55"S	120°22`41"S	0	0	1
101247	SRE6-SRE6F	Scorpiones	Urodacidae	*Urodacus*	*`laverton2?`*	26°42`55"S	120°22`41"S	0	0	1
101248	SRE6-SRE6D	Scorpiones	Urodacidae	*Urodacus*	*`laverton2?`*	26°42`55"S	120°22`41"S	0	0	1
101249	SRE6-SRE6C	Scorpiones	Urodacidae	*Urodacus*	*`laverton2?`*	26°42`55"S	120°22`41"S	0	0	1
101237	SRE6-SRE6A	Scorpiones	Urodacidae	*Urodacus*	*`laverton2`*	26°42`55"S	120°22`41"S	0	0	1
101244	5-5G	Scorpiones	Urodacidae	*Urodacus*	*`laverton2`*	26°41`11"S	120°19`12"S	1	0	0
101245	SRE6-SRE6B	Scorpiones	Urodacidae	*Urodacus*	*`laverton2`*	26°42`55"S	120°22`41"S	0	1	0
101234	SRE3-SRE3C	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie?`*	26°43`44"S	120°15`44"S	0	0	1
101236	1-1A	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°50`28"S	120°21`47"S	0	0	1
101238	SRE4-SRE4B	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°44`44"S	120°16`12"S	1	0	0
101239	SRE3-SRE3A	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°43`44"S	120°15`44"S	0	0	1
101241	SRE4-SRE4C	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°44`44"S	120°16`12"S	1	0	0
101242	6-6B	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°50`25"S	120°19`42"S	0	0	0
101243	6-6A	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°50`25"S	120°19`42"S	1	0	0
101250	4-4C	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°41`11"S	120°19`12"S	0	0	1
101252	6-6D	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°50`25"S	120°19`42"S	1	0	0
101254	11-11A	Scorpiones	Urodacidae	*Urodacus*	*`yeelirrie`*	26°38`49"S	120°06`16"S	0	1	0

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Appendix 2. Location data of SRE survey from Lake Way and Lake Maitland (2007)

REGNO	FLDNO	FAMILY	GENUS	SPECIES	SITE	NO
104710	BYM2007/3	Barychelidae	*Idiommata*	`sp. (juv.)`	Lake Way - 15km SE of Wiluna, site NLW-02-D	1
104696	BYM2007/05	Barychelidae	*Synothele*	*meadhunteri*	Lake Way - 15km SE of Wiluna, site NLW-04-E	1
104701	BYM2007/81	Ctenizidae	*Conothele*		Lake Maitland - 100km SE of Wiluna, site LM-01-G	1
104704	BYM2007/80	Ctenizidae	*Conothele*		Lake Maitland - 100km SE of Wiluna, site LM-02-T	1
104695	BYM2007/72	Nemesiidae	*Aname*	`sp. (fem), *armigera* gp`	Lake Maitland - 100km SE of Wiluna, site LM-02-D	1
104705	BYM2007/71	Nemesiidae	*Aname*	`sp. (fem), *armigera* gp`	Lake Maitland - 100km SE of Wiluna, site LM-08	1
104711	BYM2007/9	Nemesiidae	*Aname*	`sp. (fem), *armigera* gp`	Lake Way - 15km SE of Wiluna, site NLW-02-B	1
104712	BYM2007/10	Nemesiidae	*Aname*	`sp. (fem), *armigera* gp`	Lake Way - 15km SE of Wiluna, site NLW-02-C	1
104702	BYM2007/04	Nemesiidae	*Aname*	`sp. (juv), *armigera* gp`	Lake Way - 15km SE of Wiluna, site NLW-05-E	1
104699	BYM2007/13	Nemesiidae	*Aname*	`sp. (juv.)`	Lake Maitland - 15km SE of Wiluna, site NLW-01-D	1
104703	BYM2007/12	Nemesiidae	*Aname*	`sp. (juv.)`	Lake Maitland - 15km SE of Wiluna, site NLW-01-D	1
104706	BYM2007/68	Nemesiidae	*Aname*	`sp. (juv.)`	Lake Maitland - 100km SE of Wiluna, site LM-05-A	3
104708	BYM2007/73	Nemesiidae	*Aname*	`sp. (juv.)`	Lake Maitland - 100km SE of Wiluna, site LM-01-V	1
104707	BYM2007/11	Nemesiidae	*Aname*		Lake Way - 15km SE of Wiluna, site NLW-05-A	1
104694	BYM2007/84	Nemesiidae	*Kwonkan*	`MYG175`	Lake Maitland - 100km SE of Wiluna, site LM-05-I	1
104697	BYM2007/82	Nemesiidae	*Kwonkan*	`MYG175`	Lake Maitland - 100km SE of Wiluna, site LM-05-H	1
104698	BYM2007/83	Nemesiidae	*Kwonkan*	`MYG194`	Lake Maitland - 100km SE of Wiluna, site LM-03-F	1

Appendix F

Terrestrial Isopod Identification for Job Code TWI-FS-1009 Lake Way Study Area

(Judd 2010)

Dr Simon Judd
34 Shardlow Loop
Carine
Western Australia. 6020.
simon_judd@iprimus.com.au
Tel: 0429 020 042

Outback Environment
1/71 Troy Terrace
Jolimont
Western Australia. 6014.

Attn: Kimberly Moiler

4th May 2010

Re: Terrestrial Isopod Identification for Job Code TWI-FS-1009 Lake Way Study Area

I have examined the specimens received. There were two species both from the family Armadillidae.

Budddelundia sp.
Material Examined
5A* (1♀ Good Specimen), 5C* (1♀ Good Specimen) 5F (1♂ Poor Specimen), 5J (1♀ Poor Specimen), SRE4D (1♀ Poor Specimen). Total 5 Specimens.

This is an undescribed (probably) species of *Buddelundia* which is common to the arid zone. No *Buddelundia* can be identified to species level without reference to type material. This is the most common isopod in the arid zone. Three of the specimens had dried out before preservation and are brittle and difficult to work with. The other two are excellent and are marked with an asterisk. I will lodge them at the WAM on your behalf. The others are not worth keeping. Please let me know if you need them back.

Spherillo sp. 2
Material Examined
SRE2D (1 specimen)

Isopods like this are often very small and tightly rolled and it is not possible to determine the sex without dissecting them. This appears to be an adult specimen although it is impossible to tell for sure without more material. *Spherillo* is common in WA. No species of *Spherillo* are yet described from WA but the genus is widespread, particularly in drier areas. It is very likely that *Spherillo* in WA will represent a new genus but this work is yet to be done. However, I see isopods like this a lot and it is probably widespread and common. It is similar to a species that occurs north of Perth and in the Pilbara and this specimen is highly unlikely to represent a SRE species. However, I can't be definite without a complete review of the genus. I will keep it in my reference collection and if any more information becomes available I will let you know. Please contact me if you require more information.

Yours sincerely,

Simon Judd.

Appendix G

Land Snails from the area of Lake Way, Western Australia

(Whisson & Slack-Smith 2010)

Report to ***Outback Ecology***

Land Snails from the area of Lake Way, Western Australia.

collected by *Outback Ecology* during March 2010

Corey Whisson and Shirley Slack-Smith

May 2010

Department of Aquatic Zoology (Molluscs), Western Australian Museum
Locked Bag 49, Welshpool DC, Western Australia 6986

Background

Four lots of land snail specimens were collected by the environmental consultancy *Outback Ecology* during a faunal survey carried out between the 10th and 14th March 2010 of the area of the Wiluna Uranium Project near Lake Way - approximately 15 kilometres SSE of Wiluna, Western Australia. These specimens were presented to the Mollusc Section of the Western Australian Museum for identification and comment on the 15th April, 2010 (Accession Form A6740).

Specimen data, giving the site numbers for those sites at which snail specimens were collected, their co-ordinates, the collecting method employed and the vegetation types at each site were provided with the specimens (see Appendix A). No information was provided on the survey sites at which snails were not found; detailed habitats of the sites (successful and unsuccessful) or on the spatial relationship of all of the sites to the tenement boundaries.

This report follows that submitted to *Outback Ecology* on an earlier survey on the non-marine molluscs from the Lake Way area in October 2007 (Slack-Smith and Whisson 2008).

Procedures

The land snail specimens received from *Outback Ecology* were examined under a *Leica* MZ95 dissecting microscope. They were compared with dry and preserved specimens in the Molluscan Collections of the Western Australian Museum and with descriptions and figures in relevant publications.

As we have limited material from the Lake Way area, all survey specimens have been registered and deposited into the Western Australian Museum's Mollusc Collection.

Results

The land snails collected during this survey belong to the terrestrial pulmonate family Pupillidae and to the genera *Pupoides* (see Table 1).

The species identified from this survey are considered to form part of the indigenous Western Australian fauna.

Table 1. Land snail identifications from *Outback Ecology's* survey of the Lake Way area in March 2010.

Site	Family	Identification	Authority	No. Specimens	Registration No.
3-3F	Pupillidae	*Pupoides* sp.		1 dead juvenile	WAM S65387
4-4G	Pupillidae	Pupoides sp. cf. *P. beltianus*	(Tate, 1894)	2 dead adults	WAM S65388
6-6E	Pupillidae	Pupoides sp. cf. *P. beltianus*	(Tate, 1894)	33 dead juveniles & adults	WAM S65385
SRE2B	Pupillidae	Pupoides sp. cf. *P. beltianus*	(Tate, 1894)	9 dead juveniles & adults	WAM S65386

Family Pupillidae

The distributional range of the family Pupillidae is almost worldwide. However the pupillid fauna of Western Australia has been poorly collected except along the main roads of the more coastal areas of the State and along the main inland roads. As most of those collected specimens were dead-taken, it has been difficult to distinguish congeneric species, because of their generally conservative shell characters.

Sub-family Pupillinae

Pupoides sp. cf. *P. beltianus* (Tate, 1894)

The specimens collected during this survey most closely resemble the central Australian species *Pupoides beltianus* (Tate, 1894).

The known distributional range of *P. beltianus* encompasses an area from the Reynolds and Jervois Ranges in the Northern Territory; south to the Musgrave and Mann Ranges in South Australia and then west to the Barrow Ranges in Western Australia, which are situated near the junction of the borders of Western Australia, South Australia and the Northern Territory (Solem 1988).

In his 1986 and 1988 publications, Dr Solem suggested that the distribution of that species in Western Australia may extend as far north-west as the Hamersley Ranges and as far west as the Shark Bay area. However, because of variation in the shell morphology between the specimens from the more western areas of WA and those of central Australia, he listed the former only as *Pupoides* sp. aff. *P. beltianus*, indicating a doubt as to their conspecificity.

Dead-taken specimens from the previous *Outback Ecology* survey of the Lake Way area in October 2007 were tentatively identified as *Pupoides ?adelaidae*, because of their large size and because, at the time, there was insufficient material available to confidently differentiate between the species *P.adelaidae* (Adams & Angas, 1864) and *P.beltianus* (Tate, 1894) (Slack-Smith and Whisson 2008). Re-examination of these 2007 specimens plus others obtained since from nearby areas, indicate that they most closely resemble *P.beltianus*.

Pupoides sp.

It is not possible to assign a specific name to the single dead-taken juvenile sinistral shell collected at site 3-3F during this survey.

Based on the specimen's shell size, it most closely resembles *P. myoporinae* (Tate, 1880). That species has a wide but apparently-disjunct distribution across most of southern Australia, with known populations extending westwards from Yalata in South Australia to Hines Hill in Western Australia, and with a more restricted eastern range from the Eyre Peninsula to Bannerton in Victoria (Solem 1986, Solem 1991).

Discussion

None of the specimens collected - including the juvenile specimen - belong to species that could be regarded as exhibiting short range endemism.

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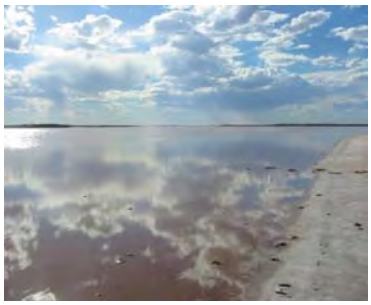
Appendix A. Outback Ecology's survey Sites containing mollusc specimens; collected during March 2010

Site No.	Collecting Date	Collecting Method	Locality	Coordinates (GPS) WGS84		Habitat	Collector
3-3F	10/03/2010	Soil sample	15km SSE of Wiluna; Lake Way	26°41`07"S	120°18`51"E	*Eucalypt woodland*	Bolton, P.
4-4G	14/03/2010	Soil sample	15km SSE of Wiluna; Lake Way	26°41`11"S	120°19`12"E	Mulga over chenopod shrubland	Bolton, P.
6-6E	14/03/2010	Soil sample	15km SSE of Wiluna; Lake Way	26°50`25"S	120°19`42"E	Open Mulga over calcrete	Bolton, P.
SRE2B	12/03/2010	Soil sample	15km SSE of Wiluna; Lake Way	26°41`05"S	120°18`01"E	*Melaleuca* floodplain	Bolton, P.



Mega Redport Pty Ltd

Lake Maitland Baseline Terrestrial Fauna Survey

June, 2008

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Lake Maitland Baseline Terrestrial Fauna Survey

Distribution:

Company	Copies	Contact Name
Mega Redport	1	Mr David Button

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Author	Reviewer	Signature	Date of Issue
Andre Schmitz	AS		14/01/08
Andre Schmitz, Paul Bolton	S.Perry, T.File, D.Jasper		5/06/08
Paul Bolton	D. Jasper		20/1/09

Executive Summary

Mega Redport Pty Ltd (Mega Redport) is currently undertaking a definitive feasibility study (DFS) for the development of the Lake Maitland Uranium Deposit, in the Murchison region of Western Australia.

The project area is located in the vicinity of the northern portion of Lake Maitland, approximately 95 km north-east of Leinster, 105 km south-east of Wiluna, and situated on the Barwidgee Pastoral Lease. The site lies within the Eastern Murchison sub-region (MUR1) of the Murchison Bioregion, which is characterised by its internal drainage, areas of red sandplains, salt lake systems associated with an occluded Palaeodrainage system, broad plains of red-brown soils and breakaway complexes.

Mega Redport commissioned Outback Ecology Services (OES) to undertake multi-seasonal baseline fauna surveys over the project area during 2007. The overall objectives of the terrestrial fauna baseline study for Lake Maitland were to:

- Develop an inventory of terrestrial vertebrate fauna species, and selected invertebrate fauna considered as potential short-range endemics (SREs), identified from the project area or likely to be present within the project area. This incorporated a desktop review of available information, a reconnaissance survey to verify the background information and further delineate habitat variables, and two comprehensive surveys at the locality.
- Assess site information in the regional context by comparisons with available data from other localities within the bioregion, and to provide an assessment of current and potential impacts on significant fauna populations and habitats.
- Provide quantitative data that can provide a baseline against which future impacts and rehabilitation can be assessed, and form the basis of a monitoring program.

This report provides information pertaining to two surveys undertaken during autumn and summer 2007. The fauna surveys were a component of a broader assessment undertaken concurrently by OES that also considered vegetation and flora, aquatic ecology, stygofauna and soils.

Database searches were made prior to the field surveys and a review of publicly-available literature was also undertaken to provide a list of mammals, reptiles, amphibians and birds that have the potential to occur over the study area. Communications were undertaken with appropriate Western Australian Museum (WAM) specialists to determine groups of SRE invertebrates thought most likely to occur over the project area, and to establish the vertebrate species required for vouchering.

An initial reconnaissance survey of the project area was undertaken over a four day period during January 2007. The aim of the reconnaissance survey was to verify the desktop study and further delineate habitats in regard to topography, wildfire, vegetation condition, patchiness, variability amongst vegetation associations and to determine any local refugia.

The autumn survey was undertaken over a ten day period from the 7th - 16th May 2007, with the summer survey undertaken from the 7th - 13th December 2007. Both surveys involved a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data collected over a fixed time period in discrete fauna habitats, using an equal or standardised sampling effort. Opportunistic sampling included data collected non-systematically within and outside of fixed sampling sites.

The focus of systematic sampling centred upon the establishment of seven survey sites of 1ha in size. Survey sites chosen were representative of the major habitats found over the project area. A major influence over site selection was the number and frequency of broadscale wildfires over the project area. Survey sites represented the broad habitats of Spinifex Plains, Mulga Woodland, Woodland on Calcrete Flats, Mallee over Spinifex, Bull Spinifex on Lake Edge, Samphire Flats and Kopi Ridge.

Pitfall traps, Elliott traps, funnel traps and cage traps were installed at five survey sites, with spotlighting searches and avifauna censussing also undertaken at these sites. Inventory searches, micro-pit trapping and soil sieving for invertebrates was undertaken over all seven survey sites. Total vertebrate trapping effort over combined surveys was 1,765 trap-nights, with an additional 604 trap-nights of micro-pits targeting invertebrates. Inventory searches, spotlighting searches, and avifauna censussing of survey sites totalled 5,120 minutes. Additional targeted searches were also made for specific or significant terrestrial fauna within specified habitats. Bats were sampled by the recording of echolocation calls using an ANABAT system over both survey periods. Opportunistic sightings of all fauna were documented.

Twenty-four species of mammal were recorded over the project area. Of these, 18 were native species, four introduced, and two were domestic stock. Four dasyurids (carnivorous marsupials), three native rodents, and six bats were recorded. Sixty species of bird were recorded. Of these, 30 were recorded from survey sites, with a further 30 species recorded opportunistically over the project area or during targeted searches for other species. Thirty-nine species of reptile were recorded, including 11 geckos, six dragons, and 15 skinks.

The Mulgara (*Dasycercus cristicauda),* listed as threatened under Commonwealth legislation and Schedule 1 under state legislation, was recorded during both surveys. The Priority 4 Bush Stone-curlew (*Burhinus grallarius)* was recorded during the autumn survey. The region is known to support a viable population of Mulgaras and they have been frequently recorded in surrounding areas. Other species of conservation significance are likely to occur at certain times of the year, including a number of migratory wading birds, Australian Bustard *(Ardeotis australis)*, Rainbow Bee-eater (*Merops ornatus*), Fork-tailed Swift (*Apus pacificus*) and the Slender-billed Thornbill (*Acanthiza iredalei iredalei*).

Species of conservation significance assessed as possibly occurring over the project area include the Malleefowl (*Leipoa ocellata*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Peregrine Falcon (*Falco peregrinus*) and Grey Falcon (*Falco hypoleucos*). Targeted searches for the Malleefowl did not reveal evidence of this species but it is known from the region. Although suitable habitat is present, it is currently severely impacted by fire, and to a lesser degree by the grazing of stock.

The short range endemic component of the fauna study focused on invertebrate taxa that have characteristics which make them prone to short range endemism. The targeted taxa in the surveys were mygalomorph spiders, Myriopods (millipedes, centipedes), scorpions, pseudoscorpions and terrestrial snails. The collected specimens were identified by taxonomic experts at the Western Australian Museum and the University of Western Australia. A number of mygalomorph taxa were collected in the project area that may have restricted ranges. However, it is difficult to make conclusive comments without a review of the genera (Main, 2008) and the collection of representative male specimens from within and outside the project area.

None of the species of pseudoscorpions, scorpions and centipedes, and terrestrial snails that were collected during the survey were considered to exhibit short range endemism, with most being widely distributed within the semi-arid zone of Western Australia. This is with the exception of the scorpion type species "maitland1" and "maitland2" from the genus *Urodacus*. This genus is currently under review and the taxonomy is subsequently uncertain.

All habitats present over the project area are widely represented throughout the region, and the vertebrate fauna assemblage recorded is similar to other regional sites. However, samphire flats and saltbush communities associated with the Lake Maitland playa are disjunct at the regional scale and provide intermittent habitat for migratory and nomadic waterbirds and are therefore considered at least locally significant. Similarly, associated Kopi Ridge habitat is discontinuous and has a patchy distribution at the regional scale.

Development concepts for the Mega Redport project at Lake Maitland are in their infancy and impacts on fauna at this stage are difficult to quantify. However, species of conservation significance have been recorded and additional species of conservation significance have been assessed as likely to occur.

Threatening processes currently affecting fauna over the project area are summarised and, given what is known of the development proposal, potential impacts listed. General management guidelines only are suggested to minimise potential impacts. A refined project definition will clarify impacts and mitigation strategies.

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1.0 INTRODUCTION

1.1 Project Background

Mega Redport Pty Ltd (a subsidiary of Mega Uranium Ltd) is currently undertaking a definitive feasibility study (DFS) in respect to the development of the Lake Maitland Uranium Deposit in the Murchison region of Western Australia.

Mega Redport Pty Ltd (Mega Redport) commissioned Outback Ecology Services (OES) to commence multi-seasonal, baseline fauna surveys over the project area during 2007. Fauna surveys were a component of a broader assessment undertaken concurrently by OES which also considered vegetation and flora, aquatic ecology, stygofauna, and soils.

1.2 Scope and Objectives of the Survey

This report documents the results of two fauna surveys conducted over the Lake Maitland project area during May and December 2007, with a reconnaissance survey during January 2007. The project area incorporated Prospecting Licenses E53/947, E53/1060, E53/1099 and adjacent areas.

Fauna surveys were planned and implemented, as far as practicable, in accordance with the Environmental Protection Authority (EPA) Position Statement No 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA, 2002), and Guidance Statement No 56 “Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia” (EPA, 2004).

The overall objectives of the terrestrial fauna baseline study for Lake Maitland were to:

a) Develop an inventory of terrestrial vertebrate fauna species, and selected invertebrate fauna, identified from the project area, or likely to be present within the project area.
b) Assess site information in the regional context by comparisons with available data from other localities within the bioregion, and to provide an assessment of current and potential impacts on significant fauna populations and habitats.
c) Provide quantitative data that can provide a baseline against which future impacts and rehabilitation can be assessed, and form the basis of a monitoring program.

The study included:

- A review of:
    - Vertebrate fauna assemblages and habitats in the bioregion;
    - Fauna species of particular conservation significance potentially present over the project area (including threatened and priority fauna, geographically-restricted fauna, and short-range endemics);
    - Current impacts to fauna and habitats over the project area; and
    - Potential impacts to terrestrial fauna from the proposed project.

- The identification of :
    - All vertebrate fauna, and targeted short-range endemic invertebrate species that are present or likely to occur over the project area (incorporating the results of this survey, recent published and unpublished regional records, and an assessment of habitats and likelihood of occurrence);
    - Biologically-significant fauna species at international, national, state, regional and local scales; and
    - Sensitive faunal habitats identified from the study area that are of particular conservation significance.

1.3 Location of Project Area

The Lake Maitland Uranium Deposit is located in the vicinity of the northern portion of Lake Maitland, approximately 95 km north-east of Leinster, and 105 km south-east of Wiluna (**Figure 1**). The deposit is located on the Barwidgee Pastoral Lease where Mega Redport currently holds Prospecting Licenses E53/947, E53/1060, and E53/1099, which are considered here as the 'project area' (**Figure 2**).

1.4 Land Use

1.4.1 Pastoral

The Lake Maitland project is situated on the Barwidgee Pastoral Lease, owned by Newmont Mining Corporation. Barwidgee has been stocked since the 1930s (Beard, 1975), and the grazing of both cattle and Damara sheep currently occurs within selected areas of the pastoral lease, including over the project area. In addition to grazing by cattle, there are high numbers of both Red Kangaroos (*Macropus rufus*) and Euros (*M. robustus*) (NLWRA, 2002).

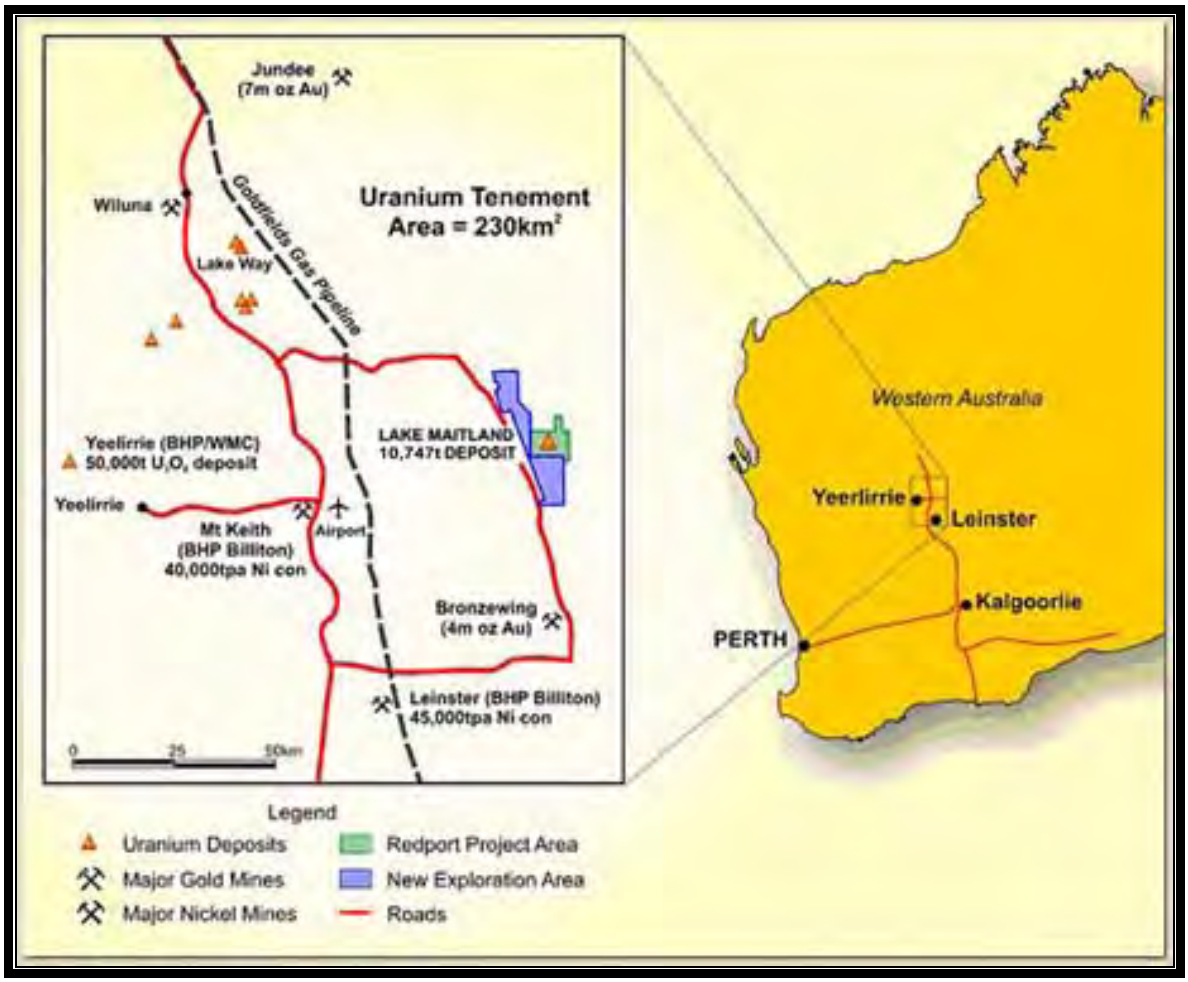

Figure 1 Locality map of the Lake Maitland project area (Mega Uranium, 2007)

1.4.2 Mining

The Lake Maitland uranium deposit was discovered by Asarco Australia Pty Ltd in 1972. The deposit was drilled by Mt Isa Mines Ltd (now Xstrata Ltd) and Esso Exploration Ltd in the 1980s and 1990s and by Mega Redport in late 2005. The uranium resource has been inferred as a 100 ppm U_3O_8 cut-off, of 32.7 million tones at 0.03% U_3O_8 (23.7 million pounds U_3O_8) (JORC and NI-43-101 compliant) (Mega Uranium, 2007).

The Lake Maitland project area is located within 25 km of View Resource's Bronzewing Gold Mine, which is also located on Barwidgee Pastoral Lease. As well as owning the Barwidgee lease, Newmont Mining Corporation also owns the contiguous Jundee, Yandal, and Lake Violet Pastoral Leases, and has other mining interests in the region, including Jundee Mine to the north.

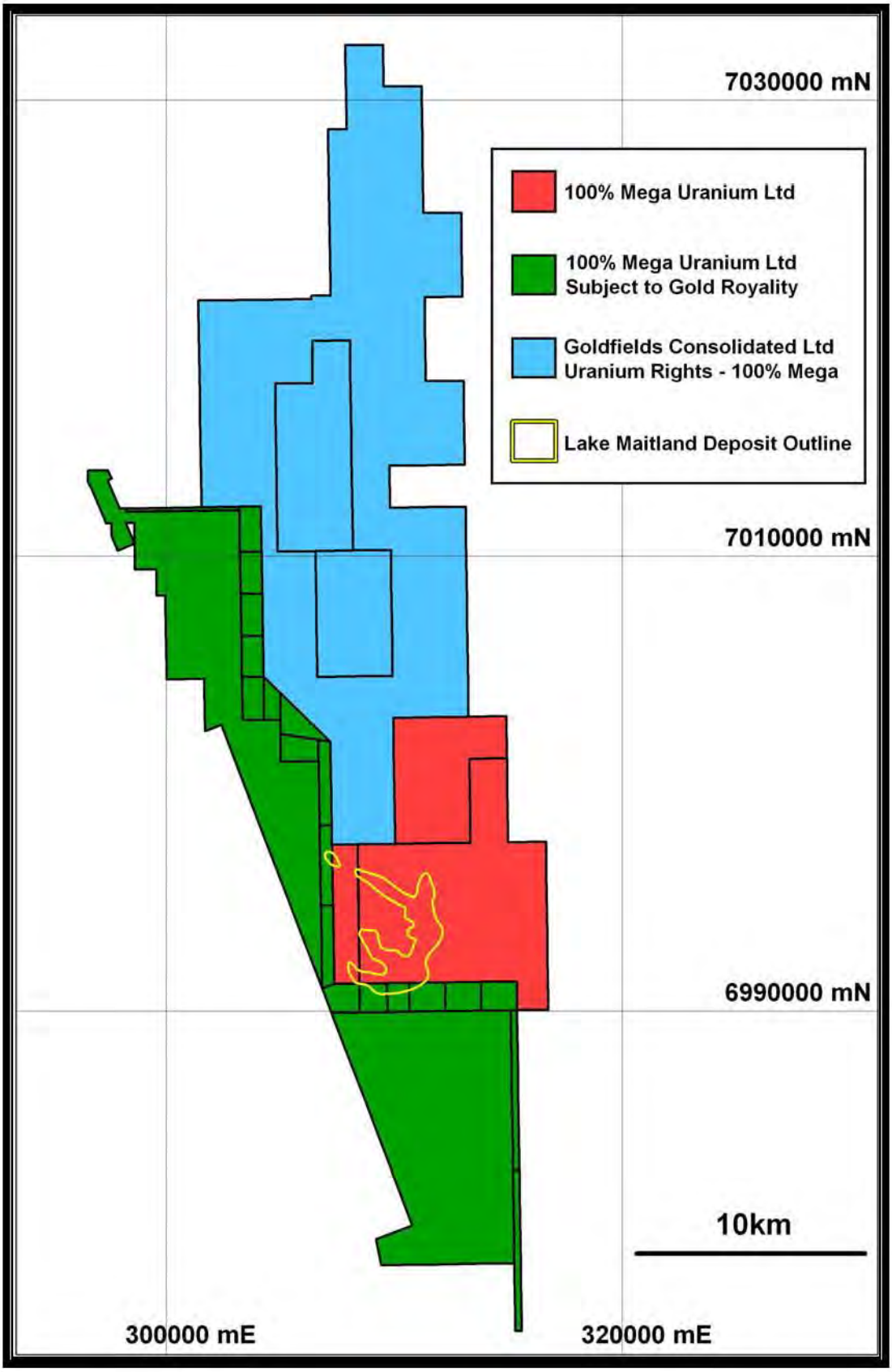

Figure 2 Lake Maitland project area showing Exploration Licenses held by Mega Redport

2.0 EXISTING ENVIRONMENT

2.1 Climate

The Murchison region is characterised as having an arid climate, with summer and winter rain and an annual rainfall in the range of 200 mm (Beard, 1990; Gilligan, 1994). However, rainfall over the project area is unreliable, with zero rainfall potentially recordable in any month (Gilligan, 1994). Summer weather in the region is influenced by anticyclonic systems to the south-east, which result in a pattern of clear skies and easterly winds (Gilligan, 1994). The region borders the southern end of the Intertropic Convergence Zone and, as a consequence, thunderstorm activity and summer rainfall is generated (Gilligan, 1994). Whilst summer rainfall is a feature of the region, most years have a dry spell lasting four to six months, typically commencing around October (Gilligan, 1994).

Winter weather patterns are directly influenced by the anticyclonic system, which results in the generation of westerly winds and rain-bearing frontal systems (Gilligan, 1994). Winter rains are usually heaviest around late May into August, and subside during the months of September and October as the anticyclonic conditions stabilise (Gilligan, 1994).

The nearest Bureau of Meteorology (BOM) weather stations to Lake Maitland are Yeelirrie and Leinster. The Yeelirrie weather station is located approximately 98 km west of Lake Maitland.. The Leinster weather station is located approximately 100 km north-east of Lake Maitland. Data has been collected at Leinster for 13 years, whereas rainfall data has been collected at Yeelirrie since 1928 with temperature data collected since 1973. Data from Yeelirrie were selected to give a better representation of long-term regional climate patterns. Significant variation in rainfall is noted across the area, and as such, data provided should be used as a guide only.

Monthly mean maximum temperature at Yeelirrie ranges from a high of 37.7^{0}C during January to a low of 19.2^{0}C in July (Figure 3). The highest temperature at Yeelirrie was 46^{0}C recorded in February 1991 whilst the lowest was -5.1^{0}C recorded in July 2000 (BOM, 2007). Mean monthly rainfall at Yeelirrie ranges from a high of 32.1mm in March to a low of 4.3 mm in September (**Figure 3**). Mean annual rainfall recorded at Yeelirrie is 238.9 mm (BOM, 2007). Zero rainfall has been recorded during each month of the year whilst peak falls as high as 211 mm (April, 1992) have been recorded within a month (BOM, 2007). Annual rainfall recorded has ranged from a low of 42.8 mm in 1950 to a peak of 506.8 mm in 1975 (BOM, 2007).

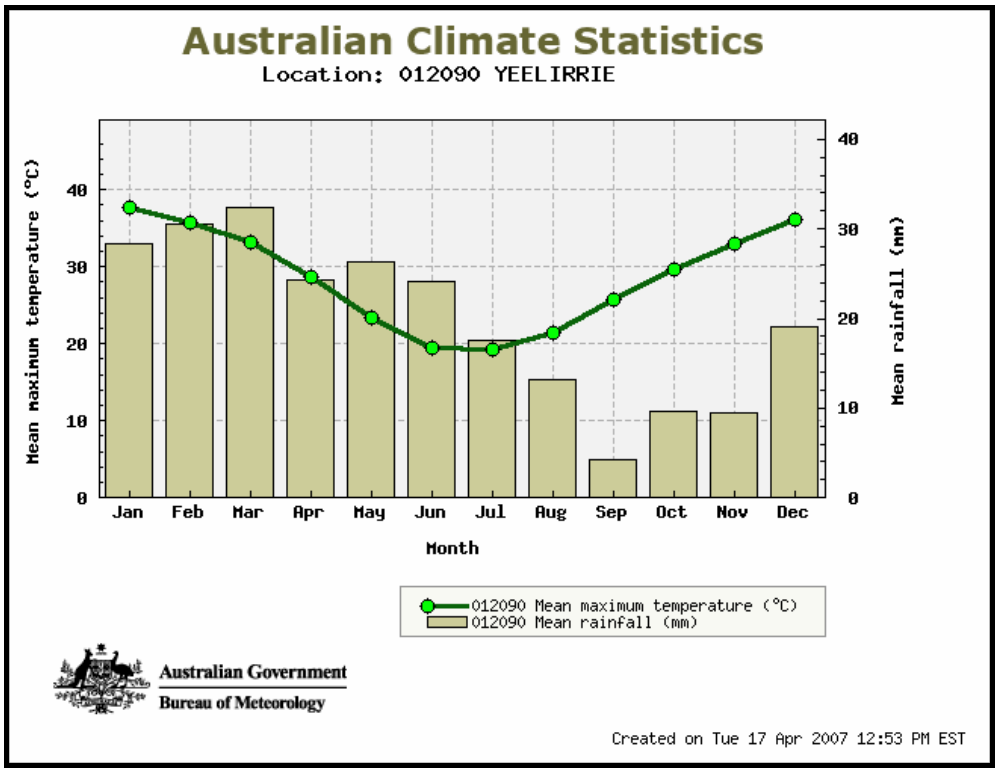

Figure 3 Climate data for Yeelirrie station (BOM, 2007).

2.2 Murchison Biogeographic Region

The project area is situated in the semi-arid to arid Eyrean Sub-region, one of three very broad sub-regions defined by Heatwole (1987) covering the entire Australian continent, with the others being the tropical Torresian sub-region and the temperate Bassian sub-regions.

Thackway and Cresswell (1995) describe a more refined system of 85 'biogeographic regions' (bioregions) covering the whole of Australia; the result of collaboration between all state conservation agencies with co-ordination by the Australian Government Department of Environment and Heritage [now the Department of Environment, Heritage and the Arts (DEWHA)]. Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

Lake Maitland is located within the Murchison Bioregion of the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995). The Murchison Bioregion comprises the northern part of the Yilgarn Craton and includes two major components, or sub-regions: the Eastern Murchison (MUR1); and the Western Murchison (MUR2).

The project area lies within the Eastern Murchison sub-region (MUR1), which is characterised by its internal drainage, areas of red sandplains, salt lake systems associated with an occluded paleodrainage system, broad plains of red-brown soils, and breakaway complexes (Cowan, 2001).

Vegetation is dominated by Mulga woodlands, hummock grasslands, saltbush shrublands and Halosarcia shrublands (NLWRA, 2002). The subregion is rich and diverse in both its flora and fauna. However, many species are wide-ranging and occur in adjoining regions (Cowan, 2002).

Land uses of the Eastern Murchison sub-region (MUR1) include (After Cowan, 2001; NLWRA, 2002):

- Grazing. The dominant landuse of the MUR1 sub-region is grazing of stock on pastoral leases, with approximately 85% of the sub-region used for this purpose (Cowan, 2001).
- Mining. Extensive mining of nickel and gold is undertaken in the sub-region. However, most mining leases are located on pastoral lands, which come under section 97 of the *Land Administration Act 1997* and are therefore still required to be stocked.
- Unallocated Crown Land (UCL) and Crown Reserves comprise just over 11% of the MUR1 sub-region.
- Conservation. NLWRA (2002) states that just 1.4% of the Murchison Bioregion is classified as conservation estate, with Cowan (2001) reporting 1.8% for the MUR1 sub-region. Since that time, a comprehensive land acquisition programme has contributed additional land for conservation purposes; and in 2004 a figure of 7.5% was reported for the bioregion (Brandis, no date), still well short of a target of 15%. Wanjarri Nature Reserve is located approximately 25 km west of the project area at its closest point.

2.3 Land Systems of the Project Area

A regional survey of land in the north-eastern Goldfields was undertaken between 1988 and 1990 by the Department of Agriculture (now the Department of Agriculture and Food) and the Department of Land Administration (now Landgate). The purpose of that survey was to develop a comprehensive description of the biophysical resources and provide an assessment of the condition of the soils and the vegetation of the north-eastern Goldfields (Pringle *et al.* 1994). A component of that survey was the mapping of land types, land systems and land units of the north-eastern Goldfields including the project area.

The project area is located over five land types and seven land systems (**Table 1**). However, the Darlot and Bullimore land systems dominate. The Darlot land system represents Lake Maitland Salt Lake and fringing saline alluvial plains, and the Bullimore land system represents extensive spinifex sandplains to the east of the lake. Calcrete platforms of the Mileura land system, supporting mainly halophytic shrublands, occur adjacent to Lake Maitland Salt Lake, whlie Mulga shrublands on sandy-surfaced plains occur on the Melaleuca land system further from the lake's edge.

Table 1 Summary of land systems over the project area (Pringle *et al.* 1994)

Land Type	Land System	Description	Total and % of north – eastern Goldfields	Predominant location over project area
Land Type 13 Sandplains with spinifex hummock grasslands, *Acacia* shrublands, heath and eucalypts	Bullimore (Blm)	Extensive sandplains supporting spinifex hummock grasslands	24,013 km² 24%	Extensive representation over the project area, particularly to the east
Land Type 17 Salt lakes and fringing alluvial plains with saline soils and halophytic shrublands	Darlot (Dar)	Salt lakes and fringing saline alluvial plains, with extensive, regularly arranged, sandy banks and numerous claypans and swamps supporting halophytic shrublands and spinifex and wanderrie grasslands	1,344 km² 1.3%	Extensive representation across Lake Maitland, including the project area
Land Type 15 Calcreted drainage plains with mixed halophytic and non-halophytic shrublands	Mileura (Mle)	Calcrete platforms and saline alluvial plains, supporting halophytic shrublands	550 km² 0.6%	Northern section of Lake Maitland, intersecting or abutting Darlot Land System
	Melaleuca (Mel)	Sandy-surfaced plains and calcareous plains, supporting spinifex or mulga wanderrie shrublands	267 km² 0.3%	Scattered on edges of Lake Maitland, often intersecting or abutting Darlot Land System
Land Type 12 Plains with deep sandy soils supporting *Acacia* shrublands (occasionally with mallees) and wanderrie grass	Desdemona (Des)	Extensive plains with deep sandy or loamy soils, supporting mulga and wanderrie grasses	2,524 km² 2.5%	North-west corner of project area abutting Bullimore Land System
	Ararak (Ara)	Broad plains with mantles of ironstone gravel supporting mulga shrublands with wanderrie grasses	2,021 km² 2.0%	Scattered, with a minor occurrence in the extreme north of the project area
Land Type 9 Plains with gritty surfaces and low tors and domes on granite with acacia shrublands	Challenge (Clg)	Gently undulating plains, occasional granite hills, tors, and low breakaways with acacia shrubland	554 km² 0.6%	Isolated occurrence in the extreme east of the project area

3.0 SURVEY METHODS

3.1 Sources of Information

3.1.1 Vertebrates

Database searches were made prior to field surveys. The Search area was defined by a polygon that was centred on the project area and covered at least 250 km by 250 km (the 'search area'). The following Searches and internet tools were used:

- The Western Australian Museum (WAM) FaunaBase database to identify potential vertebrate fauna within the study area. The bounding coordinates used were:
    - 26.04° S, 119.47° E; and
    - 28.71° S, 122.42° E.
- Threatened and Priority Fauna Database held by the Department of Environment and Conservation (DEC) to facilitate the identification of species of conservation significance within the study area. The bounding coordinates used were:
    - 26.26° S, 120.00° E; and
    - 28.05° S, 122.06° E.
- The Protected Matters and Environmental Reporting Tools of the DEWHA to identify fauna species of national, environmental significance, which are protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* that may potentially occur within the area. The bounding coordinates used were:
    - 25.93° S, 119.54° E; and
    - 28.70° S, 122.42° E.
- The Environmental Reporting tool of the DEWHA to identify fauna species of national environmental significance. The bounding coordinates used were:
    - 25.93° S, 119.56° E; and
    - 28.68° S, 122.40° E.
- The Birds Australia database to identify avifauna potentially occurring over the study area.
- The Australian Natural Resources Atlas of the National Land and Water Resources Audit (NLWRA) to gain information on significant fauna and fauna habitats within the Murchison bioregion.
- The Australian Wetlands Database of the DEWHA to ascertain regionally significant wetland habitats occurring within the study area.

A review of available literature was also undertaken to provide additional information on mammals, reptiles, amphibians and birds that have the potential to occur over the study area. The vertebrate fauna of the region has been the subject of a number of studies, predominantly as part of other mining projects in the region, including: HGM (1997), HGM (1999), Lancaster and Associates

(1981), Ninox (1989), Ninox (1993), OES (2002), OES (2004), OES (2005a), OES (2005b), OES (2006a), OES (2006b), and OES (2008).

The Western Australian Museum (WAM) has undertaken intensive surveys over the Eastern Goldfields, including the vicinity of the project area (e.g., How and Dell, 1992; Hall, *et al*. 1994). Surveys have also been conducted within Wanjarri Nature Reserve (CALM, 1996; Moriarty, 1972). Communications were undertaken with appropriate WAM staff to determine which vertebrate species may be required for collection and lodging with the WAM. These included the reptiles *Eremiascincus richardsoni, Tympanocryptis cephalus*, and *Diporiphora* sp., as well as the frog *Pseudophryne occidentalis*.

Information from the sources outlined above was augmented with additional information relating to species' likelihood of occurrence based upon personal experience and general patterns of distribution and known habitat preferences. Many of the species present on regional lists have specific habitat requirements that may be present in the general area, but not in the specific habitats of the project area. Some species, therefore, are included in such lists but are unlikely to be present in the actual study area. Relevant texts from which information on general patterns of distribution was obtained included:

Mammals: Churchill (1998); Menkhorst and Knight (2001); Strahan (2002).

Birds: The Handbook of Australian, New Zealand and Antarctic Birds (Birds Australia, various editors and dates); Barrett *et al*. 2003; Blakers *et al*. (1984); Johnstone and Storr (1998 and 2004);

Amphibians: Tyler *et al.* (2000).

Reptiles: Storr *et al*. (1983, 1990, 1999 and 2002); Wilson and Swan (2003).

Fish: Allen *et al.* (2002); Morgan and Gill (2004).

Comprehensive vegetation mapping over the project area, which is being undertaken by a concurrent study (OES, 2007), was utilised to facilitate the description and delineation of fauna habitats in this study.

3.1.2 Potential Short-range Endemic Invertebrates

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale (Allen *et al.* 2002). Factors affecting endemism through influencing distribution, speciation, and differentiation appear to be the taxon's life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions and historical environmental conditions (Allen *et al.* 2002; EPA, 2004; Ponder and Colgan, 2002; Harvey, 2002).

'Short-range endemism' refers to taxa with naturally restricted distributional ranges. The definition of what constitutes 'restricted ranges' varies from species to species, however the definition proposed by Harvey (2002) is of an area less than 10,000km^2. These taxa are typically characterised by poor dispersal, reliance on discontinuous habitats, low growth rates, often seasonally influenced activity in wetter months, and often exhibit low fecundity (Harvey, 2002). The restriction of a taxon's distribution to a specific area is often most greatly influenced by a prominent physical barrier preventing migration between adjacent populations of the same taxon.

Short-range endemic (SRE) fauna in Australia are dominated by invertebrate species, which have undergone little investigation to date, due to their diverse nature. However, in the Goldfields, terrestrial invertebrate groups that possess attributes associated with short-range endemism include terrestrial molluscs mygalomorph spiders, myriopods, scorpions and pseudoscorpions.

Communications with Dr Mark Harvey of the WAM resulted in the identification of five groups of short-range endemic (SRE) invertebrates thought most likely to occur over the project area (**Table 2**). The identification of invertebrate species requires the skills of specialists. Internationally-recognised experts from the WAM, and from the University of Western Australia (UWA), were engaged to supervise identifications of any target taxa collected during the survey (**Table 2**).

Table 2 Target SRE groups and associated staff consulted by OES to supervise identifications

Target SRE Group	Staff	
Terrestrial molluscs	Dr. Shirley Slack-Smith	WAM
Scorpions	Dr. Mark Harvey	WAM
Pseudoscorpions	Dr. Mark Harvey	WAM
Myriopods (particularly millipedes)	Dr. Mark Harvey	WAM
Mygalomorph spiders	Prof. Barbara York Main	UWA

3.2 Taxonomy and Nomenclature

Nomenclature and taxonomy of vertebrate species follows that provided in the "Checklist of the Vertebrates of Western Australia" for amphibians, reptiles and mammals (WAM, 2002), and for birds, the Birds Australia "Draft Working List of Birds of Australia and Australian Territories", 2003

based on Christidis and Boles (1994). Invertebrate taxonomy is based on nomenclature provided by the WAM and UWA.

3.3 Survey Timing and Weather

An initial reconnaissance survey of the project area was undertaken over a four day period from the 22nd -25th January 2007. Systematic fauna surveys were conducted between the 7th - 16th May 2007 (autumn survey), and the 7th - 13th December 2007 (summer survey).

Weather during the reconnaissance survey was very hot, with maximum temperatures recorded between 38ºC and 42ºC. Maximum temperatures during the autumn survey ranged between 22ºC and 28ºC, with minima between 5ºC and 12ºC. The region received good rainfalls prior to the survey, with approximately 250 mm falling between October 2006 and April 2007.

Maximum temperatures during the summer fauna survey ranged between 26ºC and 36ºC, and minimum between 14ºC and 21ºC. Humid conditions prevailed, culminating in the premature closure of all traps on the 12 December 2007 due to a downpour, with over 40 mm of rainfall recorded in Yeelirrie on the 13 December. Very little rainfall occurred prior to the summer fauna survey with just 27.2 mm recorded for the previous six months (BOM, 2007) (Leinster figures, are quoted as records for Yeelirrie, contain missing data).

3.4 Outline of Sampling Methods

The methods adopted for the survey are formulated, as far as practicable, in context with the EPA Position Statement No 3. “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA, 2002), and Guidance Statement No 56 “Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia” (EPA, 2004).

The inventory of fauna involved a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling was defined as that collected over a fixed period in a discrete vegetation community, using an equal or standardised sampling effort. Opportunistic sampling includes data collected non-systematically within and outside of fixed sampling sites. Survey design was targeted at the local scale, but employed methods that were consistent with regional surveys. The focus of systematic sampling centred upon the establishment of five survey sites.

3.4.1 Site Selection, Locations and Descriptions

A desktop review of habitats present at the site was conducted prior to the January 2007 reconnaissance survey. Aerial photography, contour mapping, land systems mapping, and Beard (1975) mapping were used to determine preliminary site selection, which was based upon the dominant landform and vegetation type.

The reconnaissance survey was undertaken to verify the desktop study and further delineate habitats, particularly in regard to topography, wildfire, vegetation condition, patchiness and variability amongst vegetation associations, as well as determine any local refugia. Data and condition assessment from a concurrent vegetation survey (i. e., OES, 2007), and communications with an OES botanist undertaking fine-scale vegetation mapping during the same period, also informed habitat delineations.

Site selection was further influenced by the proposed development in consideration to the zone of direct impacts, zone of indirect impact and zone of wider interest. Following the reconnaissance survey, sampling sites were chosen as being:

i) Representative of the major fauna habitats present.
ii) Representative of areas of environmental impact potentially arising from the proposal.
iii) Areas of ecological sensitivity or discrete habitats that may support SRE invertebrates.

A major influence over site selection was the number and frequency of broadscale wildfires over the project area. Examination of Landgate Satellite Remote Sensing Services Fire Scar Mapping (accurate to 1 km) indicated that fires had burnt extensive areas of the project area over the last five years, with some areas having been burnt several times. Spinifex Sandplains have been particularly affected, however Mulga Woodlands have also been impacted.

Survey sites selected during the reconnaissance survey of January 2007 had to be re-located during the autumn survey due to a recent, very hot and broadscale wildfire that impacted much of the eastern portion of the project area during early April 2007 (**Figure 4**). Consequently site selection was heavily biased towards areas of vegetation that was unburnt for at least three years; that is, in consideration of not only the recent wildfire, but also previous fires over the project area. Areas affected by the recent wildfire showed little recovery during the December survey.

Figure 4 Evidence of recent (left) and past (right) wildfire through the eastern side of the Lake Maitland project area affecting predominantly Spinifex and Mulga communities

The location and number of sites surveyed is summarised in **Table 3** with the "Criteria for Selection" referring to those criteria listed above. Survey sites were distributed to encompass a broad cross section of the project area. Sites did not cover all differentiated habitats available to the wide range of vertebrates present in the region at a small scale; however, they were representative of the major habitats present and thus provide a useful grouping as a sampling strategy, and within which, to discuss species occurrence.

Table 3 Survey site locations

Survey Period	Site Name		Criteria for selection	Co-ordinates (GDA94)
Autumn 2007	LM01	Spinifex Plains	i)	51 J 314915 - 6988189
Autumn 2007	LM02	Mulga Woodland	i), ii)	51 J 312554 - 6998923
Autumn 2007	LM03	Mallee over Spinifex	i), iii)	51 J 312691 - 6994795
Autumn 2007	LM04	Bull Spinifex on Lake Edge	i), ii)	51 J 309346 - 6997429
Autumn 2007	LM05	Woodland on Calcrete Flats	i), ii)	51 J 307433 - 6999091
Autumn 2007	LM06	Samphire Flats	i), ii)	51 J 307438 - 6997083
Autumn 2007	LM07	Kopi Ridge	iii)	51 J 313126 - 6988346

Sites LM01 to LM05 were established to sample vertebrate fauna with a combination of trapping, inventory searching and bird censussing conducted at these sites. Vertebrate trapping was not undertaken over Samphire *(Halosarcia)* flats habitat because past experience has shown that this habitat type is relatively unproductive. Sites LM06 and LM07 were sampled for vertebrate fauna using inventory searches and bird censussing. All sites were sampled for invertebrates (see Section 3.1.3). Survey site descriptions, with photographs, are summarised as follows:

Plate 1 Site LM01 Spinifex Plains

The Spinifex Plains site supported *Triodia desertorum* hummock grassland with an emergent open low scrub of *Hakea lorea, Melaleuca lanceolata,* and *Acacia aneura.*

Plate 2 Site LM02 Mulga Woodland

The Mulga Woodland site supported a low forest of *Acacia aneura*, *A. ayersiana,* and *Melaleuca interioris* over a low scrub of *Senna artemisioides* and *Cratystylis spinescens* over a dwarf scrub of *Eremophila latrobei* and *A. cuthbertsonii* over an open low grass of *Aristida contorta* and *Enteropogon ramosus.*

Plate 3 Site LM03 Mallee over Spinifex

The Mallee over Spinifex site supported a low woodland of *Eucalyptus eremicola* and *Acacia aneura* over a low scrub of *Hakea preissii, Eremophila oldfieldii,* and *Acacia ayersiana* over hummock grasses *Triodia basedowii* and open low grass of *Enteropogon ramosus, Enneapogon caerulescens,* and *Aristida contorta.*

Plate 4 Site LM04 Bull Spinifex on Lake Edge

The Bull Spinifex site comprised large and mature *Triodia basedowii* hummock grassland with very open low grass of *Eragrostis setifolia, Enneapogon caerulscens,* with an emergent low scrub of *Cratystylis subspinescens* and *Lycium australe.*

Plate 5 Site LM05 Woodland on Calcrete Flats

The Woodland on Calcrete Flats site comprised a low woodland of *Casuarina pauper* over a low scrub of *Acacia tetragonophylla* and *A. cuthbertsonii* over very open herbs *Sclerolaena cornishiana* over very open low grass of *Enneapogon caerulescens.*

Plate 6 Site LM06 Samphire Flats

The Samphire Flats site supported a low heath of *Halosarcia* spp. over very open low grassland of *Eragrostis lanipes.*

Plate 7 Site LM07 Kopi Ridge

The Kopi Ridge site supported a low woodland of *Eucalyptus striaticalyx* over an open low scrub of *Grevillea sarissa* over a dwarf scrub of *Lawrencia helmsii* over very open herbs *Zygophyllum compressum* over very open low grass of *Enneapogon caerulescens.*

3.4.2 Systematic Censussing

The focus of systematic censussing centred upon the establishment of survey sites of 1 ha in size within the major habitats found over the project area. Within sites LM01 to LM05 a standard trapping grid was established that incorporated pit traps, Elliott box traps, Sheffield cage traps, funnel traps and micro pit traps (for invertebrates). A representation of the trapping grid is shown in **Figure 5.**

Table 4 summarises the trapping effort that occurred at each site. Two different sized pit-traps were incorporated into the design; that is 20 L buckets as well as 150 mm diameter 'pipes', as each pit-trap has features thought to favour particular species.

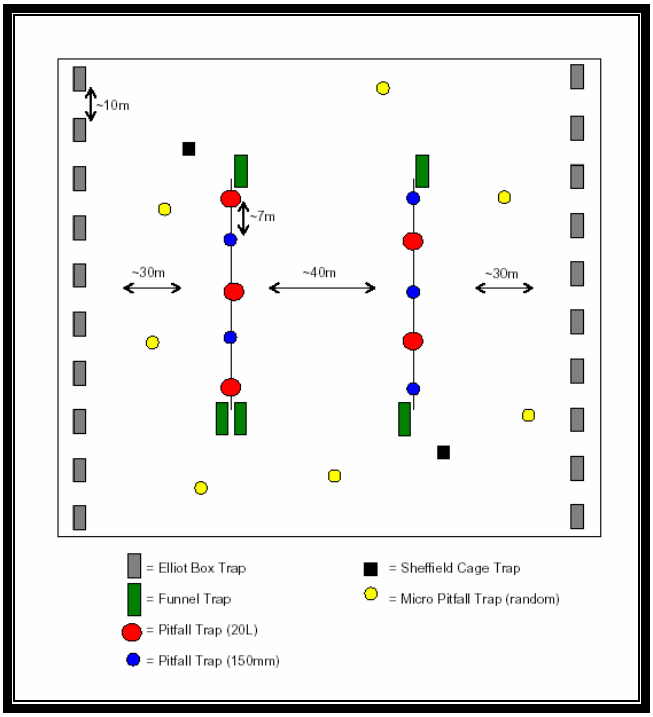

Figure 5 Representative grid layout

Following is a summary of systematic sampling undertaken at survey sites:

1. Pitfall traps and drift fence: Ten pit traps were positioned in each grid. Two types of pit traps were incorporated into the design: PVC pipe 150 mm in diameter and 400 mm deep, as well as standard 20 L PVC buckets. Pit traps were set flush with the surface of the ground, with two lines of five established at seven metre spacings. Each line of five pits was joined by a single driftline 20 cm high, set into the substrate. Pit traps were checked daily for targeted invertebrates as well as vertebrate fauna.
2. Elliot box traps: Two lines of ten medium sized Elliot traps (9 cm x 9 cm x 32 cm) were placed within the grid in sheltered areas, and baited with a mixture of rolled oats, peanut butter and sardines.
3. Sheffield cage traps: Two cage traps were placed within the grid in sheltered areas and baited as above.
4. Funnel traps: Five funnel traps measuring 75 cm x 18 cm x 18 cm were placed along drift fences shared with the pit traps
5. Micro-pits: Seven micro-pits were installed at each site at least 1.5 m apart. Traps consisted of plastic containers of 80 mm diameter and 125 mm deep, sitting flush with the soil surface, and containing approximately 200 ml of a mixture of ethylene glycol and water at a ratio of 30:70.

6. Inventory Searches: Survey sites were hand-searched for cryptic species of vertebrates and targeted invertebrate groups for at least 120 minutes at each site. Techniques included identification of active animals, raking leaf and bark litter, overturning logs and stones, searching beneath the bark of dead trees, investigating burrows and recording tracks, diggings, scats, and other signs. Bird records were also made during inventory searches. Specific searches were made for the permanent burrows of mygalomorph spiders and these were dug up and specimens collected. Lids of mygalomorph burrows were also collected for subsequent identification. Searches were made for snail shells at the base of shrubs and hummock grasses using sieving methods.
7. Soil Sieving: Species of terrestrial molluscs may be found within the top 0.2 cm to 1.0 cm of soil. Samples of this soil layer were collected for subsequent inspection in the laboratory. Sieved samples of approximately 500 cc were collected from all sites. Samples were sieved on site, and the < 0.1 cm and > 1 cm fraction returned to where it was collected. Collected samples were transported from site to the OES laboratory in Perth in Eskys.
8. Spotlight Searches: Each survey site was searched at night using head torches and spotlights for nocturnal species, such as geckos, snakes, nocturnal birds and invertebrates. Records of species observed between sites were also made.
9. Avifauna Censussing: Censuses were used to survey the avifauna present within each habitat. The duration of each census was 20 minutes per day, as recommended by Birds Australia. The surveys were carried out in the mornings between 0600 hr and 1200 hr and the number of individuals of each species observed and/or heard was recorded. To obtain sufficient data, bird censussing was un-bounded. That is, observations were not confined to survey site boundaries but all records were made in the vicinity of survey sites and within the habitat represented during the allocated time.

A summary of the trapping components undertaken at each site is given in

Table 4. The trapping grid at Site LM08 had 25 Elliott traps, instead of 20. This was established after evidence of Mulgara (*Dascercus cristicauda*) was observed.

Systematic Survey Effort

The reconnaissance survey in January 2007 was undertaken by one staff member over four days. Potential survey site locations were determined and records made of all species identified during the site visit, including tracks and traces.

The autumn survey was undertaken by three Outback Ecology staff members. The survey, including trapline establishment, was undertaken over ten days, with vertebrate trapping undertaken over a five day period. One of the three staff members was dedicated to the invertebrate component of the survey.

Table 4 Summary of trapping undertaken at each site

	Site No	Description	Pits: 20L bucket		Pits: 150mm		Elliott Traps		Cage Traps		Funnel Traps		Micro-pits	
			May	Dec	May	Dec	May	Dec	May	Dec	May	Dec	May	Dec
Vertebrates and SREs	LM01	Spinifex Plains	5	5	5	5	20	20	2	2	5	5	7	7
	LM02	Mulga Woodland	5	5	5	5	20	20	2	2	5	5	7	7
	LM03	Mallee over Spinifex	5	5	5	5	20	20	2	2	5	5	7	7
	LM04	Bull Spinifex	5	5	5	5	20	20	2	2	5	5	7	7
	LM05	Woodland - Calcrete Flats	5	5	5	5	20	20	2	2	5	5	7	7
Sub-totals			***25***	***25***	***25***	***25***	***100***	***100***	***10***	***10***	***25***	***25***	***35***	***35***
SREs only	LM06	Samphire Flats											10	10
	LM07	Kopi Ridge											10	10
Additional	LM08	'Mulgara Grid'					25							
Grand Totals			**25**		**25**		**225**		**20**		**50**		**110**	

Table 5 Total trapping effort

Site No.		Pit Trap-nights		Elliot Trap-nights		Funnel Trap-nights		Cage Trap-nights		Total		Micro Pit Trap-nights	
		May	Dec	May	Dec	May	Dec	May	Dec	May	Dec	May	Dec
LM01	Spinifex Plains	50	40	100	80	25	20	10	8	185	148	42	35
LM02	Mulga Woodland	50	40	100	80	25	20	10	8	185	148	49	35
LM03	Mallee over Spinifex	50	40	100	80	25	20	10	8	185	148	49	35
LM04	Bull Spinifex	50	40	100	80	25	20	10	8	185	148	49	35
LM05	Calcrete Flats	50	40	100	80	25	20	10	8	185	148	56	35
LM06	Samphire Flats											42	50
LM07	Kopi Ridge			600	400	125	100	50	40	925	740	42	50
LM08	'Mulgara Grid'			100						100			
Totals		450		1,000		225		90		**1,765**		604	

The summer survey was undertaken by three staff members over an eight day period, with vertebrate trapping undertaken over four days. Trapping was planned to be undertaken over a five day period but a heavy downpour of rain necessitated the closure of traplines one day early. One of the three staff members was dedicated to the invertebrate component of the survey.

Trapping effort displayed as 'trap-nights' is shown in **Table 5**. One trap-night is the equivalent of one trap open for one night. Note that standard pit traps were checked for targeted invertebrates as well as vertebrate fauna. A total of 1,765 trap-nights were undertaken over the project area, excluding micro-pits (**Table 5**).

A total of 5,120 minutes was spent on systematic surveys within representative sites, with 980 minutes spent undertaking surveys of avifauna (**Table 6**). Opportunistic sightings around the greater project area also contributed significantly to the number of species recorded. Systematic inventory and spotlighting searches totalled 3,780 minutes and 360 minutes respectively. One staff member undertook bird census and spotlighting surveys, whereas three staff members undertook the inventory (or hand-searching) components, with one staff member focussing on invertebrates.

Table 6 Total bird census, inventory, and spotlighting effort

Site		Bird Census (Minutes)		Inventory (Minutes)		Spotlighting (Minutes)		Total (Minutes)
		May	**Dec**	**May**	**Dec**	**May**	**Dec**	
LM01	Spinifex Plains	100	80	90 (x3)	90 (x3)	60		780
LM02	Mulga Woodland	100	80	90 (x3)	90 (x3)	60		780
LM03	Mallee over Spinifex	100	80	90 (x3)	90 (x3)	60		780
LM04	Bull Spinifex	100	80	90 (x3)	90 (x3)	60		780
LM05	Calcrete Flats	100	80	90 (x3)	90 (x3)	60		780
LM06	Samphire Flats	40		90 (x3)	90 (x3)		60	640
LM07	Kopi Ridge	40		90 (x3)	90 (x3)			580
Total		980		3,780		**360**		**5,120**

3.4.3 Non-systematic Sampling

To supplement the systematic sampling, the presence of all vertebrate species was recorded wherever, and whenever, possible during systematic surveys (four days during January 2007, ten days during the autumn survey, and eight days during the summer survey). Non-systematic sampling included:

1. Opportunistic sightings: The presence of all vertebrate and invertebrate species encountered was recorded while working and travelling within the project area during the day and night, including during the reconnaissance survey and trap line establishment period. Opportunistic sampling includes data collected non-systematically within and outside fixed sampling quadrats.
2. Secondary evidence: Tracks, diggings, scats, burrows and nests were recorded wherever and whenever possible, including invertebrates (particularly mygalomorph burrows).
3. Spotlighting (nocturnal road surveys): Tracks were traversed in a vehicle at low speeds at night time, with any fauna detected within headlights recorded. Over 270 minutes of nocturnal road surveys were undertaken over the three survey periods.
4. Anecdotal evidence: Observations and/or photographs taken by employees and contractors based at Barwidgee Station.

3.4.4 Targeted Searches

Bat Fauna

Bats were sampled primarily via echolocation call detection through electronic detectors. No typical bat habitat such as watercourses, large eucalypts with hollows, natural surface water, or rocky outcrops/cave systems occurs over the project area. The only surface water occurring was that associated with a stock well 'Bore 15'. Bats often drink at surface water, after emerging from shelter at dusk, and sampling was undertaken at Bore 15 over five nights. Bats also forage for insects under artificial light and one night's sampling was undertaken under the lights at Barwidgee Homestead, during the autumn survey and under the lights of the Lake Maitland camp during the summer survey (

Table 7).

The echolocation call detection system consisted of an Anabat detector (Titley Electronics, Ballina, NSW) that was able to transform ultrasonic bat echolocation calls for analysis. Techniques employed included Anabat detector through ZCAIM (Zero-Crossings Analysis Interface Module), as well as Anabat detector directly onto minidisk (that is, in real time). Interpretation of results obtained was made by Mr Robert Bullen who has experience in the region, including work interpreting bat calls for DEC. This method of detecting bat echolocation is not exhaustive as some bat calls cannot be distinguished (i. e., *Nytophilus* spp) (Churchill, 1998).

Table 7 Bat call detection locations

Date	Site	Co-ordinates	Technique	Habitat
Autumn 11/05/2007	Bore 15	51 J 312410 7003497	Anabat onto Minidisk	Artificial water within Mulga woodland
Autumn 12/05/2007	Bore 15	51 J 312410 7003497	Anabat onto Minidisk	Artificial water within Mulga woodland
Autumn 13/05/2007	Bore 15	51 J 312410 7003497	Anabat onto Minidisk	Artificial water within Mulga woodland
Autumn 14/05/2007	Bore 15	51 J 312410 7003497	Anabat onto Minidisk	Artificial water within Mulga woodland
Autumn 15/05/2007	Barwidgee Homestead	51 J 293087 7007863	Anabat onto ZCAIM	Under artificial lights at homestead
Summer 09/12/2007	Lake Maitland Camp	51 J 311507 6997157	Anabat onto Minidisk	Under artificial lights at mine camp
Summer 10/12/2007	Bore 15	51 J 312410 7003497	Anabat onto Minidisk	Artificial water within Mulga woodland
Summer 12/12/2007	Lake Maitland Camp	51 J 311507 6997157	Anabat onto Minidisk	Under artificial lights at mine camp

Plate 8 Bat call detection site - Bore 15

Other Targeted Searches

From the desktop study, literature review, and reconnaissance survey, habitats were identified with the potential to support significant fauna species known from the region. Targeted searches were made for these significant terrestrial fauna within specified habitats. A total of approximately 2,010 minutes was spent searching for these species during the combined survey periods. Targeted searches were aimed at:

1. Slender-billed Thornbill (*Acanthiza iredalei*): A targeted search of approximately 150 minutes by one person was made for Slender-billed Thornbill in particular, but also Striated Grasswren (*Amytornis striatus*), Bush Stone-curlew (*Burhinus grallarius*), and Australian Bustard (*Ardeotis australis*). Samphire/Saltbush habitats of the Lake Maitland Salt Lake, sporadically interspersed with spinifex, were searched during the May fauna survey.
2. Malleefowl (*Leipo ocellata*): Searches for the distinctive mounds, or other signs or sightings of Malleefowl, totaling approximately 150 minutes by two people, were undertaken during the autumn survey period, as well as all travel through the project area during all other survey periods. A recent fire enabled large areas of land to be examined for evidence of Malleefowl mounds relatively quickly. Specific transect searches, totaling approximately 210 minutes by three people, were made for the Malleefowl in particular, but also any other species of conservation significance, over suitable shrubland habitat during the summer survey.
3. Mulgara (*Dasycercus cristicauda*): Searches, totaling approximately 150 minutes by two people, were made for signs or sightings of Mulgara over unburnt sections of Spinifex Plains during the the reconnaissance survey and the autumn survey. Transect searches, totaling approximately 210 minutes by three people, were made for signs or sightings of Mulgara during the summer survey.
4. Mygalomorph spiders and other invertebrates: Litter-covered areas surrounding the salt lake, as well as under shrubs, mallee and Mulga, were searched for the typical lidded trapdoors of mygalomorph (trapdoor spider) burrows as well as the open burrows of *Teyl* species. Aerial soil tubes of *Aname* species were searched for in Spinifex Grassland.

3.4.5 Sorting and Identification of Invertebrate Specimens

All invertebrate specimens collected from survey sites were sorted in the field into major taxonomic groups. Any specimens of millipedes, scorpions, and pseudoscorpions collected by hand-searching were placed into 70% ethanol immediately upon capture. Spiders were placed in 100% ethanol upon capture due to their softer body parts.

All vials were sealed and labelled before transportation to the OES Perth laboratory. Within the laboratory all specimens, including those collected opportunistically, were grouped and labelled by OES staff into categories suitable for delivery to WAM and UWA. Standard identification keys (eg.

Brunet, 1997; CSIRO, 1970; DEW, 2007; Harvey and Yen, 1989; Raven *et al.* 2002) were used to group specimens typically to the level of Order.

Spiders were sorted by OES staff to differentiate potential mygalomorph species. Potential mygalomorph spiders were delivered to Professor Barbara York Main of UWA for subsequent identification, and millipede, scorpions and centipede specimens were delivered to Dr Mark Harvey of WAM.

The sieved soil samples collected from survey sites were inspected for terrestrial mollusc specimens in the OES Laboratory. A thin layer of soil was placed into a gridded petri dish and inspected under magnification. Mollusc specimens collected were subsequently wrapped in tissue, placed in labelled vials and delivered to Ms Shirley Slack-Smith of WAM.

4.0 VERTEBRATE FAUNA

4.1 Sampling Adequacy

Standard species accumulation curves were produced for the different vertebrate groups recorded during both survey periods as a basic aid to assessing sampling adequacy. Data is inclusive of all sampling methods; however, in regard to mammals it excludes bats, feral animals, and domestic stock. Accumulation curves are presented as the number of species recorded over time.

4.1.1 Autumn Survey

From the species accumulation curves (Figure 6) it can be seen that reptile and native mammal data indicate a point of diminishing returns towards the end of the autumn survey period with just one additional native mammal and one additional reptile recorded over the last three days.

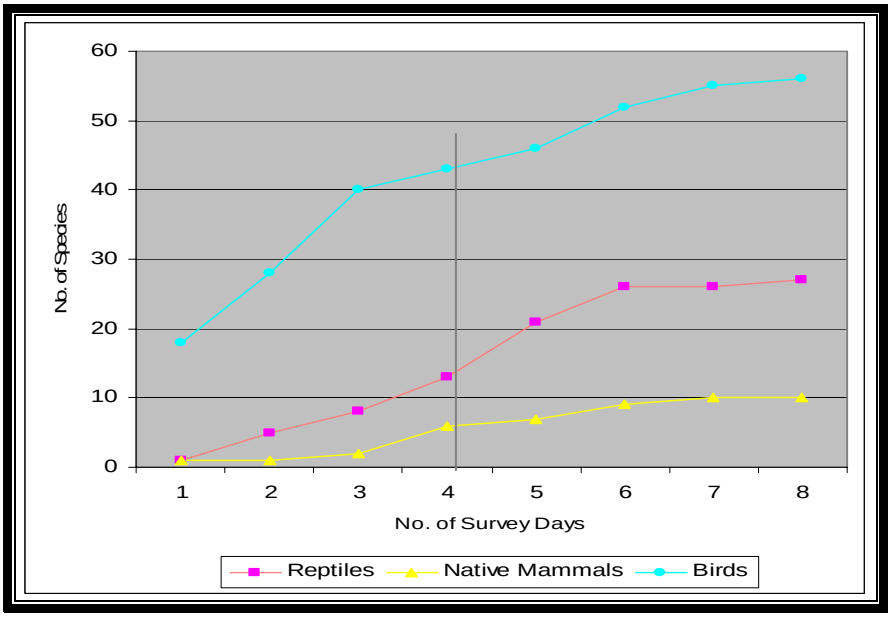

Figure 6 Species accumulation curves for vertebrate fauna: Autumn survey

The number of bird species recorded increased quickly at the commencement of the trapping component of the survey before slowing tapering off. However, new bird species were still being recorded at the end of the autumn survey, with four additional species recorded over the last three days.

The accumulation curve for native mammals indicates just one mammal recorded during the first two days before slowly rising to a total of ten on day seven. The number recorded was expected for the bioregion, with the number of small mammal species being relatively low compared to birds and reptiles. Small dasyurids often have wide yet patchy distributions with low population densities. Due to their absence of fixed home ranges they are often considered 'serially nomadic', dispersing widely until favourable conditions are encountered (Gibson and McKenzie, 2005). Three small and one medium-sized dasyurid were captured during the survey.

Based on the accumulation curves, the data suggest that sampling was adequate for the particular season sampled. However, sampling during a different season would likely increase numbers of all groups for the site, particularly reptiles. Although 27 species of reptile were recorded, few of the nocturnal geckos were recorded due to the cool night time temperatures experienced during the autumn survey.

4.1.2 Summer Survey

More reptiles were recorded during the summer survey when compared to the autumn survey, but fewer species of mammals and birds were recorded. Warmer temperatures were experienced during the summer survey that facilitated the capture of reptiles. However, overall conditions were much better during the autumn survey, with the flowering of plants and growth flushes after significant rainfall recorded during summer of 2006-2007, favouring mammals and birds.

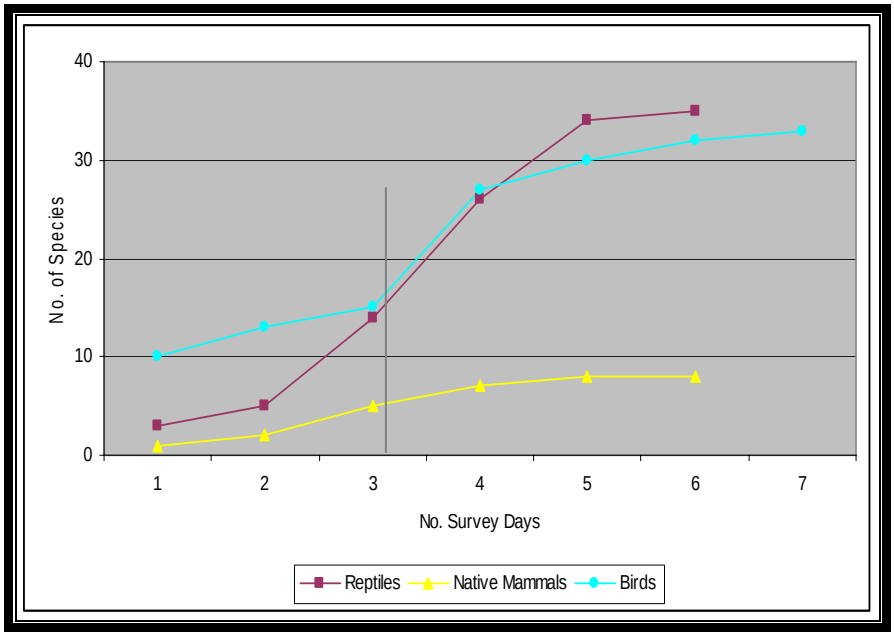

Figure 7 Species accumulation curves for vertebrate fauna: Summer survey

The accumulation curve for birds includes an additional day as traplines were closed prematurely due to inclement weather, although bird censussing continued (Figure 7). Interestingly, more reptile species were than bird species were recorded. Thirty-five reptile species were recorded, including many gecko species not recorded during the autumn survey. Numbers increased appreciably after the commencement of trapping on day three. The accumulation curve for mammals indicates a point of diminishing returns towards the end of the summer survey. However, new bird and reptile species were still being recorded towards the end of the survey.

4.1.3 Combined Surveys

Combined survey effort totalled 1,765 vertebrate trap nights and 5,120 minutes spent on systematic surveys within representative habitats during both surveys, as well as over 2,000 minutes spent on targeted searches (Tables 5 and 6). More than 280 records were made during the trapping component of the surveys, with evidence of 24 mammals, 39 reptiles and 60 birds being recorded.

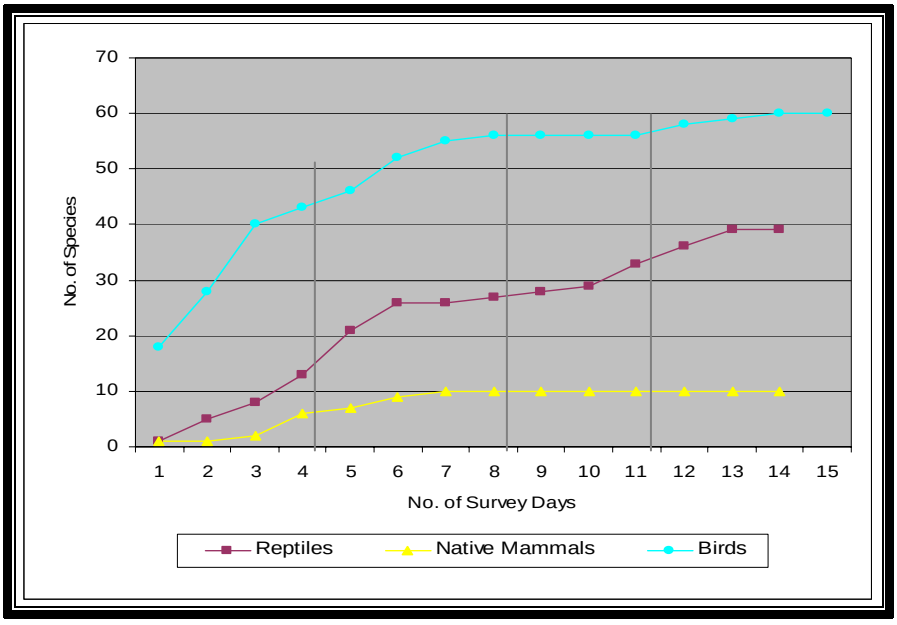

Figure 8 Species accumulation curves for vertebrate fauna: Combined surveys

Apart from one bat species (data not included in accumulation curves), no additional native mammals were recorded during the summer survey, and just four additional birds. In contrast, 11 additional reptiles (or 28% of the total reptile list) were recorded during the summer survey, including several species of gecko.

Combined accumulation curves indicate an adequate sampling intensity, particularly for mammals and birds (Figure 8). Due to the prevailing weather conditions experienced during sampling events, no amphibians were recorded over the project area. However, the Desert Tree Frog (*Littoria rubella*) was recorded at Barwidgee Station during the autumn survey.

4.2 Vertebrate Fauna Habitats

The five sites selected for systematic surveying represented fauna habitats that are characteristic of the project area, and are generally consistent with classifications used elsewhere in biodiversity assessments. Fauna habitats where systematic surveying was undertaken were classified as:

- LM01: Spinifex Plains
- LM02: Mulga Woodland

- LM03: Mallee over Spinifex
- LM04: Bull Spinifex on Lake Edge
- LM05: Woodland on Calcrete Flats

The other characteristic habitat over the project area is Samphire (*Halosarcia* spp.) Flats (LM06) associated with the vegetated lake bed of Lake Maitland Salt Lake. Vertebrate trapping was not undertaken over Samphire Flats habitat because past experience has shown that this habitat type is relatively unproductive. Amphibians are absent in this habitat due to the salinity, and apart from the Salt Lake Dragon (*Ctenophorus salinarum*), reptiles and small ground mammals targeted by this methodology are largely absent, probably due to a combination of salinity, regular flooding, and lack of structural complexity.

Spinifex and shrubland habitats over the project area are currently significantly impacted by frequent fire, and to a lesser extent, by stock grazing and weed invasion. Selection of survey sites was heavily biased towards areas of unburnt vegetation.

Table 8 No. of species (species richness) recorded at survey sites

Group	LM01 Spinifex Plains	LM02 Mulga Woodland	LM03 Mallee over Spinifex	LM04 Bull Spinifex	LM05 Woodland on Calcrete
Mammals (excluding bats and exotics)	7	4	7	4	3
Birds	7	15	16	7	14
Reptiles	13	20	16	10	17
Amphibians	-	-	-	-	-
Total	27	39	39	21	34

Woodland sites (LM02 and LM05) and/or sites incorporating trees (LM03) recorded greater species richness for birds and reptiles than did other sites (Table 8). Moreover, abundances also reflected this trend for birds (Table 9). Reptiles were more abundant at sites on sandy soils supporting spinifex (LM01 and LM03). These sites also recorded higher species richness for mammals than other sites. Reptile species richness was lower at sites LM04 and LM05. These sites lacked sandy substrates, which are important to a wide-range of burrowing and fossorial ground fauna. Bird diversity is likely to be influenced by the structural complexity of woodland habitats, whereas many of the small mammals and reptiles recorded are burrowing species that prefer sandy substrates.

Table 9 Abundances recorded at survey sites

Group	LM01 Spinifex Plains	LM02 Mulga Woodland	LM03 Mallee over Spinifex	LM04 Bull Spinifex	LM05 Woodland on Calcrete
Mammals (excluding bats and exotics)	30	8	17	30	6
Birds	15	58	41	33	43
Reptiles	38	37	47	26	24
Amphibians	-	-	-	-	-
Total	83	103	105	89	73

Sites that recorded lower overall species richness tended to support species that were absent at other, more productive sites. For example, the Stripe-faced Dunnart *(Sminthopsis macroura)* was recorded exclusively at site LM04, together with over 75% of Desert Mouse *(Pseudomys desertor)* captures. Both species are found in a variety of habitats throughout their range, but may have been restricted to these habitat types due to competition for food and resources from other species.

4.3 Vertebrate Fauna Recorded within the Project Area

Results of database searches are presented in Appendices A to H. A list of species potentially found over the project area, based on database searches and a literature review, is presented in Appendix I. It is unlikely that all of the species listed in Appendix I actually occur over the project area due to the lack of specific micro-habitats preferred by some species. Records of species identified from the project area during the two combined surveys are detailed below.

4.3.1 Mammals

Twenty-four species of mammal, representing 12 families, were recorded over the project area during the combined surveys (Tables 10 and 11). Of these, 18 were native species, four introduced, and two domestic stock. Four Dasyurids and three native rodents were recorded. By comparison, 15 native mammals were recorded by How and Dell (1992) over three comprehensive survey periods at Banjawarn in the Duketon-Sir Samuel block of the biological survey of the Eastern Goldfields, and 15 over one survey period by OES (2008) at Lake Way.

In their study, How and Dell (1992) recorded more Dasyurid species, while this study recorded more bats. All rodents, and all but two bats, recorded by How and Dell (1992) were also recorded during this study. The seven species of bats recorded by OES (2008) at Lake Way were the same seven species recorded during this survey (Table 11). Species recorded during this survey and not recorded by OES (2008) or How and Dell (1992) were the Mulgara *(Dasycercus cristicauda)* and Desert Mouse *(Pseudomys desertor)*.

There are 47 mammal species known from the entire Murchison bioregion (NLWA, 2002), while WAM searches (Appendix B) list 27 native mammal species as recorded in the general vicinity of the project area. However, many of these are bats and exotic species, and/or species restricted to habitats not represented over the project area, particularly rocky escarpments. Furthermore, NLWA (2002) considers that 20 mammal species no longer occur in the bioregion, and a number of species are now either extinct (e.g. Lesser Stick-nest Rat (*Leporillus apicalis*), Pig-footed Bandicoot (*Chaeropus ecaudatus*), Crescent Nail-tail Wallaby (*Onycholgalea lunata*), Long-tailed Hopping-mouse (*Notomys longicaudatus*) and Short-tailed Hopping-mouse(*Notomys alexis*)) or regionally extinct (e.g. Numbat (*Myrmecobius fasciatus*), Chuditch (*Dasyrus geoffroii*), Common Brushtail Possum (*Trichosurus vulpecular*), Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*) and Greater Bilby (*Macrotis lagotis*)). Apart from the hopping-mice all these species are critical weight range (CWR) mammals with weights between 35g and 5,500g) that have been most affected by environmental changes following European settlement, fox and cat predation and changed fire regimes (Burbidge and McKenzie, 1989). The bioregion, therefore, has very high 'faunal attrition' and 'faunal contraction' indices at 0.45 and 0.4 respectively (NLWA, 2002).

Table 10 Mammals (excluding bats) recorded from Lake Maitland

Species		Survey		Sites					Other
		Au	Su	LM01	LM02	LM03	LM04	LM05	
Echidna	*Tachyglossus aculeatus*	x	x	x	x	x		x	
Mulgara	*Dasycercus cristicauda*	x	x	x					MUL
Wongai Ningaui	*Ningaui ridei*	x	x			x			
Stripe-faced Dunnart	*Sminthopsis macroura*	x					x		
Ooldea Dunnart	*Sminthopsis ooldea*	x				x		x	
Euro	*Macropus robustus erubescens*	x	x		x	x			
Red Kangaroo	*Macropus rufus*	x	x	x			x	x	
Spinifex Hopping-mouse	*Notomys alexis*	x	x	x	x	x			
Desert Mouse	*Pseudomys desertor*	x	x	x		x	x		
Sandy Inland Mouse	*Pseudomys hermannsburgensis*	x	x	x	x		x		
*House Mouse	*Mus musculus*	x	x	x			x	x	
Dingo / Wild dog	*Canis lupus dingo*	x	x	x		x			
*Red Fox	*Vulpes vulpes*		x						x
*Feral Cat	*Felis catus*	x	x			x	x		
*European Rabbit	*Oryctolagus cuniculus*	x	x	x	x	x	x	x	
*European Cattle	*Bos taurus*	x	x		x	x		x	
*Sheep	*Ovis aries*	x	x						x

** Introduced species*

All native mammals were either trapped, or recorded through inventory searches, spotlight searches and AnaBat recordings. Evidence of all mammals, other than bats, domestic sheep, and the Red Fox (*Vulpes vulpes*) were recorded within survey sites. Movements of domestic stock appear to be well controlled, with high quality fencing separating cattle and Damara sheep from large parts of the project area. The Red Fox was not recorded during the autumn survey, however a scat was recorded in Mulga Woodland during the summer survey. Large numbers of Wild Dogs (*Canis lupus*) may be suppressing this species.

The threatened Mulgara was trapped during both surveys at two sites in Spinifex Plains habitat, including at a location where they had been captured previously in 1997 (HGM, 1997). During the autumn survey three males were captured, and evidence of the species (i.e. burrows and diggings) was recorded. During the summer survey, an adult female in breeding condition was also captured (Section 7.2). The Desert Mouse was common in unburnt spinifex communities with 33 trapping records. Also recently recorded from Mt Keith, its presence at Lake Maitland is close to the western edge of its distribution. This range of this species has recently been significantly extended, possibly as a consequence of an irruption in response to good seasons in central Australia (Cooper *et. al*. 2006).

The Spinifex Hopping-mouse (*Notomys alexis*) was the most common mammal species captured with 49 records. However, the vast majority of records were made during the autumn survey, with just five records made during the summer survey. By contrast, the House Mouse (*Mus musculus*) was relatively uncommon with just eight trapping records overall.

The Red Kangaroo was abundant in the chenopod flats and calcrete flats covering and surrounding Lake Maitland Salt Lake, and the Euro was common in shrubland and Mulga Woodland.

Table 11 Bat species recorded from Lake Maitland

Species		SITE			
		May 2007		Dec 2007	
		Bore 15	Barwidgee Homestead	Bore 15	Maitland Camp
Hill's Sheathtail Bat	*Taphozous hilli*				x
Gould's Wattled Bat	*Chalinolobus gouldii*	x		x	x
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	x	x	x	x
Inland Broad-nosed Bat	*Scotorepens balstoni*	x		x	x
Finlayson's Cave Bat	*Vespadelus finlaysoni*	x	x		
Southern Freetail Bat	*Mormopterus planiceps*	x			x
White-striped Freetail Bat	*Tadarida australis*	x	x		

Seven bat species were recorded during combined surveys (Table 11). Four or five species were recorded consistently at Bore 15 over the four nights surveyed. Hill's Sheathtail Bat (*Taphozous hilli*) was not recorded during the autumn survey, and just once during the summer survey. The same seven species of bats were also recorded by OES (2008) at Lake Way, in comparable habitats. Given the habitats present, seven species is considered a satisfactory result for the site. Hill's Sheathtail Bat and Finlayson's Cave Bat (*Vespadelus finlaysoni*) roost in cave systems and are therefore not likely to roost in the project area due to a lack of habitat. The other five species are known to use hollows in trees as roost sites and therefore may roost over the project area in woodland habitats. Of the bat species recorded, none are considered of conservation significance.

4.3.2 Birds

Sixty species of bird were observed during the combined surveys (Table 12). Of these, 30 were recorded from survey sites, with a further 30 species recorded opportunistically over the project area, or during targeted searches for other species. This compares with 50 recorded by Ninox (1993) at the nearby Bronzewing Gold Project, 70 by How and Dell (1992) in the Duketon-Sir Samuel block of the biological survey of the Eastern Goldfields, 111 at Wanjarri Nature Reserve (Moriarty, 1972), and 210 by Birds Australia in the Murchison Bioregion (Blakers *et al*. 1984; Barrett, *et al.* 2003). Differences in numbers are due to differences in survey scale and survey intensity. Scale refers to the size of area surveyed and variability of habitats covered. Survey intensity includes the length of the survey period as well as timing of surveys. For example, Birds Australia data were accumulated over many years over the entire bioregion within numerous habitats. Similarly, Moriarty (1972) data were accumulated over many years, and within additional habitats that do not occur over the project area (CALM, 1996). Moriarty (1972), How and Dell (1992) and Birds Australia data are likely to include species not present at Lake Maitland due to the range of habitats surveyed, however these studies give an indication of species that may occur in the outer area.

Table 12 Bird species recorded from Lake Maitland

Species		Survey		Sites					Other
		Au	Su	LM01	LM02	LM03	LM04	LM05	
Emu	*Dromaius novaehollandiae*	x	x			x			
Black-shouldered Kite	*Elanus axillaris*	x							x
Black Kite	*Milvus migrans*		x						x
Collared Sparrowhawk	*Accipiter cirrhocephalus*		x						x
Wedge-tailed Eagle	*Aquila audax*	x	x						x
Little Eagle	*Hieraaetus morphnoides*	x	x						x
Brown Falcon	*Falco berigora*	x	x						x
Australian Hobby	*Falco longipennis*	x							x

Species		Survey		Sites					Other
		Au	Su	LM01	LM02	LM03	LM04	LM05	
Nankeen Kestrel	*Falco cenchroides*	x	x						x
Bush Stone-curlew	*Burhinus grallarius*	x							x
Black-fronted Dotterel	*Elseyornis melanops*	x							x
Common Bronzewing	*Phaps chalcoptera*	x	x		x	x			
Crested Pigeon	*Ocyphaps lophotes*	x	x	x		x		x	
Diamond Dove	*Geopelia cuneata*	x		x					
Galah	*Eolophus roseicapillus*	x	x					x	
Little Corella	*Cacatua sanguinea*	x							x
Cockatiel	*Nymphicus hollandicus*	x							x
Australian Ringneck	*Barnardius zonarius*	x	x			x			
Mulga Parrot	*Psephotus varius*	x	x		x	x			
Budgerigar	*Melopsittacus undulatus*	x							x
Tawny Frogmouth	*Podargus strigoides*	x							x
Spotted Nightjar	*Eurostopodus argus*	x							x
Australian Owlet-nightjar	*Aegotheles cristatus*	x	x						x
Splendid Fairy-wren	*Malurus splendens*	x							x
Variegated Fairy-wren	*Malurus lamberti*	x	x		x	x			
White-winged Fairy-wren	*Malurus leucopterus*	x	x				x	x	
Redthroat	*Pyrrholaemus brunneus*	x			x			x	
Weebill	*Smicrornis brevirostris*	x				x			
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	x	x		x	x		x	
Slaty-backed Thornbill	*Acanthiza robustirostris*	x			x		x	x	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	x			x	x		x	
Yellow-throated Miner	*Manorina flavigula*	x	x	x		x			
Singing Honeyeater	*Lichenostomus virescens*	x	x		x		x	x	
Grey-headed Honeyeater	*Lichenostomus keartlandi*	x							x
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	x							x
Grey-fronted Honeyeater	*Lichenostomus plumulus*	x							x
White-plumed Honeyeater	*Lichenostomus penicillatus*	x						x	
Brown Honeyeater	*Lichmera indistincta*	x			x				
Crimson Chat	*Epthianura tricolor*	x							x
Red-capped Robin	*Petroica goodenovii*	x							x
White-browed Babbler	*Pomatostomus superciliosus*	x	x		x			x	
Chiming Wedgebill	*Psophodes occidentalis*	x	x		x	x	x	x	
Chestnut Quail-thrush	*Cinclosoma castanotus*	x							x
Crested Bellbird	*Oreoica gutturalis*	x							x
Rufous Whistler	*Pachycephala rufiventris*	x	x		x	x		x	
Grey Shrike-thrush	*Colluricincla harmonica*	x				x			
Magpie-lark	*Grallina cyanoleuca*	x	x						x
Willie Wagtail	*Rhipidura leucophrys*	x	x		x				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	x	x		x		x	x	

Species		Survey		Sites					Other
		Au	Su	LM01	LM02	LM03	LM04	LM05	
White-winged Triller	*Lalage sueurii*		x						x
Black-faced Woodswallow	*Artamus cinereus*	x	x						x
Grey Butcherbird	*Cracticus torquatus*	x							x
Pied Butcherbird	*Cracticus nigrogularis*	x	x	x		x			
Australian Magpie	*Gymnorhina tibicen*	x	x	x		x	x		
Little Crow	*Corvus bennetti*	x	x	x				x	
Western Bowerbird	*Chlamydera guttata*	x	x			x			
Australian Pipit	*Anthus novaeseelandiae*	x	x	x			x		
Zebra Finch	*Taeniopygia guttata*	x	x		x				
White-backed Swallow	*Cheramoeca leucosternus*	x							x
Welcome Swallow	*Hirundo neoxena*	x	x						x

Some migratory, nomadic or irruptive bird species, such as particular honeyeater species and passerines such as the Grey Fantail (*Rhipidura fuliginosa*) and Western Gerygone (*Gerygone fusca*), were not present during surveys due to the time of year. Migratory birds are those with regular seasonal movements and several species move into the Murchison during the winter-spring period, with some returning to the southwest during summer-autumn, and others moving to northern Australia during this period. Irruptive and nomadic species are those that occur in an area occasionally due to a response to temporary favourable conditions (either on-site or elsewhere). Appendix I includes those migratory, nomadic, or irruptive species likely to occur over the project area over particular seasons or favourable climatic conditions. Similarly, it also includes a number of waders and waterbirds that may be present over Lake Maitland in periods of flood. However, Lake Maitland is almost completely vegetated with very little unvegetated lake bed (playa) present. Water does not appear to persist for extended periods compared to other salt lakes in the region. Although listed in Birds Australia (Appendix I), there is little potential for the Hooded Plover (*Thinornis rubricollis*), a rare waterbird that prefers sandy beaches, to utilise Lake Maitland due to the lack of surface water and shore habitat. However, some waders and waterbirds may be attracted to the project area if persistent or permanent surface water becomes available as part of the project design.

Targeted searches for Slender-billed Thornbill, Malleefowl, Striated Grasswren and Australian Bustard did not reveal any evidence of these species. However, the Bush Stone-curlew, a Priority 4 species, was recorded in chenopod flats surrounding Lake Maitland during the autumn survey.

Of the bird species not recorded at survey sites, a significant number were recorded at Bore 15. Although not a natural habitat, stock wells such as this provide permanent fresh water, thereby influencing the distribution and abundance of birds over an area.

4.3.3 Reptiles

The Murchison Bioregion is rich in reptiles and over 80 species are known from the region (NLWRA, 2002). However, due to the lack of habitats over the project area that are represented elsewhere in the bioregion, the number is likely to be significantly lower for the site.

Thirty-nine species of reptile were recorded during the surveys, including 11 geckos, six dragons, and 15 skinks. Thirty-two species were recorded by OES (2008) during a single survey at Lake Way, and 46 by How and Dell (1992) over three survey periods in the Duketon-sir Samuel block of the biological survey of the Eastern Goldfields.

Although habitat preferences for reptiles are not completely understood, dunefields, rocky ranges and hills, granite tors, and riverine habitats are all habitats that support a large number of species but are not represented over the project area. For example, the Perentie (*Varanus giganteus*) is known from immediately north of the project area (R. Dodds, *pers comm*). However, this species as well as others such as *Ctenophorus ornatus* (Ornate Dragon) and *Ctenophorus caudicinctus* (Ring-tailed Dragon) prefer rocky areas and are unlikely to be present due to a lack of habitat The Long-nosed Dragon (*Lophognathus longirostris),* recorded by OES (2008), is not likely to be present due to a lack of creekline habitat. Semi-arboreal species that rely on loose bark, hollow limbs, and logs are likely to be restricted in distribution over the project area. Nevertheless an arboreal Gecko with a spiny tail was observed in woodland on calcrete flats, but not captured. This is likely to be the Western Spiny-tailed Gecko (*Strophurus strophurus*) due to morphology, habitat, and distribution patterns. The Pygmy Spiny-tailed Skink *(Egernia depressa)* was also recorded in woodland on calcrete flats habitat (Site LM05). One species of snake was recorded, the Monk Snake (*Parasuta monachus*) (Table 13). It is likely that more snake species utilise the project area but were not captured due to unfavourable weather conditions.

An anecdotal record exists for Stendacher's Turtle *(Chelodina steindachneri)* from Lake Maitland (R. Dodds, *pers comm*). This species is common in semi-arid areas and undertakes extended aestivation during times of drought.

Table 13 Reptile species recorded from Lake Maitland

Species		Survey		Site					Other
		Au	Su	LM 01	LM 02	LM 03	LM 04	LM 05	
Central Military Dragon	*Ctenophorus isolepis isolepis*	x	x	x	x	x			
Central Netted Dragaon	*Ctenophorus nuchalis*	x	x					x	
Claypan Dragon	*Ctenophorus salinarum*	x	x					x	
Lozenge-marked Dragon	*Ctenophorus scutulatus*	x	x		x				
Thorny Devil	*Moloch horridus*	x	x	x	x				
Bearded Dragon	*Pogona minor minor*		x		x				

Species		Survey		Site					Other
		Au	Su	LM 01	LM 02	LM 03	LM 04	LM 05	
Sandplain Gecko	*Diplodactylus stenodactylus*	x	x				x		
Fat-tailed Gecko	*Diplodactylus conspicillatus*		x	x	x	x	x		
	Diplodactylus pulcher		x					x	
	Gehyra purpurascens	x	x		x	x		x	
Variagated Gecko	*Gehyra variegata*	x	x			x		x	
Bynoe's Gecko	*Heteronotia binoei*	x	x		x	x			
	Nephrurus vertebralis		x					x	
Banded Knob-tailed Gecko	*Nephrurus wheeleri*		x						x
Beaked Gecko	*Rhynchoedura ornata*	x	x		x	x		x	
Spiny-tailed Gecko	*Strophurus sp*	x						x	
Jewelled Gecko	*Strophurus elderi*		x			x	x		
	Delma nasuta		x			x			
Burton's Legless Lizzard	*Lialis burtonis*	x	x		x	x			
Fence Skink	*Cryptoblepharus plagiocephalus*	x	x		x				
	Ctenotus atlas	x		x					
	Ctenotus grandis	x	x			x		x	
	Ctenotus helenae		x		x	x	x		
	Ctenotus leonhardii	x	x	x	x	x	x	x	
Leopard Ctenotus	*Ctenotus pantherinus ocellifer*	x	x		x	x	x		
	Ctenotus schomburgkii	x	x	x	x	x	x	x	
	Ctenotus severus		x	x	x				
Pygmy Spiny-tailed Skink	*Egernia depressa*		x					x	
Broad-banded Sand-swimmer	*Eremiascincus richardsonii*		x					x	
	Lerista bipes	x	x	x	x	x	x	x	
	Lerista desertorum	x	x	x	x	x			
	Lerista muelleri	x	x		x		x	x	
Dwarf Skink	*Menetia greyii*	x	x	x	x		x	x	
Central Blue-tongue	*Tiliqua multifasciata*		x	x					
Pygmy Desert Monitor	*Varanus eremius*	x	x	x					
Gould's Goanna	*Varanus gouldii*	x	x						x
Yellow-spotted Monitor	*Varanus panoptes rubidus*	x	x		x			x	
Monk Snake	*Parasuta monachus*	x							x
Steindachner's Turtle	*Chelodina steindachneri*	x							x

4.3.4 Amphibians

Although no amphibians were recorded over the project area, the Desert Tree Frog *(Littoria rubella)* was present at Barwidgee Homestead during the reconnaissance survey. This Eyrean species is near its southern distributional range in the project area.

WAM list ten species that could potentially occur in the region. Five species were recorded by How and Dell (1992) in the Duketon-Sir Samuel block of the biological survey of the Eastern Goldfields. All have aquatic larval stages and all, except the Desert Tree Frog, burrow to avoid desiccation

through heat. Salt levels are likely to be too high within Lake Maitland Salt Lake to support frogs and, if present, they are more likely to occur in intermittent and temporary freshwater pools surrounding the lake or associated with stock watering sites such as Bore 15. The Desert Tree Frog usually favours Eucalypts along creeklines, or man-made habitats, and is not likely to be present in natural habitats over the project area due to a lack of such preferred habitat.

4.3.5 Introduced Species

Introduced exotic species that occur in the Murchison bioregion are listed in Table 14. Apart from the species recorded, the Feral Goat (*Capra hircus*), and Dromedary Camel (*Camelus dromedarius*) are also all likely to be present over the project area at certain times; although the current pastoral operation on Barwidgee is controlling feral grazing animals.

The introduced birds listed in Table 14 are largely restricted to the modified environments of major towns to the south of the project area and are unlikely to occur in the project area.

Table 14 Introduced exotic species possibly occurring over the project area (NLWA, 2002)

Group	Common Name	Scientific Name
Mammals	*House Mouse	*Mus musculus*
	*Dingo / Wild Dog	*Canis lupus dingo*
	*Red Fox	*Vulpes vulpes*
	*Cat	*Felis catus*
	*European Rabbit	*Oryctolagus cuniculus*
	Brumby / Horse	*Equus caballus*
	Donkey	*Equus asinus*
	Dromedary Camel	*Camelus dromedarius*
	*European Cattle	*Bos taurus*
	Goat	*Capra hircus*
	*Sheep	*Ovis aries*
Birds	Rock Dove	*Columba livia*
	Laughing Turtle-Dove	*Streptopelia senegalensis*
	Spotted Turtle-Dove	*Streptopelia chinensis*

* Recorded during surveys

5.0 SHORT-RANGE ENDEMIC INVERTEBRATES

There were a number of invertebrate groups identified that have the potential to exhibit short range endemism, which were collected at Lake Maitland during both the autumn and summer surveys. Specimens were delivered to appropriate experts at the WAM and the UWA (Appendix J). Specimens included mygalomorph spiders, scorpions, centipedes, pseudoscorpions and terrestrial snails.

5.1 Mygalomorph Spiders

Mygalomorph spiders are known as the 'primitive' spiders and encompass funnel-web and trapdoor spiders. These spiders fall within the sub-order Mygalomorphae, which is represented by ten families in Australia, eight of which are known to occur in Western Australia. Of these eight families, the family Migidae is confined to the moist forested and topographically elevated areas of the southwest (Main, 2008) and is therefore unlikely to occur over the project area.

The remaining seven families potentially occur within the project area of Lake Maitland. These families include the Actinopodidae, Barychelidae, Ctenizidae, Dipluridae, Idiopidae, Nemesiidae and Theraphosidae (Raven *et al*. 2002). A Threatened and Priority Fauna Database search of the project area by the DEC revealed that the Priority 2 mygalomorph spider *Kwonkan moriartii* (Main 1983) has been collected from Kathleen Valley, approximately 70 km southwest of the project area (Appendix A). Little is known about this species other than that the single record is represented by the halotype specimen collected in 1962. This species was not collected during either the autumn or summer survey at Lake Maitland.

A number of mygalomorph spider specimens were collected during both surveys (Appendix J). Evidence of presence, in the form of mygalomorph spider burrows and trapdoor lids, was also documented. Mygalomorph spiders were collected from sites LM01 to LM05, but not from Samphire Flat habitat or Kopi Ridge habitat (LM06 and LM07). Identifications of mygalomorphs collected during the autumn and summer surveys are presented in

Table 15 and Table 16 respectively.

Table 15 Mygalomorph spiders collected during the autumn survey

Site	Sex	Family	Genus/Species
LM01	Female	Nemesiidae	*Aname* sp
	Female	Idiopidae	*Aganippe* sp
	Female	Idiopidae?	*Possibly Aganippe* ? or *Eucyrtops* ?
LM02	Female	Nemesiidae	*Aname* sp
	Juvenile	Nemesiidae	Possibly *Teyl? or Aname?*
	Female	Nemesiidae	*Aname* sp
	Female	Idiopidae	*Gaius* sp
LM03	Female	Idiopidae	*Arbanitis* sp
LM04	Male	Dipluridae	*Cethegus* sp
Barwidgee Station homestead	Female	Idiopidae	*Gaius* sp

Specimens from three of the six families possibly occurring over the project area were identified during the autumn survey, with at least five separate genera identified within these families (Table 15). Mulga Woodland (site LM02) was the most productive habitat for mygalomorph spiders during the autumn survey with at least three taxa occurring, followed by Spinifex Plains habitat (site LM01), with at least two taxa.

Six families were identified during the summer survey (including one specimen from the family Theraphosidae, which are predominantly restricted to the tropics). At least nine separate taxa were represented. Both the Mulga Woodland (site LM02) and the Spinifex Plains habitat (LM01) were the most productive habitat for mygalomorph spiders during the summer survey with at least four taxa occurring at each (Table 16).

Table 16 Mygalomorph spiders collected during the summer survey

Site	Sex	Family	Species
LM01	Female	Theraphosidae	*Selenocosmia sterlingi* Hogg
	Male	Idiopidae	*Gaius villosus* Rainbow
	Male	Idiopidae	*Gaius villosus* Rainbow
	Male	Ctenizidae	*Conothele sp. nov.*
	Female + Juvenile	Idiopidae	*Gaius villosus* Rainbow
	Female	Nemesiidae	*Aname sp.* B
LM02	Female	Idiopidae	*Gaius villosus* Rainbow
	Female	Nemesiidae	*Aname sp.* A
	Female	Idiopidae	*Gaius villosus* Rainbow
	Male	Ctenizidae	*Conothele sp. nov.*
	Female	Idiopidae	*Gaius villosus* Rainbow
	Juvenile	Barychelidae	*Unidentifiable*
	Female	Idiopidae	*Gaius villosus* Rainbow
LM03	Male	Idiopidae	*Gaius villosus* Rainbow
	Male	Nemesiidae	*Kwonkan sp. nov.* A
LM04	Female	Dipluridae	*Cethegus sp. nov.*
LM05	3 x Female	Nemesiidae	*Aname sp.* B
	Female / Juvenile	Dipluridae	*Cethegus sp. nov.*
	Female	Dipluridae	*Cethegus sp. nov.*
	Female	Dipluridae	*Cethegus sp. nov.*
	Male	Nemesiidae	*Kwonkan sp. nov.* A
	Male	Nemesiidae	*Kwonkan sp. nov.* A

Mygalomorph systematics and taxonomy is complex, with many known taxa undescribed or currently in the process of revision. The identifications presented in

Table 15 were as complete as possible at the time of writing this report (Main pers comm., 2007). Identifications are often complicated by the sex (females harder to identify) and maturity of the specimens collected. The results presented in Table 16 tend to have more specific identifications since a number of male specimens were captured. Male specimens of mygalomorph spiders often have the diagnostic characteristics necessary to identify a specimen confidently to species level.

There were two specimens of Barychelidae collected at site LM02 during the summer survey (Table 16). Both specimens were juveniles and subsequently could not be identified beyond family level. Adults, particularly males, would be necessary to allow more specific identification.

Two specimens from the Ctenizidae family were found during the summer survey (Table 16). These were both *Conothele* sp. *nov.* from sites LM01 and LM02. Currently the distribution of this species is unknown due to the lack of male specimens documented from the outer wheatbelt and eastern Goldfields. This species possibly has a restricted range (Main, 2008).

One species of the Dipluridae family was collected during the autumn and summer surveys (Tables 15 and 16). *Cethegus* sp. *nov.* and was collected at sites LM04 and LM05. The genus *Cethegus* is widely distributed in the tropics and is the only web-weaving mygalomorph in WA. They are known as the 'curtain web' spiders and in arid areas they site their burrows adjacent to shrubs, rocks or logs, and construct a distinctive curtain web of strands of silk and soil attached to the adjacent structures. Currently, only one species has been formally described from WA (*C. fugax* (Simon) from the northern jarrah forest) but several other species are recognised. The specimens from Lake Maitland are difficult to relate to other populations due to the lack of male specimens collected (Main, 2008).

One species of the family Idiopidae was found at LM01 and at Barwidgee station during the autumn survey (Table 15); and LM01, LM02 and LM03 during summer survey (Tables 16). The specimens from the autumn survey were identified as *Gaius* sp., however, it was not possible to be more specific in their identification without male specimens. During the summer survey, a rainfall event provided the conditions that are conducive for males of *Gaius* and other genera to leave their burrows in search for females. The male specimens of *Gaius* were captured in vertebrate pitfall traps (Plate 9) and these specimens allowed Main (2008) to confidently identify them as *Gaius villosus* Rainbow. The species *G. villosus* is a very large trapdoor spider that is widely distributed in the lower Murchison, northern and central wheatbelt and western Goldfields (Main, 2008) (Plate 10).

Plate 9 *Gaius villosus* Rainbow: Male specimens captured in a vertebrate pit trap (150mm diameter pipe) after a summer storm (LM01: Spinifex Plains)

Plate 10 *Gaius villosus* Rainbow: Trapdoor burrow (left) and adult female (right), from Site LM02: Mulga Woodland

Four species were found from two genera (*Kwonkan* and *Aname*), which belong to the family Nemesiidae (Tables 15 and 16). One male specimen from the species *Kwonkan* sp. *nov.* A was found at LM03 and two male specimens from the species *Kwonkan* sp. *nov* B were found at LM05. However, species A and B are doubtfully distinct (variation in leg spination) and are probably the same species (Main, 2008). The general morphology of these specimens of *Kwonkan* is distinctive from all named species from this genus, with this species likely to have a restricted distribution in the area surveyed (Main, 2008).

The other two species collected, which belong to the family Nemesiidae, are: *Aname* sp. A from site LM02; and *Aname* sp. B from sites LM01 and LM05. The species *Aname* sp. A (Plate 11) is possibly from the "armigera" species group; however, male specimens would be necessary to determine the correct identity of this species. The "armigera" species group is generally widespread in semi-arid regions, such as the wheatbelt and the western part of the goldfields. Main (2008) was not familiar with *Aname* sp. B following an examination at the female specimens. This "species" may be restricted in its distribution and male specimens would be required to identify it more accurately.

Plate 11 *Aname* sp. A: female specimen collected at LM02: Mulga over Chenopod

One specimen from the family Theraphosidae was collected during the summer survey (Table 16). This specimen was the species *Selenocosmia stirlingi* Hogg collected at site LM01 (Plate 12). This species is commonly referred to as the "barking spider" or "bird eating spider" from Central Australia. On the basis of the current identification, the species is widely distributed in the arid interior (WA, SA and NT). However, the species needs reviewing as some populations may rightly belong to one (or several) unnamed species (Main 2008).

Plate 12 *Selenocosmia stirlingi* Hogg: burrow (left) and adult female (right) collected at site LM01: Spinifex Plains

In summary, there were a number of mygalomorph genera collected in the survey area that possibly have restricted ranges; these were *Conothele* sp, *Cethegus*, *Aname* sp. B. and *Kwonkan* sp. nov A and B. However, without a review of all these genera it is difficult to make conclusive comments; with current knowledge *Aname* sp. B is the most likely to have a restricted distribution (Main, 2008).

5.2 Scorpions, Pseudoscorpions and Centipedes

During the autumn survey, scorpions were collected from sites LM01 to LM03 and centipedes from sites LM02 to LM04 (Table 17). During the summer survey, scorpions were also collected from sites LM01 to LM03 and centipedes from sites LM01, LM02 and LM05 (Table 18). Pseudoscorpions were collected from sites LM04 and LM05 during the summer survey only. Millipedes were not collected during either the autumn or summer surveys. All specimens were delivered to the WAM for identification.

Table 17 Myriopods and scorpions collected during the autumn survey

Site	Class	Order	Family	Genus	Species	Authority
LM01	Arachnida	Scorpiones	Buthidae	Lychas	annulatus	Glauert, 1925
LM02	Arachnida	Scorpiones	Buthidae	Lychas	annulatus	Glauert, 1925
LM02	Chilopoda	Scolopendrida	Scolopendridae	Cormocephalus	aurantiipes	(Newport, 1844)
LM02	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	rubripes	(Brandt, 1840)
LM02	Chilopoda	Scolopendrida	Scolopendridae	Scolopendra	laeta	Haase, 1887
LM03	Arachnida	Scorpiones	Buthidae	Lychas	annulatus	Glauert, 1925
LM03	Arachnida	Scorpiones	Buthidae	Lychas	sp. nov. `adonis'	
LM03	Chilopoda	Scolopendrida	Scolopendridae	Scolopendra	laeta	Haase, 1887
LM04	Chilopoda	Scolopendrida	Scolopendridae	Cormocephalus	turneri?	Pocock, 1901
LM05	Chilopoda	Geophilida	Unidentified	Unidentified	unidentified	

Most specimens collected during the autumn survey were either common or very common and widespread in Western Australia. The scorpion *Lychas* sp*. nov. `adonis'* is a newly described taxon that is known from many arid and semi-arid areas of Western Australia.

The Geophilid centipedes are the most difficult of all centipede groups to identify due to the lack of taxonomic research on the Australian fauna. They are found over much of Australia, within a variety of habitats. It has been suggested that some species could possibly be SREs, but little information is known *(*Harvey, pers. comm.*).*

Table 18 Myriopods and scorpions collected during the summer survey

Site	Class	Order	Family	Genus	Species	Authority
LM01	Arachnida	Scorpiones	Buthidae	Isometroides	`sp`	
	Arachnida	Scorpiones	Buthidae	Lychas	`annulatus`	Glauert, 1925
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	curtipes	L.E.Koch, 1983
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	curtipes	L.E.Koch, 1983
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	curtipes	L.E.Koch, 1983
LM02	Arachnida	Scorpiones	Buthidae	Lychas	`annulatus`	Glauert, 1925
	Arachnida	Scorpiones	Urodacidae	Urodacus	yaschenkoi?	Birula
	Arachnida	Scorpiones	Urodacidae	Urodacus	**`sp. maitland1`**	
	Arachnida	Scorpiones	Urodacidae	Urodacus	**`sp. maitland1`**	
	Arachnida	Scorpiones	Urodacidae	Urodacus	**`sp. maitland2`**	
LM03	Arachnida	Scorpiones	Buthidae	Lychas	`adonis`	
	Arachnida	Scorpiones	Buthidae	Lychas	`adonis`	
	Arachnida	Scorpiones	Buthidae	Lychas	`annulatus`	Glauert, 1925
	Arachnida	Scorpiones	Urodacidae	Urodacus	yaschenkoi?	Birula
	Arachnida	Scorpiones	Urodacidae	Urodacus	**`sp. maitland2`**	
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	curtipes	L.E.Koch, 1983
LM04	Arachnida	Pseudoscorpiones	Olpiidae	Indolpium	`sp.`	
LM05	Arachnida	Pseudoscorpiones	Olpiidae	Indolpium	`sp.`	
	Chilopoda	Scolopendrida	Scolopendridae	Arthrorhabdis	paucispinus	L.E.Koch, 1984
	Chilopoda	Scolopendrida	Scolopendridae	Cormocephalus	strigosus	Kraepelin, 1908
	Chilopoda	Scolopendrida	Scolopendridae	Cormocephalus	turneri	Pocock, 1901
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	curtipes	L.E.Koch, 1983
	Chilopoda	Scolopendrida	Scolopendridae	Ethmostigmus	rubripes	(Brandt, 1840)

None of the species collected during the summer survey could be regarded as SRE and most are widely distributed in the semi-arid zone of Western Australia (Harvey, pers comm., 2008). The only exceptions may be the species of *Urodacus* labelled “maitland1” from LM02 (Mulga over Chenopod) and “maitland2” from LM02 (Mulga over Chenopod) and LM03 (Mallee over Spinifex). This genus is currently under review and the taxonomy has proven to be problematic with numerous unnamed species and variable morphologies.

5.3 Terrestrial Snails

Molluscs were collected from sites LM03, LM04, LM05, and LM07 (Table 19) during the autumn survey and from sites LM03, LM04 and LM05 during the summer survey (Table 20). Slack-Smith & Whisson (2008) suggest that the two species collected from the Lake Maitland project area belong to the family Pupillidae and within the genus *Pupoides*.

Table 19 Terrestrial snails collected during the autumn survey

Site	Species	Authority
LM03	*Pupoides* ?adelaidae	Adams & Angas, 1864
LM04	*Pupoides* ?adelaidae	Adams & Angas, 1864
LM05	*Pupoides* ?adelaidae	Adams & Angas, 1864
	Pupoides ?myoporinae	Tate, 1880
LM07	*Pupoides ?myoporinae*	Tate, 1880

Table 20 Terrestrial snails collected during the summer survey

Site	Species	Authority
LM03	*Pupoides* ?adelaidae	Adams & Angas, 1864
LM04	*Pupoides* ?adelaidae	Adams & Angas, 1864
LM05	*Pupoides* ?adelaidae	Adams & Angas, 1864
	Pupoides ?myoporinae	Tate, 1880

Pupoides ?adelaidae (named by Adams & Angas 1864) is a dextrally-coiled species that also has a wide geographic distribution from Victoria to the eastern wheatbelt of Western Australia (Solem, 1986). This species has not been recorded from the Lake Maitland-Wiluna area but there are records of its occurrence to the east and west. This species was collected from the Mallee over Spinifex site (LM03), Bull Spinifex site (LM04) and Woodland on Calcrete Flats site (LM05).

Pupoides ?myoporinae (named by Tate 1880) is a sinistrally-coiled species that has a wide but disjunct geographical range in Victoria/South Australia and in Western Australia (Solem, 1986). This species has not been recorded from the Lake Maitland-Wiluna area; however, it has been found to the east and west. The specimens from Lake Maitland are tentatively identified as *Pupoides myoporinea* despite some apparently minor morphological differences (Slack-Smith & Whisson, 2008). This species was collected from Calcrete Flats site (LM05) during both surveys and the Kopi Ridge site (LM07) during the autumn survey.

In summary, Slack-Smith & Whisson (2008) conclude that there is no reason to believe that, at the species level, either of these two molluscan taxa exhibit any degree of short range endemicity, as both are believed to belong to species that occupy wide geographical ranges. The full reports are included in Appendices K and N.

6.0 SURVEY LIMITATIONS AND CONSTRAINTS

The EPA (2004) lists a number of possible limitations and constraints that can impinge on the adequacy of fauna surveys. These are replicated in Table 18 with an assessment relating to the current survey undertaken by OES. A number of factors can influence the design and intensity of a fauna survey. All fauna surveys are limited to some degree by time and seasonal factors, and ideally, a number of surveys should be undertaken over a number of years and within a number of different seasons. Nevertheless, all the factors identified by the EPA (2004) were considered in the design of the current survey.

No specific formal guidance is available for the survey of terrestrial SRE invertebrates. Moreover, prescriptive survey guidelines, including standard methodologies, have not been established by regulating authorities.

Terrestrial invertebrate sampling of the project area focussed on mesic habitats that were presumed more likely to support SRE invertebrate taxa. The survey used a variety of sampling techniques over two seasons. However, sampling was targeted at very specific invertebrate groups known to support examples of short-range endemism, and it was not possible to complete identifications of the majority of invertebrates collected.

In consideration of the target taxa of interest, mygalomorph spiders in particular are typically sedentary with movement from fixed burrows restricted to specific climatic conditions pertaining to humidity and/or temperature (and therefore restricted opportunities for sampling either groups through pit-trapping). Targeted searches for mygalomorph burrows was undertaken to overcome this constraint.

Table 21 Summary of Potential Fauna Survey Constraints

Aspect	Constraint?	Comment Regarding Current Survey
Competency/experience of consultants	No	All members of the survey team were fauna specialists employed by OES, and have many years experience undertaking fauna surveys of this kind in WA. All potential SRE invertebrates were, or will be, identified by appropriate experts.
Scope	Limited	All terrestrial fauna groups were sampled using well-known and standardised techniques. However, little is known of invertebrate SREs and habitats, and standardised methodologies are not available.
Proportion of fauna identified	No	Species area curves suggest further survey intensity during current survey would not be productive. A high proportion of the total vertebrate fauna was recorded (apart from amphibians).
Information sources (e.g. historic or recent)	No	Relatively well surveyed region due, predominantly, to regional surveys and those undertaken for mining operations. Recent work undertaken in relatively close proximity to the survey site.

Aspect	Constraint?	Comment Regarding Current Survey
Proportion of task achieved, and further work which might be needed	Limited	Further targeted work in different seasons may be required for potential SRE invertebrates, dependent upon final identifications of specimens collected during the summer survey.
Timing / weather / season / cycle	No	Timing, weather, and seasonality of surveys was appropriate for vertebrates. Low nightime temperatures during the autumn survey was compensated by adequate temperatures during the summer survey. Amphibians would require targeted surveying after appropriate rainfall events. Humid temperatures and rainfall facilitated sampling of potential SRE invertebrates during the summer survey.
Disturbances	Limited	Inappropriate fire regimes (for biodiversity management), and recent/frequent burns in particular have impacted habitats of the site. However, the survey results are a reflection of current land management practices.
Intensity	No	1,765 trap-nights and 5,120 minutes of census, inventory, and spotlighting searching is considered adequate intensity for a first local baseline survey of this type within this IBRA subregion.
Completeness	No	Survey was complete. All major taxa covered, as well as all major habitats and landforms. The project area was adequately covered geographically.
Resources	No	Resources were adequate to carry out the survey satisfactorily. Survey participants were competent in identification of species present. Target SRE invertebrates were, or will be, identified by appropriate specialists.
Remoteness / access problems	No	All representative areas to be sampled were accessible by 4WD vehicle.
Availability of contextual information	No	Information is available for the IBRA subregion including WAM Faunabase, DEC lists, NLWRA, as well as regional fauna surveys.

7.0 CONSERVATION SIGNIFICANCE

7.1 Framework for conservation significance

Fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under Commonwealth and state legislation. At the national level, fauna are protected under the *EPBC Act 1999*. Within WA fauna can be listed under various Schedules under the *Western Australian Wildlife Conservation Act (WC Act) 1950*. Definitions of conservation significance are presented in Appendix L.

The International Union for the Conservation of Nature (IUCN) reviews the conservation status and lists fauna under various categories (the IUCN Red List). Categories for fauna and their conservation status used under the EPBC Act are those recommended by the IUCN. The *WC Act 1950* uses a set of 'Schedules', but the DEC also classifies species using IUCN categories.

International agreements that Australia has entered into include the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), the Bonn Convention

(The Convention on the Conservation of Migratory Species of Wild Animals) and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

The *EPBC Act 1999* has lists of migratory species that are recognised under these international treaties. Particular species listed in JAMBA are also protected under Schedule 3 of the *WC Act 1950*.

The DEC also recognises species not listed under the *WC Act 1950*, but for which there is some concern, and has produced a supplementary list of 'Priority' fauna. These species, as well as those listed in various Government endorsed Action Plans, (i.e. Duncan, *et al*. 1999; Garnett and Crowley, 2000) are also of recognised significance. Other species of conservation significance include endemics, those with restricted or fragmented ranges, or those that are at the extreme limits of their distribution. SRE fauna are those with naturally restricted distributional ranges.

Based on the above, the conservation significance of terrestrial vertebrate fauna potentially occurring over the project area can be assessed at four spatial scales:

- International / National - Species listed under the *EPBC Act 1999*, IUCN, and International Treaties;
- State - Species listed under the *WC Act 1950*;
- Regional - DEC listed Priority Species and species listed in Action Plans; and
- Local - Species not listed under any Acts or relevant publications, but considered of conservation significance due to patterns of distribution.

7.2 Vertebrate species of conservation significance potentially occurring over the project area

7.2.1 International, National, State and Regional Significance

The search of the DEC Threatened and Priority Fauna Database (Appendix A) identified a number of vertebrate species recorded from the region. *Kwonkan moriartii* , a mygalomorph or trapdoor spider, was also recorded and is considered in Section 5. Vertebrates identified were:

- Mulgara (*Dasycercus cristicauda)*
- Ghost Bat *(Macroderma gigas)*
- Malleefowl *(Leipoa ocellata)*
- Major Mitchell's Cockatoo *(Cacatua leadbeateri)*
- Australian Bustard *(Ardeotis australis)*
- Bush Stone-curlew *(Burhinus grallarius)*
- Striated Grasswren *(Amytornis striatus striatus)*
- Thick-billed Grasswren *(Amytornis textilis textilis)*
- White-browed Babbler (western wheatbelt) *(Pomatostomus superciliosus ashbyi)*
- Giant Desert Skink *(Egernia kintorei)*

Information from the DEC Threatened and Priority Fauna Database was augmented with additional information relating to species' likelihood of occurrence based upon other database searches and texts, as well as personal experience and general patterns of distribution and known habitat preferences. A list was prepared of species of conservation significance with the potential to occur over the project area (Table 19). Table 19 includes several additional species to those identified from the DEC Threatened and Priority Fauna Database. Likelihood of occurrence is then discussed on an individual species basis.

Species considered regionally extinct, outside their range, or restricted to habitats not present at the project site, have been excluded from Table 19. This includes the Greater Stick-nest Rat, Lesser Stick-nest Rat, Pig-footed Bandicoot, Long-tailed Hopping-mouse, and Short-tailed Hopping-mouse. In consideration of the habitats available over the project area, freshwater fish have also been omitted. In consideration of the DEC Threatened and Priority Fauna Database the following species have been omitted from Table 19.

- Priority 4: Thick-billed Grasswren (western sub-species) *(Amytornis textilis textilis)*

  This species once occurred in the region, and the record from the DEC Threatened and Priority Fauna Database refers to historical data from 1974. However, the species is now extinct in areas it formerly occurred and is now only found in the vicinity of Shark Bay (Higgins *et al.* 2001).

- Priority 4: White-browed Babbler (western wheatbelt) (*Pomatostomus superciliosus ashbyi)*.

  The Priority 4 listing for the White-browed Babbler refers to the population in the southwest of WA (Garnett and Crowley, 2000). A DEC Threatened and Priority Fauna Database record exists for the region from 1978 (Appendix A), and the White-browed Babbler was recorded during surveys. However, the project area is not in the western wheatbelt region that the priority rating refers to, and the species is relatively common in the Murchison bioregion.

- Priority 4: Ghost Bat (*Macroderma gigas)*

  The only record of the Ghost Bat from the DEC Threatened and Priority Fauna Database search is a 'day sighting' from 1961 at Lake Carnegie (Appendix A). The Ghost Bat is known only from northern Australia, including the Pilbara and the Kimberley, and it is unlikely that it occurs in the Murchison Bioregion (Churchill, 1998).

Table 22 Species of International, National, State or Regional conservation significance potentially occurring over the project area

Group	Name		National	State	Regional	Likelihood of occurrence
Mammals	Mulgara	*Dasycercus cristicauda*	VU	S1		R
	Long-tailed Dunnart	*Long-tailed Dunnart*			P4	U
	Greater Bilby	*Macrotis lagotis*	VU	S1		U
	Southern Marsupial Mole	*Notoryctes typhlops*	VU	S1		U
Birds	Night Parrot	*Pezoporus occidentalis*	EN	S1		U
	Malleefowl	*Leipoa ocellata*	VU	S1		P
	Slender-billed Thornbill	*Acanthiza iredalei iredalei*	VU			L
	Princess Parrot	*Polytelis alexandrae*	VU		P4	U
	Striated Grasswren	*Amytornis striatus striatus*			P4	U
	Australian Bustard	*Ardeotis australis*			P4	L
	Bush Stone-curlew	*Burhinus grallarius*			P4	R
	Major Mitchell's Cockatoo	*Cacatua leadbeateri*		SP		P
	Peregrine Falcon	*Falco peregrinus*		SP		P
	Grey Falcon	*Falco hypoleucos*			P4	P
	Barking Owl	*Ninox connivens*			P2	U
	Masked Owl	*Tyto novaehollandiae*			P3	U
	Rainbow Bee-eater	*Merops ornatus*	Mig			L
	Fork-tailed Swift	*Apus pacificus*	Mig			L
	Migratory Waders/waterbirds	Various	Mig			L
Reptiles	Great Desert Skink	*Egernia kintorei*	VU	S1		U
	Woma	*Aspidites ramsayi*		SP		U

EN	Endangered	SP	Specially Protected
VU	Vulnerable	Mig	Migratory Species
S1	Schedule 1	P#	Priority Fauna
R	Recorded		
L	Likely		
P	Possible		
U	Unlikely		

A targeted search was made for the Slender-billed Thornbill in particular, but also Striated Grasswren, Bush Stone-curlew, and Australian Bustard within Samphire/Saltbush habitats of the Lake Maitland Salt Lake during the autumn fauna survey (Figure 9). No species of conservation significance were recorded. The most common bird was the White-winged Fairy-wren (*Malurus leucpterus*). This is a

sedentary, territorial species that nests co-operatively. At least five individual territories were traversed.

Figure 9 Area searched for Slender-billed Thornbill and/or other species of conservation significance during the autumn survey

Searches for the distinctive mounds, or other sign or sightings of Malleefowl were undertaken during the autumn survey period (as well as all travel through the project area during all survey periods). In addition, specific transect searches were made for the Malleefowl as well as any other species of conservation significance, over suitable shrubland habitat during the summer survey (Figure 10). No species of conservation significance were recorded.

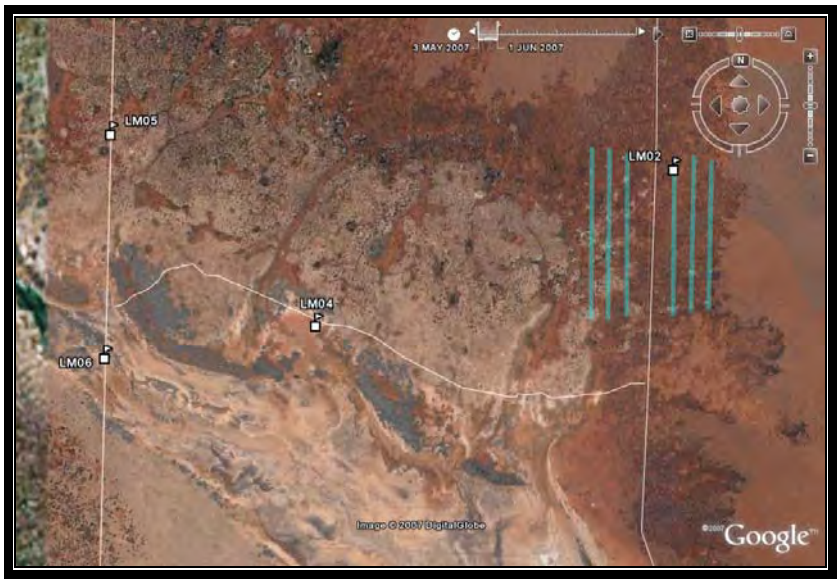

Figure 10 Transects searched for evidence of the Malleefowl and/or other species of conservation significance during the summer survey

Figure 11 Transects searched for evidence of the Mulgara and/or other species of conservation significance during the summer survey

Mammals

Mammals of conservation significance are known from the bioregion with the potential to occur over the project area.

The Mulgara was recorded during the current survey. This species inhabits sandplains dominated by *Triodia* spp*,* where it burrows between low sand dunes. The Mulgara is infrequently recorded in part due to boom-bust cycles, contracting to core habitat areas in lean times, and expanding rapidly after favourable conditions prevail (Gibson and McKenzie, 2005). The Threatened and Priority Fauna Database contains 22 records from Wanjarri Nature Reserve, Barwidgee, Mt Keith, Jundee Mine Site and Sir Samuel (Appendix A). The area surrounding the project area incorporating the Pastoral Leases of Barwidgee, Jundee, and Mt Keith are known to support Mulgara. Recent records have been made and on-going monitoring and management of populations is undertaken (Pearson, *et al.* 2005).

Plate 13 Mature spinifex community identified as a suitable survey site during the reconnaissance survey (left) and the same area at the time of the autumn survey (right)

The Mulgara was recorded by HGM (1997) over the Lake Maitland project area in 1997 in areas of almost pure stands of spinifex, with an equal ratio of open space to spinifex, with little overstorey. Areas of habitat identical to this description were noted during the January reconnaissance survey and a survey site was established there. However, a broadscale wildfire during early April 2007 burnt out this site and much of the eastern portion of the project area (Plate 10). A revised Spinifex Plain survey site was selected (LM01) along with an original gridline used by HGM (1997) (that is, LM08). However, a fire since 1997 had affected both these areas, and it is estimated that spinifex recovery was approximately four years post-fire (Plate 11).

Plate 14 Sites where Mulgara were captured: LM01 (left) showing recent coppicing after fire and the Mulgara Grid LM08 (right)

Three individual adult male Mulgaras were captured during the autumn survey at sites LM01 and LM08. During the summer survey, one adult female in breeding condition (lactating teats) was captured. Transect searches in Spinifex Plains habitat between sites LM01 and LM08 (Figure 11) revealed evidence of the Mulgara in the form of two active burrow complexes, five fresh diggings and over 90 old diggings. Locations of all burrows and fresh diggings were recorded. Due to recent rains, diggings considered 'fresh' were those made during the previous 24 hrs. All others were considered 'old'.

The pyric successional stage of the spinifex community is not considered ideal Mulgara habitat, however, it appears that a population is persisting in sub-optimal habitat. Regardless, given the past records over the project area and the regional records of this species on adjacent properties, it is clear that, firstly, the area is important for this species, secondly, Spinifex Plains habitat of the appropriate structure is present over the project area, and finally, that appropriate management is required for the species continued survival. In particular, the appropriate management of fire.

Plate 15 Mulgaras captured at Site LM01 (left) and the Mulgara Grid LM08 (right)

The Long-tailed Dunnart has been collected intermittently in various locations primarily to the north of the project area (FaunaBase, 2007). It occurs in rocky habitats (Strahan, 2002) and may be rarely captured due to the difficulties of installing pit traps in these areas. Suitable habitat does not occur over the project area, therefore this species is unlikely to occur here.

The Greater Bilby once occurred over the project area and a WAM record exists for the species north of Wiluna in 1985. However, in WA it now only occurs in areas of the Gibson and Great Sandy Deserts south to Warburton, the Pilbara and Dampierland bioregions, as well as the Kimberley (Faunabase, 2007; Pavey, 2006). It is unlikely that the Bilby still survives in the East Murchison sub-region and it is unlikely to be present over the project area as it is well outside of its known distribution.

The Southern Marsupial Mole (*Notoryctes typhlops*) was identified by NLWRA (2002) (Appendix E) as occurring in the East Murchison sub-region. This species occupies arid areas immediately east and north of the project area, living underground in sand dunes, inter-dunal flats and sandy soils along river flats. The Southern Marsupial Mole is unlikely to occur over the project area due to the site being outside of its known distribution, and lack of suitable habitat.

Birds

Birds of conservation significance that are known from the bioregion have the potential to occur over the project area.

The Night Parrot (*Pezoporus occidentalis*) is only very rarely recorded. Although It has been associated with hummock grasslands in the past, particularly dense clumps of mature spinifex, its preferred habitat appears to be samphire flats and saltbush associated with salt lake systems (Blakers *et al.* 1984; Higgins, 1999), or a juxtaposition of mature spinifex and chenopod habitats (FMG, 2005). Although these habitats occur over the project area, the majority, and more recent records for this species are from the Pilbara. The species is not expected to occur over the project area.

The Malleefowl is a ground-dwelling bird that builds large and distinctive mounds of soil and litter within which its eggs are incubated. The Malleefowl's distribution includes the project area (Blakers *et al*. 1984; Barrett, *et al.* 2003), which is close to the historical northern limit of it's range, but its current range is now predominantly to the south and west (Marchant and Higgins, 1993). Nevertheless, the Threatened and Priority Fauna Database includes relatively recent records in the region from Wanjarri Nature Reserve, Mt Keith and Yandal Station from between 1997 and 2001 (Appendix A), and it is also known from Yeelirrie Station. It is therefore possible that this rare species could still occur in the habitats present in the project area, particularly Mulga communities, and if so, it would be on the edge of its current distribution. No Malleefowl, or their distinctive mounds, were noted during targeted searches over the project area. In addition, recent fires over portions of the project area facilitated in the identification of historical mounds over large areas. No evidence was recorded and it appears that this bird no longer occurs over the project area. Nevertheless, it is possible that with the abatement of threatening processes, predominantly by implementing an appropriate fire regime and integrated feral predator control, this bird may re-colonise the project area.

The Slender-billed Thornbill's habitat is saltbush communities and samphire flats associated with salt lake systems. Suitable habitat occurs over the project area and although targeted searches failed to record this species, it is likely to be present. Although listed Federally, as well as in South Australia and the Northern Territory, this species is not listed under WA legislation. It is thought that populations in northern South Australia and east of the Flinders Ranges, and possibly those that occur northwest of Lake Gairdner, are the most likely to be in decline (DEW-SPRAT, 2007).

The Striated Grasswren occurs in spinifex communities, with or without an overstorey of shrubs, on sandy or loamy plains. The species once occurred in the vicinity of the project area and two relatively old records from 1979 and 1987 are contained within the Threatened and Priority Fauna Database from Wanjarri Nature Reserve (Appendix A). It now occurs as scattered but widespread populations in the Gibson Desert and Little Sandy Desert, as well as the Pilbara (Higgins, *et al*. 2001). Although suitable habitat is present in the project area, the species is unlikely to occur as the area is outside of its current distribution.

The Australian Bustard and Bush Stone-curlew occur on plains in the region. A Bush Stone-curlew was heard and seen on the saltbush flats of Lake Maitland during the autumn survey. The Threatened and Priority Fauna Database contains seven records of the Australian Bustard from the Wanjarri Nature reserve to the west of the project area, and one record of the Bush Stone-curlew from Mt Keith (Appendix A). Both these species have a wide range across Australia Suitable habitat is

present and both are likely to occur over the project area, at least intermittently. Juvenile recruitment of these ground-nesting birds is impacted upon by introduced predators,,changed fire regimes and the availability of food sources.

The Princess Parrot (*Polytelis alexandrae*) is an inhabitant of lightly wooded country of desert areas to the east of the project area, from the Great Sandy Desert through the Gibson Desert and into the Great Victoria Desert. The project area is outside of the core range of this species (Higgins, 1999), and its preferred habitat of swales between sand dunes, savannah woodland, or eucalypt-lined creeklines does not occur. The Princess Parrot is therefore unlikely to occur.

Distribution of the Major Mitchell Cockatoo (*Lophochroa leadbeateri*) is patchy and disjunct. Although the project area lies outside the species distribution as identified by Johnstone and Storr, (1998), Higgins (1999) shows the project area on the edge of its range and a DEC Threatened and Priority Fauna Database record exists from just east of Wiluna in 1967 (Appendix A). It may be possible that this species occurs from time-to-time although its preferred habitat of very open woodland has only a limited occurrence over the project area.

The Peregrine Falcon (*Falco peregrinus*) is widespread in Australia, but requires specific nesting sites. It does not build a nest and requires cliffs, rocky outcrops, or large tree hollows none of which occur over the project area. Similarly, the Grey Falcon (*Falco hypoleucos*) has a very broad but scattered distribution across Australia and prefers larger creeklines supporting River Red Gums and often nests in Eucalypts along watercourses; habitat that does not occur over the project area. Both species, however, are highly mobile and may occur over the project area from time-to-time.

Although the Barking Owl (*Ninox connivens*) was recorded by Birds Australia in the bioregion, it is outside of its usual range (Johnstone and Storr, 1998) and is unlikely to occur over the project area. The Masked Owl (*Tyto novaehollandiae*) in WA is primarily found in the southwest. However, scattered records have been made in the arid zone including at Yandil Station (Higgins, 1999), as well as unconfirmed sightings from Wanjarri Nature Reserve (Higgins, 1999). The veracity of records have been compromised due to confusion with the more common Barn Owl *(Tyto alba*). It is unlikely that the Masked Owl utilises the project area given the lack of suitable woodland habitat, the few and scattered regional records and the distance of the project area from the species core distribution. ,.

Although not recorded, the Rainbow Bee-eater (*Merops ornatus*) and the Fork-tailed Swift (*Apus pacificus*) are federally-listed migratory species likely to occur over the habitats of the project area. The Rainbow Bee-eater occupies numerous habitats including open woodlands with sandy loamy soil, sandridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Pizzey and Knight, 1998). The Fork-tailed Swift is an aerial species that would overfly the project area without specifically utilising the habitats present.

No records are known of waders and/or waterbirds that directly utilise Lake Maitland, and no records were made during the current surveys. Commonwealth database searches (Appendices C and D) identified the Oriental Plover (*Charadrius veredus*) and Great Egret (*Ardea alba*), listed as either migratory and/or marine under the EPBC Act, as potentially occurring over the search area. However, many more are likely to occur over the search area (Jaensch and Vervest, 1990). A number of migratory wading birds and marine waterbirds listed under Commonwealth legislation (i.e. JAMBA, CAMBA and ROKAMBA) are known from the region and possibly occur intermittently over the lake bed habitat of the project area. The Birds Australia database (Appendix F) lists at least 14 species, predominantly from the genera *Calidris* and *Tringa* that, although having a 'low' reporting status in the bioregion, potentially occur intermittently. The majority of members from these genera are migratory waders that breed in northern latitudes. Most utilise coastal areas but some species will also utilise inland waters. It is these species that potentially occur over the project area. Migratory waders arrive during the summer and depart during the winter to breed in northern latitudes. Although the vast majority of the lake bed is vegetated with samphire and saltbush, significant summer rainfall, or persistent surface water during this time, has the potential to attract these species to Lake Maitland.

In periods of flood, Lake Maitland could provide temporary habitat for up to 45 species of waterbird including up to 19 species listed as either migratory and/or marine under the *EPBC Act 1999* (Table 20).

Table 23 Waterbirds and waders listed under the EPBC Act as either migratory or marine potentially utilising habitats of the project area

Species		Migratory Listed	Marine Listed
Nankeen Night Heron	*Nycticorax caledonicus*		x
Great Egret	*Ardea alba*	x	x
Straw-necked Ibis	*Threskiornis spinicollis*		x
Buff-banded Rail	*Gallirallus philippensis*		x
Baillon's Crake	*Porzana pusilla*		x
* Common Greenshank	*Tringa nebularia*	x	x
* Wood Sandpiper	*Tringa glareola*	x	x
* Common Sandpiper	*Actitis hypoleucos*	x	x
* Red-necked Stint	*Calidris ruficollis*	x	x
* Sharp-tailed Sandpiper	*Calidris acuminata*	x	x
* Curlew Sandpiper	*Calidris ferruginea*	x	x
Black-winged Stilt	*Himantopus himantopus*		x
Red-necked Avocet	*Recurvirostra novaehollandiae*		x
Red-capped Plover	*Charadrius ruficapillus*		x
* Oriental Plover	*Charadrius veredus*	x	x
Australian Pratincole	*Stiltia isabella*		x
Silver Gull	*Larus novaehollandiae*		x
Gull-billed Tern	*Sterna nilotica*		x
Whiskered Tern	*Chlidonias hybridus*		x

* Non-breeding migrants

Reptiles

Reptiles of conservation significance that are known from the bioregion have the potential to occur over the project area.

The Great Desert Skink (*Egernia kintorei*) occurs on red sandplains and sand ridges supporting spinifex *(Triodia* spp.), predominantly to the east of the project area (Pearson *et al*. 2001). Nationally, current strongholds for the Great Desert Skink appear to be the Tanami Desert, Uluru and an area of the Gibson Desert north of Warburton. Although the precise distribution of this species is likely to remain vague, three main populations appear to occur in WA; at Patjarr (240 km northwest of Warburton), the vicinity of Lake MacKay and Rudall River National Park. A historical record appears in the DEC Threatened and Priority Fauna Database database from Kathleen Valley in 1964 (Appendix A), approximately 70 km southwest of the project area. Evidence of this species was not obtained during the survey, including during targeted searches in preferred habitat. The project area is outside of the species current core distribution and it is unlikely that the Great Desert Skink occurs.

The Woma Python (*Aspidites ramsayi*) occurs throughout arid zones of Australia with a disjunct south-west population in WA and is now very rare (and may be taxonomically differentiated from the desert 'form'). In the more arid zones, the Woma Python favours open myrtaceous heath on sandplains, and dunefields dominated by spinifex. In the south-west it also appears to favour sandplain habitats (Storr *et al.* 2002), though few records exist. The project area is situated outside of the northern limit of the south-west distribution and it is unlikely that this species occurs.

7.2.2 Local Significance

Although not a threatened species, the Spotted Mulga Snake (*Pseudechis butleri)* is listed by the NLWA (2002) as endemic to the bioregion and, although not recorded, has the potential to occur over the project area within Mulga Woodland. Reptile species complexes within which taxonomy is unresolved include the genera *Heteronotia, Cryptoblepharus*, and *Menetia.*

The Desert Mouse *(Pseudomys desertor)* was captured in large numbers during the autumn survey, with fewer numbers during the summer survey. This species is generally widespread in arid areas in central Australia and the project area would, at one time, have been considered outside of this species range. Previous trapping at Mt Keith and on Barwidgee Station during 1997 and 1998 did not record this species. However, subsequent trapping at Mt Keith in 2001 documented the species in reasonable numbers. A similar pattern of expansion has been documented in the Pilbara (Cooper, *et*

al. 2006). Extended drought conditions and a lack of survey intensity probably explain why the species was once considered rare (Kerle, 1995). The dramatic increase in range of this species may be a consequence of a population irruption in response to good seasons (Cooper, *et al.* 2006), and the authors note that small and isolated refugia may be important in times of drought.

The Ooldea Dunnart *(Sminthopsis ooldea)* is a common species that occurs predominatly east of the project area. Similarly the Stripe-faced Dunnart *(Sminthopsis macroura)* occurs predominantly north and east of the project area in the Murchison, Pilbara, and Kimberley. Both these species occur toward the edge of their distributions over the project area.

Plate 16 Desert Mouse within a pit-trap (left) and Stripe-faced Dunnart (right)

7.3 Short-range Endemic Invertebrates

The common habitat factors favoured by the targeted SRE groups, including gorges, rocky ranges and ridges (particularly those that face south or southeast and/or near water supplies), rivers and creeklines, are absent over the project area . However , Mulga habitats in the region are known to support many species of mygalomorph spiders some of which possess short range endemism.

Some better-known invertebrate species, not necessarily with SRE attributes, have been listed as threatened under state or Commonwealth legislation. The DEC Threatened and Priority Fauna Database search (Appendix A) includes the Priority 2 mygalomorph spider *Kwonkan moriartii* (Main 1983) that was collected from Kathleen Valley, approximately 100km south of the project area. This species was not found at the Lake Maitland project area during the autumn or summer survey in 2007.

Since SRE invertebrates have attracted little attention to date, there is a considerable level of uncertainty in regard to their taxonomy and identification. For mygalomorph spiders, Main (2008) was able to place many of the spiders found during the recent surveys into their appropriate genera and some could be placed into groups and species within those genera. However, in a number of cases it was not possible to be specific in the identifications due to the lack of mature male specimens. In regard to short range endemism, Main (2008) concludes that *Conothele* sp., *Cethegus*, *Aname* sp B.

and *Kwonkan* sp. *nov* A and B possibly have restricted ranges. However, without a review of all these genera it is difficult to make conclusive comments. Current knowledge suggests that *Aname* sp. B is the most likely to have a restricted distribution (Main, 2008).

Dr Mark Harvey identified specimens of pseudoscorpions, scorpions and centipedes. None of the specimens collected could be considered as short range endemic, with most being widely distributed in the semi-arid zone of Western Australia. This is with the exception of two scorpion species from the genus *Urodacus,* which is currently under review and the taxonomy is uncertain. The uncertainty in species distributions for the *Urodacus* scorpion species "maitland1" and "maitland2" appears to be a reflection of the numerous unnamed species and variable morphologies within the genus rather than an indication of short range endemism.

Specimens of terrestrial molluscs collected during the survey were tentatively identified as *Pupoides ?adelaidae* and *Pupoides ?myoporinae*. Slack-Smith & Whisson (2008) concluded that there is no reason to believe that, at the species level, either of these two molluscan taxa exhibit any degree of short range endemicity, as all are believed to belong to species that occupy wide geographical ranges.

7.4 Significant Habitats

State and National Significance

Habitats which are site or type specific and possess high ecological value are of state significance. Habitats which exhibit such a level of significance may contain either specific habitat dependent fauna or a high biodiversity or are poorly represented elsewhere. If a habitat is poorly represented in conservation reserves its conservation significance is increased.

Habitat that is considered critical to the survival of a Federally-listed threatened species or threatened ecological community can be entered by the Australian Government Minister for Environment and Water Resources onto a register of critical habitat. Habitat listed in the register in relation to a species or ecological community is critical habitat for that species or ecological community.

No critical habitat is located over the project area, and no World Heritage Properties, Ramsar Wetland Sites or Nationally Important Wetland sites are in the vicinity (Appendix C and D). However the Murchison bioregion includes many important salt lake wetlands such as the Lake Carnegie System, Lake Barlee, Lake Ballard and Lake Marmion that are listed on the directory of Nationally Important Wetlands. In addition, Wooleen Lake, Lake Barlee, and Aneen Lake also qualify as refugia in semi-arid Australia (Morton, *et al.* 1995) (Appendix H). Recognised values of these wetlands include their importance to waterbirds. For example, Lake Barlee is an intermittent salt lake where up to 200,000 pairs of banded stilt *(Cladorhynchus leucocephalus)* may breed when the lake is in flood (Burbidge and Fuller 1982).

The closest wetland of significance to Lake Maitland is the Lake Carnegie System, approximately 120 km to the northwest of the project area, which is listed in the Directory of Important Wetlands in Australia.

Sensitive Habitats

All of the broad terrestrial fauna habitat types identified over the project area are represented elsewhere in the bioregion, and none are considered of regional significance.

The landscape within which the project area is situated is subject to frequent burning, and inappropriate fire regimes have been recognised as a major threatening process in the Bioregion (NLWRA, 2002). Habitats that provide refuge against frequent fire are important for the maintenance of biodiversity in such a landscape. For example, SRE species including invertebrates are more likely to be associated with more mesic areas as they offer protection from heat, desiccation and predators, and provide a source of moisture, such as rocky areas and riverine systems. No such habitats occur over the project area.

Samphire flats and saltbush communities associated with the Lake Maitland are disjunct at the regional scale and provide intermittent habitat for waterbirds and are, therefore, considered at least locally significant. These habitats also support other fauna of conservation significance, such as the Slender-billed Thornbill, Bush Stone-curlew, and Australian Bustard, and are particularly prone to impacts from grazing pressures due to the palatability of the vegetation. Similarly, associated Kopi Ridges are discontinuous and have a patchy distribution at the regional scale.

The threatened Mulgara occurs over the project area as well as surrounding lands. Spinifex communities of the appropriate structure, and at the appropriate pyric successional sequence, are required to maintain this regionally important population, as well as effective feral predator control. Spinifex communities are prone to inappropriate fire management, and in particular frequent broadscale fire, and although spinifex habitat on sandplain exists, it is not suitable Mulgara habitat in the long term unless managed appropriately. In this sense, Spinifex Plains habitat can be considered sensitive to inappropriate fire management.

8.0 IMPACTS TO FAUNA POPULATIONS

8.1 Current Impacts and Habitat Condition

Threatening impacts have been analysed for the Murchison Bioregion by the National Land and Water Audit (NLWA, 2002). Ecosystems and species at risk are currently subject to a large number of threatening processes, and the trend is not known in many cases. Impacts identified in the bioregion by the audit include changed fire regimes, grazing pressure, feral animals, weeds and vegetation clearing. These factors are deemed to be causing a general loss of soil fertility and vegetation cover in the bioregion, with a consequent loss of native species.

Terrestrial vertebrate species at risk within the bioregion have also been identified (Appendix E) and specific threats to their viability described by the audit (Table 21).

Table 24 Vertebrate species 'at risk' by NLWA (2002) within the MUR1 subregion, and their threatening processes

Species name	Threatening processes	Threatening processes notes
Great Desert Skink *Egernia kintorei*	Changed fire regimes	No data
	Feral animals	Foxes and cats
Western Slender-billed Thornbill *Acanthiza iredalei iredalei*	Changed fire regimes	No data
Princess Parrot *Polytelis alexandrae*	Grazing pressure	No data
Malleefowl *Leipoa ocellata*	Feral animals	Foxes and cats
	Firewood collection	No data
	Grazing pressure	No data
Mulgara *Dasycercus cristicauda*	Changed fire regimes	No data
	Feral animals	Foxes and cats
Greater Bilby *Macrotis lagotis*	Changed fire regimes	No data
	Feral animals	Foxes
Southern Marsupial Mole *Notoryctes typhlops*	Changed fire regimes	No data
	Feral animals	Foxes and cats

Specific threats to terrestrial vertebrates in general identified in the bioregion (NLWA, 2002) include:

- Feral predators (cats and foxes);
- Changed fire regimes; and
- Vegetation fragmentation.

Although vegetation clearing is not significant in the region, vegetation and habitat fragmentation can occur through degradation of habitats; for example, through the effects of over-grazing. Habitats over the project area are currently in good condition, however, the lease is currently being used for pastoral purposes and the effects of stock grazing are evident across all habitats. Spinifex Plains are usually avoided by stock, but access is provided to cattle when spinifex is resprouting after fire. Large

numbers of Red Kangaroos and European Rabbits are also present over saltbush flats covering and surrounding the Lake Maitland Salt Lake. Impacts of weeds on fauna habitats appear to be minimal. Inappropriate fire regimes for biodiversity outcomes are currently affecting the project area, particularly over Spinifex Plains and Mulga Woodland habitats. Extensive impacts to vegetation by past and recent broadscale fire were observed during surveys, particularly to the south and east of the site. A study of fire maps from the area indicated that fires had burnt extensive areas over the last five years, with some areas having been burnt several times.

Inappropriate fire regimes, and frequent broadscale fires in particular, can simplify vegetation communities and lead to reduced heterogeneity of the landscape. Reduced shelter from frequent burns also leads to greater impacts on ground fauna from introduced predators. A number of large fires have affected the project area in recent years, and this regime is predicted to continue until resources become available regionally for effective fire management and control.

8.2 Potential Impacts of Proposal and General Management Guidelines

Development concepts for the Mega Redport project over Lake Maitland are in their infancy, and impacts to vertebrate fauna and invertebrate SRE fauna at this stage cannot be quantified. However, a number of species of conservation significance are likely to occur.

The resource deposit at Lake Maitland is located in the playa itself and clearing within this habitat will be required. Some clearing within Mulga communities will also be required for infrastructure, including a camp. From the information provided, at this early stage it appears that most of the potential impacts to terrestrial vertebrate fauna could be expected to be associated with:

- Open pits required to access the ore body;
- A mining camp;
- Associated mine plant and infrastructure;
- Linear infrastructure such as roads and service corridors, and associated traffic;
- Alterations to surface and groundwater hydrology due to the effects of de-watering or groundwater drawdown;
- Affects of noise and dust;
- Impact of light from processing plant;
- Potential to introduce weeds and increase populations of exotic species; and
- Secondary impacts, such as off-road vehicles, increased access, and increased risk of fire

General Management Guidelines

The general management guidelines below are suggested to minimise potential impacts to the terrestrial vertebrate fauna of the project area:

- Reduce vegetation clearance to an absolute minimum;

- Progressively rehabilitate pits to an appropriate standard;
- If possible, avoid clearance or disturbance to Mulgara habitat of Spinifex Sandplains;
- Minimise impacts to surface hydrology by avoiding drainage features wherever possible;
- Assess the likely impact of dewatering and any groundwater drawdown on vegetation;
- Discourage the establishment of any artificial water supplies and assess the likely impact of dewatering and any groundwater drawdown on waterbirds and migratory waders;
- Reduce artifical light sources where possible and /or direct light sources toward area of interest;
- Implement standard dust suppression methods across the project area, particularly during construction but also during operation, to reduce impacts to surrounding vegetation;
- Prevent the establishment of new weed species, and the further spread of existing weed species;
- Develop strategies to reduce the likelihood of increased populations of feral animals, such as appropriate refuse management; and
- Consider the preparation and implementation of a succinct Fire Management Plan, not only to reduce the risk of unplanned fire emanating from the project area, but also to mitigate against wildfire from off-site ignition sources.

For SRE invertebrates, the level of uncertainty in regard to taxonomy and identification has made it difficult to evaluate the potential impact of the mining development. For mygalomorph spiders, there were a number of taxa that possibly have restricted ranges, however, it is difficult to make conclusive comments without a review of the genera and collection of representative males from regions within and outside the project area. The uncertainty in species distributions for the *Urodacus* scorpion species “maitland1” and “maitland2” appears to be a reflection of the numerous unnamed species and variable morphologies within the genus rather than an indication of short range endemism. Additionally, it appears that the terrestrial snail specimens collected represent taxa that do not display short-range endemism. If large areas known to inhabit possible short range endemic taxa (specifically mygalomorph spiders) are to be impacted by the development, it would be useful to establish whether populations of the species exist outside the areas of impact.

9.0 STUDY TEAM

The Lake Maitland Fauna Survey was conducted by:

Mr Andre Schmitz	B.App.Sc. Env. Man.	Senior Environmental Scientist
Ms Brooke Hay	B.Sc. Zool.	Biologist
Mr Paul Bolton	B. Sc (Hons)	Biologist (Short-range Endemic invertebrates)
Mr Jarrad Donald	BSc. Env. Man.	Environmental Scientist

Co-ordination of the autumn short-range endemic invertebrate survey was undertaken by:

Dr. Tamara O'Keeffe B.Sc. (Hons) (PhD, Soil Science, UWA)

The Lake Maitland Fauna Autumn Survey (Vertebrates and Invertebrates) was conducted under the following Licence issued by DEC:

- Licence to Take Fauna for Scientific Purposes (Regulation 17) – Licence No: SF005819
  - Date of issue: 10/04/2007
  - Date of expiry: 31/05/2007
  - Valid from: 01/05/2007

The Lake Maitland Fauna Summer Survey (Vertebrates and Invertebrates) was conducted under the following Licence issued by DEC:

- Licence to Take Fauna for Scientific Purposes (Regulation 17) – Licence No: SF006124
  - Date of issue: 09/11/2007
  - Date of expiry: 31/12/2007
  - Valid from: 01/12/2007

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Appendix A

Search Results of the Threatened Fauna Database held by the Department of Environment and Conservation

26.26 °S **120 °E** / **28.05 °S** **122.06 °E** Mining Proposal area, Lake Maitland

*	Date	Certainty	Seen	Location Name	Method

Schedule 1 - Fauna that is rare or is likely to become extinct

Dasycercus cristicauda — Mulgara — *22 records*

This small carnivorous marsupial lives in burrows and occurs in arid sandy regions from the eastern Pilbara to central Australia.

1995	1	2	Jundee Mine Site	Caught or trapped
1996	1	1	Jundee Mine Site	Caught or trapped
1996	1	1	WANJARRI NATURE RESERVE	Caught or trapped
1997	1	2	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	7	Mt Keith	Caught or trapped
1997	1	6	Mt Keith	
1997	1	1	Mt Keith	Caught or trapped
1997	1	1	Mt Keith	Caught or trapped
1997		2	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1997	1	1	Barwidgee	Caught or trapped
1998	1	1	Mount Keith Mine Site	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Day sighting
1998	1	1	Barwidgee	Caught or trapped
1998	1	1	Barwidgee	Caught or trapped
2004	1	1	Sir Samuel	Caught or trapped
2004	1	1	Sir Samuel	Caught or trapped

Leipoa ocellata — Malleefowl — *5 records*

This species was once widely distributed across southern Australia. It prefers woodland or shrubland with an abundant litter layer that provides essential material for the construction of its nest mound.

1984	2		Yeelirrie	
1997	1	1	WANJARRI NATURE RESERVE	Tracks
1997	1	1	WANJARRI NATURE RESERVE	Tracks
1998	1	1	Mount Keith	Day sighting
2001	1	2	Yandal Station	Day sighting

Egernia kintorei — Giant Desert Skink — *1 records*

A burrowing species of skink found in a variety of desert habitats on sandy, clay and loamy soils.

1964	1	1	Kathleen	Caught or trapped

Schedule 4 - Other specially protected fauna

Cacatua leadbeateri — Major Mitchell's Cockatoo — *1 records*

This species is sporadically distributed through arid and semi-arid Australia and may occur in sparsely timbered grasslands and shrublands and rocky outcrops.

1967	2		Millrose	Day sighting

26.26 °S **120 °E** / **28.05 °S** **122.06 °E** Mining Proposal area, Lake Maitland

*	Date	Certainty	Seen	Location Name	Method

Priority Two: Taxa with few, poorly known populations on conservation lands

Kwonkan moriartii **Kwonkan moriartii** *2 records*

There is very little information for this species except that the single record in the search area represents the holotype specimen collected in 1962.

1962	1	1	Kathleen	
1962	1	1	Kathleen	

Priority Four: Taxa in need of monitoring

Macroderma gigas **Ghost Bat** *1 records*

This species is Australia's only carnivorous bat and has a patchy distribution across northern Australia. It shelters in caves, mine shafts and deep rock fissures and is sensitive to disturbance.

1961	1	1		Day sighting

Ardeotis australis **Australian Bustard** *9 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

1974	1	4	Lake Violet	Day sighting
1982	1	4	Wiluna	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	1	Wanjarri Nature Reserve	Day sighting
1983	1	2	Wanjarri Nature Reserve	Day sighting
1985	1	2	Wanjarri Nature Reserve	Day sighting
1985	1	1	Wanjarri Nature Reserve	Day sighting
1987	1	2	Wanjarri Nature Reserve	Day sighting

Burhinus grallarius **Bush Stonecurlew** *1 records*

A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.

1985	1	10	Mt Keith	

Amytornis striatus striatus **Striated Grasswren** *2 records*

This subspecies of Striated Grasswren inhabits spinifex on sandhills and rocky hillslopes and may occur in the area in question.

1979	1	1	Wanjarri Nature Reserve	Caught or trapped
1987	1	1	Wanjarri Nature Reserve	Day sighting

Amytornis textilis textilis **Thick-billed Grass-wren (western ssp)** *1 records*

This species inhabits shrubland, preferring the denser vegetation along drainage depressions.

1974	1	5	Wiluna	Day sighting

Pomatostomus superciliosus ashbyi **White-browed Babbler (western wheatb** *1 records*

This species of bird lives in eucalypt forests and woodlands, and forages on or near the ground for insects and seeds.

1978	1		Millbillillie	Day sighting

26.26 °S	**120 °E**	**/**	**28.05 °S**	**122.06 °E**

Mining Proposal area, Lake Maitland

*	*Date*	*Certainty*	*Seen*	*Location Name*	*Method*

***** Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Appendix B

Search Results of the Western Australian Museum's Faunabase

Fishes collected between -26.0435, 119.4673 and -28.7118, 122.4232

Diodontidae
Tragulichthys jaculiferus

Amphibia collected between -26.0435, 119.4673 and -28.7118, 122.4232

Hylidae
Cyclorana maini
Cyclorana platycephala
Litoria rubella

Myobatrachidae
Limnodynastes spenceri
Neobatrachus aquilonius
Neobatrachus centralis
Neobatrachus kunapalari
Neobatrachus sutor
Neobatrachus wilsmorei
Notaden nichollsi
Pseudophryne occidentalis

Birds collected between -26.0435, 119.4673 and -28.7118, 122.4232

Acanthizidae
Acanthiza apicalis
Acanthiza chrysorrhoa
Acanthiza robustirostris
Acanthiza uropygialis
Aphelocephala leucopsis castaneiventris
Calamanthus campestris
Gerygone fusca
Gerygone fusca fusca
Gerygone fusca mungi
Pyrrholaemus brunneus
Sericornis frontalis balstoni
Sericornis frontalis maculatus
Smicrornis brevirostris

Accipitridae
Accipiter cirrocephalus cirrocephalus
Circus assimilis
Hamirostra isura
Hamirostra melanosternon

Aegothelidae
Aegotheles cristatus cristatus

Anatidae
Cygnus atratus
Tadorna tadornoides

Ardeidae
Ardea pacifica

Campephagidae
Coracina novaehollandiae
Coracina novaehollandiae novaehollandiae
Coracina novaehollandiae subpallida

Caprimulgidae
Eurostopodus argus

Cinclosomatidae
Cinclosoma castaneothorax marginatum

Climacteridae
Climacteris affinis superciliosa
Climacteris rufa

Columbidae
Ocyphaps lophotes
Phaps chalcoptera

Corvidae
Corvus bennetti
Corvus orru

Cracticidae
Cracticus nigrogularis
Cracticus tibicen
Strepera versicolor

Cuculidae
Chrysococcyx basalis

Dicruridae
Grallina cyanoleuca
Rhipidura leucophrys

Falconidae
Falco berigora berigora
Falco cenchroides
Falco cenchroides cenchroides
Falco longipennis longipennis

Halcyonidae
Dacelo novaeguineae

Hirundinidae
Cheramoeca leucosternus
Hirundo ariel

Maluridae
Amytornis striatus striatus
Amytornis textilis
Malurus lamberti assimilis
Malurus leucopterus
Malurus leucopterus leuconotus
Malurus splendens

Megapodiidae
Leipoa ocellata

Meliphagidae
Acanthagenys rufogularis
Certhionyx variegatus
Epthianura aurifrons
Epthianura tricolor
Lichenostomus penicillatus
Lichenostomus plumulus
Lichenostomus virescens
Manorina flavigula
Phylidonyris albifrons

Neosittidae
Daphoenositta chrysoptera pileata

Otididae
Ardeotis australis

Pachycephalidae
Colluricincla harmonica
Oreoica gutturalis
Pachycephala rufiventris rufiventris

Pardalotidae
Pardalotus striatus murchisoni
Pardalotus striatus westraliensis
Pardalotus striatus westraliensis x murchisoni

Passeridae
Taeniopygia guttata castanotis

Podargidae
Podargus strigoides brachypterus

Podicipedidae
Poliocephalus poliocephalus

Pomatostomidae
Pomatostomus superciliosus

Psittacidae
Cacatua roseicapilla assimilis
Melopsittacus undulatus
Neophema bourkii
Neophema splendida
Platycercus varius
Platycercus zonarius
Platycercus zonarius zonarius
Polytelis alexandrae
Polytelis anthopeplus anthopeplus

Ptilonorhynchidae
Ptilonorhynchus maculatus guttatus

Rallidae
Porzana pusilla palustris

Strigidae
Ninox novaeseelandiae

Sylviidae
Cincloramphus cruralis

Reptiles collected between -26.0435, 119.4673 and -28.7118, 122.4232

Agamidae
Caimanops amphiboluroides
Ctenophorus caudicinctus
Ctenophorus caudicinctus infans
Ctenophorus caudicinctus mensarum
Ctenophorus fordi
Ctenophorus isolepis gularis
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus reticulatus
Ctenophorus salinarum
Ctenophorus scutulatus
Lophognathus longirostris
Moloch horridus
Pogona minor minor
Tympanocryptis cephala

Boidae
Antaresia perthensis
Antaresia stimsoni stimsoni

Cheluidae
Chelodina steindachneri

Elapidae
Acanthophis pyrrhus
Brachyurophis approximans
Brachyurophis fasciolata fasciolata
Brachyurophis semifasciata
Demansia psammophis cupreiceps
Furina ornata
Parasuta monachus
Pseudechis australis
Pseudechis butleri
Pseudonaja modesta
Pseudonaja nuchalis
Simoselaps bertholdi
Suta fasciata

Gekkonidae
Diplodactylus conspicillatus
Diplodactylus elderi
Diplodactylus granariensis rex
Diplodactylus pulcher
Diplodactylus squarrosus
Diplodactylus stenodactylus
Gehyra purpurascens
Gehyra variegata
Heteronotia binoei
Nephrurus vertebralis
Nephrurus wheeleri
Nephrurus wheeleri wheeleri
Rhynchoedura ornata
Strophurus assimilis
Strophurus elderi
Strophurus strophurus
Strophurus wellingtonae
Underwoodisaurus milii

Pygopodidae
Delma butleri
Delma fraseri petersoni
Delma nasuta
Lialis burtonis
Pygopus nigriceps

Scincidae
Cryptoblepharus carnabyi
Cryptoblepharus plagiocephalus
Ctenotus ariadnae
Ctenotus calurus
Ctenotus dux
Ctenotus grandis grandis
Ctenotus greeri
Ctenotus hanloni
Ctenotus helenae
Ctenotus leonhardii
Ctenotus pantherinus ocellifer
Ctenotus quattuordecimlineatus
Ctenotus schomburgkii
Ctenotus severus
Ctenotus uber uber
Egernia depressa

Egernia formosa
Egernia inornata
Egernia kintorei
Egernia striata
Eremiascincus richardsonii
Lerista bipes
Lerista desertorum
Lerista muelleri
Menetia greyii
Morethia butleri
Tiliqua multifasciata
Tiliqua occipitalis

Typhlopidae
Ramphotyphlops hamatus
Ramphotyphlops waitii

Varanidae
Varanus acanthurus
Varanus brevicauda
Varanus caudolineatus
Varanus eremius
Varanus giganteus
Varanus gouldii
Varanus panoptes rubidus
Varanus tristis
Varanus tristis tristis

Mammals collected between -26.0435, 119.4673 and -28.7118, 122.4232

Canidae
Vulpes vulpes

Dasyuridae
Antechinomys laniger
Dasycercus cristicauda
Ningaui ridei
Pseudantechinus woolleyae
Sminthopsis crassicaudata
Sminthopsis dolichura
Sminthopsis hirtipes
Sminthopsis longicaudata
Sminthopsis macroura
Sminthopsis ooldea

Equidae
Equus caballus

Macropodidae
Macropus robustus erubescens
Macropus rufus

Molossidae
Mormopterus beccarii
Mormopterus planiceps
Tadarida australis

Muridae
Mus musculus
Notomys alexis
Pseudomys albocinereus
Pseudomys bolami
Pseudomys desertor
Pseudomys hermannsburgensis

Thylacomyidae
Macrotis lagotis

Vespertilionidae
Chalinolobus gouldii
Nyctophilus geoffroyi
Scotorepens balstoni
Vespadelus baverstocki
Vespadelus finlaysoni
Vespadelus regulus

Appendix C

Search Results of the Federal Government Environment Protection and Biodiversity Conservation Act Protected Matters Database

Protected Matters Search Tool

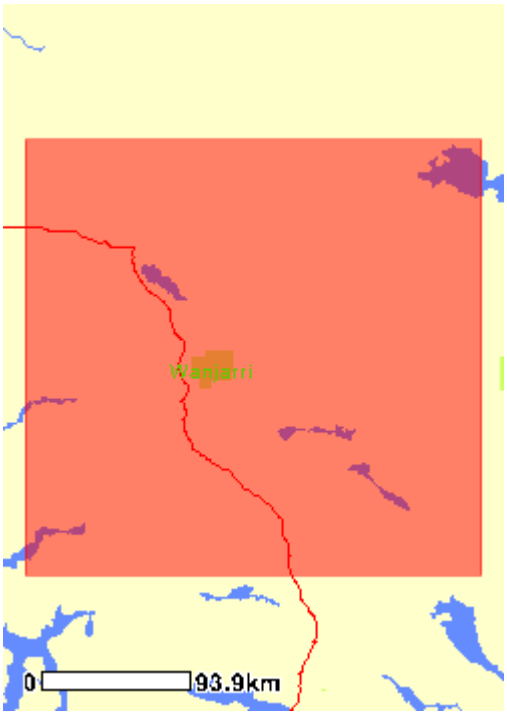
19 June 2007 17:08

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html



Search Type: Area

Buffer: 0 km

Coordinates: -25.932,119.541, -28.686,119.541, -28.686,122.419, -25.93,122.419

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	7
Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources

including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	2
Commonwealth Heritage Places:	None
Places on the RNE:	4
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Acanthiza iredalei iredalei ***** Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata *****	Vulnerable	Species or species habitat likely to

Malleefowl		occur within area
Polytelis alexandrae * Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasycercus cristicauda * Mulgara	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) * Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Egernia kintorei * Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis * Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Leipoa ocellata * Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus * Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus ***** Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Commonwealth Lands [Dataset Information]		
Defence		
Unknown		
Places on the RNE [Dataset Information] Note that not all Indigenous sites may be listed.		
Indigenous		
Weebo Protected Area WA		
Yeelirrie Pool Mythological and Occupation Site WA		
Yeelirrie Station Mythological Site WA		
Natural		
Wanjarri Nature Reserve WA		

Extra Information

State and Territory Reserves [Dataset Information]

Wanjarri Nature Reserve, WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated:

Department of the Environment and Water Resources
GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

Appendix D

Search Results of the Department of Environment and Water's Environmental Reporting Tool

Environmental Reporting Tool

2 February 2007 17:53

Database Report

This report includes places of national environmental significance that are registered in the Department of the Environment and Heritage's databases, for the selected area. The information presented here has been provided by a range of groups across Australia, and the accuracy and resolution varies.

Search Type:	Area
Buffer:	0 km
Coordinates:	-25.927,119.562, -28.682,119.562, -28.682,122.395, -25.92,122.395

Report Contents: Summary >> Details >> Caveat >> Acknowledgment

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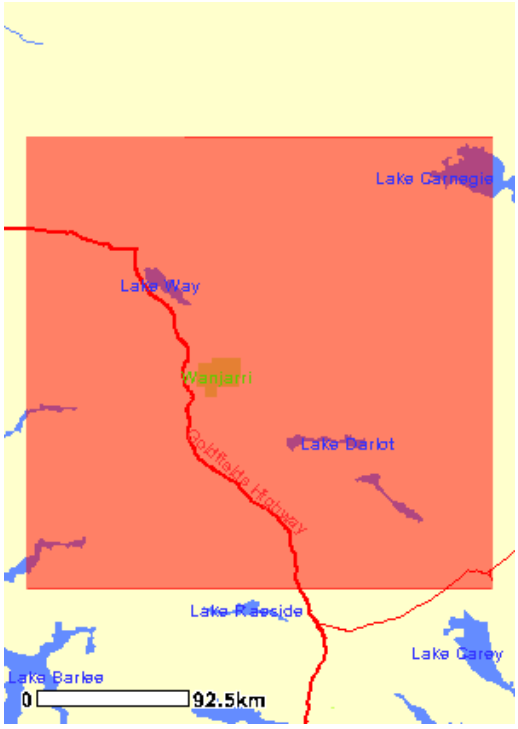

Biodiversity	
Threatened Species:	7
Migratory Species:	3
Listed Marine Species:	4
Invasive Species:	None
Whales and Other Cetaceans:	None
Threatened Ecological Communities:	None
Heritage	
World Heritage Properties:	None
Australian Heritage Sites:	4
Wetlands	
Ramsar sites: (Internationally important)	None
Nationally Important Wetlands:	1
National Pollutant Inventory	
Reporting Facilities:	None
Airsheds:	None
Catchments:	None
Protected Areas	
Reserves and Conservation Areas:	1
Regional Forest Agreements:	None

Biodiversity		
Threatened Species [Dataset Information]	Status	Comments
Birds		
Acanthiza iredalei iredalei Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area

Reptiles		
Egernia kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
Plants		
Pityrodia augustensis Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Comments
Migratory Terrestrial Species		
Birds		
Leipoa ocellata Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Listed Marine Species [Dataset Information]	Status	Comments
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Heritage		
Australian Heritage Sites [Dataset Information] Note that not all Indigenous sites may be listed.		

Indigenous

Weebo Protected Area WA

Yeelirrie Pool Mythological and Occupation Site WA

Yeelirrie Station Mythological Site WA

Natural

Wanjarri Nature Reserve WA

Wetlands

Nationally Important Wetland Sites [Dataset Information]

Lake Carnegie System, WA

Other

Reserves and Conservation Areas [Dataset Information]

Wanjarri Nature Reserve, WA

Caveat

The information presented here has been drawn from a range of sources, compiled for a variety of purposes. Details of the coverage of each dataset are included in the metadata [Dataset Information] links above.

Acknowledgment

This database has been compiled from a range of data sources. The Department of the Environment and Heritage acknowledges the following custodians who have contributed valuable data and advice on species of national environmental significance:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCLIM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. The Department of the Environment and Heritage is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Department of the Environment and Water Resources
GPO Box 787 Canberra ACT 2601 Australia
Telephone: (02) 6274 1111

Appendix E

Species Identified as ‘At Risk’ by the National Lands and Water Resources Audit (MUR1)

Murchison (MUR1)

Table: Species at risk in each subregion: their status, trend and subregional distribution. The reliability of the assessment of trend is indicated and whether recovery plans have been prepared.

Species Group	Species name	EPBC listing	State listing	Trend	Recommended rank	Existing recovery plans (yes/no)	Subregional occurrence
MUR1							
Birds	*Acanthiza iredalei iredalei* (Slender-billed Thornbill (western))	Vulnerable	NT (E) SA (V)	Unknown	Qualitative	No	AW1; AW2; COO1; COO2; COO3; CR1; EYB2; EYB3; EYB5; FLB4; FLB5; GAS2; GAS3; GAW1; GAW2; GAW4; GAW5; GD1; GS1; GS2; GVD2; GVD5; GVD6; HAM; KAN2; LSD2; MAL1; MAL2; MUR1; MUR2; NCP1; NCP3; NCP4; NUL1; NUL2; NUL3; YAL
Birds	*Leipoa ocellata* (Malleefowl)	Vulnerable	NSW (E) NT (E) SA (V) VIC (E) WA (V)	Unknown	Quantitative and qualitative	No	AW1; AW2; BBS23; BBS24; BBS25; CAR2; COO1; COO2; COO3; CP2; CP3; CP4; CP5; CR1; DRP10; DRP5; DRP9; ESP1; ESP2; EYB1; EYB3; EYB4; EYB5; GD1; GS1; GS2; GS3; GVD1; GVD2; GVD4; GVD6; HAM; MAL1; MAL2; MDD1; MDD2; MDD3; MDD4; MDD5; MDD6; MUR1; MUR2; NCP1; NCP2;
Birds	*Pezoporus occidentalis* (Night Parrot)	Endangered	SA (E) VIC (X) WA (E)	Extinction	No data	No	AW1; CAR1; CHC2; DL1; GD1; GD2; GS1; GS2; GS3; GSD1; GSD2; GSD5; LSD1; LSD2; MDD2; MDD4; MGD4; MUL10; MUL8; MUR1; MUR2; PIL1; PIL2; PIL3; PIL4; YAL

Birds	*Polytelis alexandrae* (Princess Parrot, Alexandra's Parrot)	Vulnerable	NT (V)	Unknown	Quantitative and qualitative	No	CHC3; CR1; FIN1; FIN2; FIN3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GSD4; GVD1; GVD3; LSD2; MAC1; MAC2; MAC3; MUR1; NUL1; NUL2; MII3; PIL1; SEQ1; TAN1
Mammals	*Dasycercus cristicauda* (Mulgara)	Vulnerable	NSW (X) NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; BRT2; BRT3; CAR1; CAR2; CHC1; CHC2; COO3; CR1; DMR1; DMR3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GVD1; GVD2; HAM; LSD1; LSD2; MAC1; MAC3; MUR1; MUR2; NUL1; NUL2; PIL1; SSD1; SSD2; TAN1
Mammals	*Leporillus apicalis* (Lesser Stick-nest Rat)	Extinct	NT (X) VIC (X) WA (X)	Extinction	No data	No	AW1; CAR2; CR1; GAS3; GD1; GS1; GVD1; GVD2; HAM; LSD2; MAL1; MDD2; MUR1; NUL2; PIL3; YAL
Mammals	*Leporillus conditor* (Wopilkara, Greater Stick-nest Rat)	Vulnerable	SA (V) VIC (X) WA (V)	Extinction	No data	No	BBS24; BHC1; CAR2; DRP10; GS1; HAM; MDD1; MUR1; NUL2; YAL
Mammals	*Macrotis lagotis* (Greater Bilby)	Vulnerable	NT (V) QLD (E) SA (E) WA (V)	Extinction	Quantitative and qualitative	No	AW1; AW2; BBS22; BBS24; BHC1; CAR2; CHC2; CHC3; CHC4; COO2; COO3; CP2; CP3; CR1; DL2; DMR3; DRP8; GAS1; GAS3; GD1; GD2; GSD1; GSD2; JF1; JF2; LSD1; LSD2; MAL2; MDD1; MDD6; MGD4; MGD7; MUR1; MUR2; NSS1; NSS2; NUL2; OVP1; OVP2; OVP4; PIL1; PIL2; PIL4; SSD6;

Mammals	*Notomys amplus* (Short-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	CAR2; GD1; MUR1; YAL
Mammals	*Notomys longicaudatus* (Long-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW2; BHC1; BHC2; CR1; GD1; MUR1; YAL
Mammals	*Notoryctes typhlops* (Yitjarritjarri, Southern Marsupial Mole)	Endangered	NT (V) SA (E) WA (E)	Unknown	Qualitative	No	COO3; CR1; CR2; FIN1; FIN2; FIN3; GAW2; GD1; GSD2; GSD5; GVD1; GVD2; GVD3; GVD4; LSD2; MAC2; MUR1; NUL1; NUL2; TAN1; TAN2
Mammals	*Onychogalea lunata* (Crescent Nail-tail Wallaby)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW1; COO3; CR1; GD1; MAL2; MUR1; NUL2
Reptiles	*Egernia kintorei* (Great Desert Skink)	Vulnerable	NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; CR1; DMR1; FIN2; GAS2; GD1; GSD1; GSD2; GSD4; LSD1; MAC1; MAC2; MUR1; TAN1

Murchison (MUR1)

Table: Species at risk in each subregion: their threatening processes.

Species name	Threatening processes	Threatening processes notes
Acanthiza iredalei iredalei (Slender-billed Thornbill (western))	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Feral animals	Foxes and cats
Egernia kintorei (Great Desert Skink)	Changed fire regimes	No data
Egernia kintorei (Great Desert Skink)	Feral animals	Foxes and cats
Eucalyptus articulata (Ponton Creek Mallee)	Changed fire regimes	No data
Leipoa ocellata (Malleefowl)	Feral animals	Foxes and cats
Leipoa ocellata (Malleefowl)	Firewood collection	No data
Leipoa ocellata (Malleefowl)	Grazing pressure	No data
Macrotis lagotis (Greater Bilby)	Changed fire regimes	No data
Macrotis lagotis (Greater Bilby)	Feral animals	Foxes
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Changed fire regimes	No data
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Feral animals	Foxes and cats
Polytelis alexandrae (Princess Parrot, Alexandra's Parrot)	Grazing pressure	No data

Appendix F

Search Results of the Birds Australia Atlas Database (Murchison Bioregion)

Murchison (MUR1)

Table: Species at risk in each subregion: their status, trend and subregional distribution. The reliability of the assessment of trend is indicated and whether recovery plans have been prepared.

Species Group	Species name	EPBC listing	State listing	Trend	Recommended rank	Existing recovery plans (yes/no)	Subregional occurrence
MUR1							
Birds	*Acanthiza iredalei iredalei* (Slender-billed Thornbill (western))	Vulnerable	NT (E) SA (V)	Unknown	Qualitative	No	AW1; AW2; COO1; COO2; COO3; CR1; EYB2; EYB3; EYB5; FLB4; FLB5; GAS2; GAS3; GAW1; GAW2; GAW4; GAW5; GD1; GS1; GS2; GVD2; GVD5; GVD6; HAM; KAN2; LSD2; MAL1; MAL2; MUR1; MUR2; NCP1; NCP3; NCP4; NUL1; NUL2; NUL3; YAL
Birds	*Leipoa ocellata* (Malleefowl)	Vulnerable	NSW (E) NT (E) SA (V) VIC (E) WA (V)	Unknown	Quantitative and qualitative	No	AW1; AW2; BBS23; BBS24; BBS25; CAR2; COO1; COO2; COO3; CP2; CP3; CP4; CP5; CR1; DRP10; DRP5; DRP9; ESP1; ESP2; EYB1; EYB3; EYB4; EYB5; GD1; GS1; GS2; GS3; GVD1; GVD2; GVD4; GVD6; HAM; MAL1; MAL2; MDD1; MDD2; MDD3; MDD4; MDD5; MDD6; MUR1; MUR2; NCP1; NCP2;
Birds	*Pezoporus occidentalis* (Night Parrot)	Endangered	SA (E) VIC (X) WA (E)	Extinction	No data	No	AW1; CAR1; CHC2; DL1; GD1; GD2; GS1; GS2; GS3; GSD1; GSD2; GSD5; LSD1; LSD2; MDD2; MDD4; MGD4; MUL10; MUL8; MUR1; MUR2; PIL1; PIL2; PIL3; PIL4; YAL

Birds	*Polytelis alexandrae* (Princess Parrot, Alexandra's Parrot)	Vulnerable	NT (V)	Unknown	Quantitative and qualitative	No	CHC3; CR1; FIN1; FIN2; FIN3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GSD4; GVD1; GVD3; LSD2; MAC1; MAC2; MAC3; MUR1; NUL1; NUL2; MII3; PIL1; SEQ1; TAN1
Mammals	*Dasycercus cristicauda* (Mulgara)	Vulnerable	NSW (X) NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; BRT2; BRT3; CAR1; CAR2; CHC1; CHC2; COO3; CR1; DMR1; DMR3; GAS2; GAS3; GD1; GD2; GSD1; GSD2; GVD1; GVD2; HAM; LSD1; LSD2; MAC1; MAC3; MUR1; MUR2; NUL1; NUL2; PIL1; SSD1; SSD2; TAN1
Mammals	*Leporillus apicalis* (Lesser Stick-nest Rat)	Extinct	NT (X) VIC (X) WA (X)	Extinction	No data	No	AW1; CAR2; CR1; GAS3; GD1; GS1; GVD1; GVD2; HAM; LSD2; MAL1; MDD2; MUR1; NUL2; PIL3; YAL
Mammals	*Leporillus conditor* (Wopilkara, Greater Stick-nest Rat)	Vulnerable	SA (V) VIC (X) WA (V)	Extinction	No data	No	BBS24; BHC1; CAR2; DRP10; GS1; HAM; MDD1; MUR1; NUL2; YAL
Mammals	*Macrotis lagotis* (Greater Bilby)	Vulnerable	NT (V) QLD (E) SA (E) WA (V)	Extinction	Quantitative and qualitative	No	AW1; AW2; BBS22; BBS24; BHC1; CAR2; CHC2; CHC3; CHC4; COO2; COO3; CP2; CP3; CR1; DL2; DMR3; DRP8; GAS1; GAS3; GD1; GD2; GSD1; GSD2; JF1; JF2; LSD1; LSD2; MAL2; MDD1; MDD6; MGD4; MGD7; MUR1; MUR2; NSS1; NSS2; NUL2; OVP1; OVP2; OVP4; PIL1; PIL2; PIL4; SSD6;

Mammals	*Notomys amplus* (Short-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	CAR2; GD1; MUR1; YAL
Mammals	*Notomys longicaudatus* (Long-tailed Hopping-mouse)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW2; BHC1; BHC2; CR1; GD1; MUR1; YAL
Mammals	*Notoryctes typhlops* (Yitjarritjarri, Southern Marsupial Mole)	Endangered	NT (V) SA (E) WA (E)	Unknown	Qualitative	No	COO3; CR1; CR2; FIN1; FIN2; FIN3; GAW2; GD1; GSD2; GSD5; GVD1; GVD2; GVD3; GVD4; LSD2; MAC2; MUR1; NUL1; NUL2; TAN1; TAN2
Mammals	*Onychogalea lunata* (Crescent Nail-tail Wallaby)	Extinct	NT (X) WA (X)	Extinction	No data	No	AW1; COO3; CR1; GD1; MAL2; MUR1; NUL2
Reptiles	*Egernia kintorei* (Great Desert Skink)	Vulnerable	NT (V) SA (E) WA (V)	Unknown	Quantitative and qualitative	No	BRT1; CR1; DMR1; FIN2; GAS2; GD1; GSD1; GSD2; GSD4; LSD1; MAC1; MAC2; MUR1; TAN1

Murchison (MUR1)

Table: Species at risk in each subregion: their threatening processes.

Species name	Threatening processes	Threatening processes notes
Acanthiza iredalei iredalei (Slender-billed Thornbill (western))	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Changed fire regimes	No data
Dasycercus cristicauda (Mulgara)	Feral animals	Foxes and cats
Egernia kintorei (Great Desert Skink)	Changed fire regimes	No data
Egernia kintorei (Great Desert Skink)	Feral animals	Foxes and cats
Eucalyptus articulata (Ponton Creek Mallee)	Changed fire regimes	No data
Leipoa ocellata (Malleefowl)	Feral animals	Foxes and cats
Leipoa ocellata (Malleefowl)	Firewood collection	No data
Leipoa ocellata (Malleefowl)	Grazing pressure	No data
Macrotis lagotis (Greater Bilby)	Changed fire regimes	No data
Macrotis lagotis (Greater Bilby)	Feral animals	Foxes
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Changed fire regimes	No data
Notoryctes typhlops (Yitjarritjarri, Southern Marsupial Mole)	Feral animals	Foxes and cats
Polytelis alexandrae (Princess Parrot, Alexandra's Parrot)	Grazing pressure	No data

Appendix G

Birds Australia Regional Summaries (Murchison Bioregion)

IBRA Region:	**Murchison**		
Physical characteristics	*Area*	Total area of region:	28,119,906
	Rainfall Index	Comparison with average rainfall:	
		Atlas period 1:	-0.57
		Atlas period 2:	0.77
		Difference in rainfall index between Atlas periods:	Higher
	Use Index	Use zone:	Extensive
		Percent cleared:	0.0
		Continental stress:	High
Number of surveys	*Atlas 1*	10 min surveys:	540
		60 min surveys:	415
		10 min surveys used for analysis:	306
	Atlas 2	2-ha searches:	496
		500 m area searches:	457
		5 km area searches:	153
		Area searches used for analysis:	299
		Incidental records:	131

Comments

The avifauna of this semi-arid bioregion does not stand out from that of other bioregions with a similar climate elsewhere in Australia. It contains no limited range taxa, a small proportion of the Vulnerable Malleefowl population and almost no introduced birds. Reporting rates of most birds were higher, but there were no trends in any guilds despite the high level of continental stress.

Status: Typical semi-arid avifauna.
Rare and threatened: No major populations.
Increasers: None indicative of landscape health.
Indicators: Emu, Australian Bustard, Banded Lapwing, White-browed Treecreeper, Hooded Robin, Jacky Winter, Grey-crowned Babbler.
Trend: No trends detected.
Scenario: Avifauna probably largely stable within large climatic fluctuations.
Actions: No grazing in representative areas and the adoption of reduced, conservative grazing rates in key habitat across the bioregion.

Murchison

Common name	Species name		Importance of bioregion for species
Limited range species			
None			
Threatened taxa		**Status**	
Malleefowl	*Leipoa ocellata*	Vulnerable	Moderate
Introduced species		**Type of introduction**	
Rock Dove	*Columba livia*	Exotic species	Moderate
Laughing Turtle-Dove	*Streptopelia senegalensis*	Exotic species	Moderate*
Spotted Turtle-Dove	*Streptopelia chinensis*	Exotic species	Minor*

* not recorded in Atlas 2 so may no longer be present

Murchison

Group		No. of species	Index Atlas 1	Index Atlas 2	BIAS	National trend	Regional variation	Bioregional trend	Comparison with national trend
All Australian breeding species		165	294	406	-0.3	Not significant	Significant	Significant increase	Increase greater than national trend
Ground nesters	**Obligate**	30	40	26	-0.4	Significant decrease	Significant	Not significant	
Hollow nesters	**Obligate**	19	45	46	-0.3	Not significant	Significant	Not significant	
Ground seed eaters	**Obligate**	8	16	35	-0.1	Significant increase	Significant	Not significant	
	Facultative	17	61	71	-0.2	Significant decrease	Significant	Not significant	
Ground insect eaters	**Obligate**	38	88	96	-0.3	Not significant	Significant	Not significant	
	Facultative	43	73	92	-0.3	Significant decrease	Significant	Not significant	
Freshwater	**Obligate**	37	39	30	-0.4	Significant decrease	Significant	Not significant	
Grassland	**Obligate**	31	64	74	-0.5	Significant decrease	Significant	Not significant	
	Facultative	28	108	79	-0.5	Significant decrease	Significant	Not significant	

Murchison

MUR

	Area (ha)	28,119,906	6	th largest bioregion	
Class	**Value**	**Rank** (1 high-85 low)	**IBRA average**	**IBRA total**	**Units**
All species					
Atlas period 1	195	55	232	698	
Atlas period 2	188	53	226	731	
Both periods	210	59	254	743	
Australian resident species					
No. species	188	57	215	555	
No. genera	130	55	139	248	
Species/genus	1.45	64	1.53	2.24	
Species:area ratio	0.31	79	0.31	0.39	ln(no. species)/ln(bioregion area)
Australian endemic species					
No. endemic species	123	42	124	355	
Endemic/total resident species	0.65	11	0.58	0.64	
Range limitation					
Index of range limitation (frequency)	11.8	68	20.4	100	Sum(100/ no. bioregions)
Index of range limitation (reporting rate)	12.4	66	22.7	100	Sum(100xreporting rate/ no. bioregions)
No. species recorded in 10 or fewer bioregions	0	85	8	154	
Index of importance of bioregion to species recorded in 10 or fewer bioregions	0.0	85	1.2	100	Sum(100/ no. bioregions)
Threatened taxa					
No. Critically Endangered taxa	0		-	15	
No. Endangered taxa	0		-	24	
No. Vulnerable taxa	1		-	35	
Total	1	73	4.0	74	
Introduced species					
Exotic species					
No. species	3	60	6.3	30	
Representation in bioregion	1.4	55	2.6	5.4	No. ESx100/ no. spp. in bioregion
Relative abundance in bioregion	0.2	59	2.6	100	Rep. rate ESx100/ Rep rate spp. in bioregion
Percentage of Australian total	10.0	60	20.9	100	No. ES in regionx100/ no. ES in Australia
Australian translocated species					
No. species	0	85	0.9	16	
Representation in bioregion	0.0	85	0.4	3	No. ATSx100/ no. spp. in bioregion
Relative abundance in bioregion	0.0	85	0.3	100	Rep. rate ATSx100/ Rep rate spp. in bioregion
Percentage of Australian total	0.0	85	5.5	100	No. ATS in regionx100/ no. ATS in Australia
Total introduced species					
No. species	3	62	7.2	36	
Representation in bioregion	1.4	56	2.9	6	No. TISx100/ no. spp. in bioregion
Relative abundance in bioregion	0.2	62	3.0	100	Rep. rate TISx100/ Rep rate spp. in bioregion
Percentage of Australian total	6.5	62	15.5	100	No. TIS in regionx100/ no. TIS in Australia

Appendix H

Refugia for Biological Diversity in Arid and Semi-arid Australia (MUR1)

Refugia for Biological Diversity in Arid and Semi-arid Australia

Biodiversity Series, Paper No. 4
Biodiversity Unit

S.R. Morton, J. Short and R.D. Barker
with an Appendix by G.F. Griffin and G. Pearce

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4.10. Murchison

Area

278,360 km2.

Primary land-use

Mining, grazing by sheep.

National Parks and Nature Reserves

Goongarrie National Park and Wanjarri Nature Reserve.

Management problems

Wanjarri Nature Reserve - weeds, wildfire, and increasing numbers of tourists largely due to close proximity to gold and nickel mines.

Land degradation due to over-grazing (Wilcox and Cunningham 1994) and to goats (Freudenberger 1993).

ANZECC-listed species

Birds: Malleefowl *Leipoa ocellata* (E) at Wanjarri Nature Reserve (Keally and Chapman 1991); also Alexandra's parrot *Polytelis alexandrae* (V).

Species that are regionally endemic

The elapid snake *Pseudechis butleri* (Cogger 1992)..

Relict populations

The agamid *Egernia kintorei* (Cogger *et al.* 1993, pp. 88-90).

Other significant populations

Many surveys have revealed a rich vertebrate fauna and an extensive flora, but generally the species are widely distributed (Dell *et al*. 1992; How *et al*. 1992; Hall *et al*. 1994). The Region comprises a rich interzone between the arid and mesic biotas of south-western Australia, corresponding roughly to the "line" between the mulga/spinifex country and the eucalypt environments (Dell *et al*. 1988; McKenzie and Hall 1992).

Birds: Wanjarri Nature Reserve contains striated grass wren *Amytornis striatus*, Australian bustard *Ardeotis kori*, bush thick-knee *Burhinus grallarius*, and regent parrot *Polytelis anthopeplus* (Keally and Chapman 1991).

Plants: Dell *et al*. (1988) recorded the rare plant *Calytrix watsonii*. Leigh *et al*. (1984) noted *Hemigenia exilis* (p. 234) and *H. tysoni* (p. 236).

Wetland sites

Waterbirds occur throughout ephemeral wetlands of the interior (Lane and McComb 1988). One of particular importance is Lake Barlee, an intermittent salt lake where up to 200,000 nests of the banded stilt *Cladorhynchus leucocephalus* may be used about once every 10 years when the Lake floods (Burbidge and Fuller 1982; Jaensch and Lane 1993).

Aneen Lake is a large (12,000 ha) salt lake south-west of Meekatharra with numerous islands and peninsulas, comprising a seasonal, intermittent saline or brackish lake and marsh. Some parts of the Lake are likely to hold shallow water in most years; the whole system fills every 5-10 years from summer-autumn rain. The Lake is a regular and major breeding area for gull-billed tern *Gelochelidon nilotica* and whiskered tern *Chlidonias hybrida*. It also supports several thousand waterbirds when full (Jaensch and Lane 1993).

Wooleen Lake is a floodplain lake with associated marshes on Roderick River, which outflows to the Murchison River 6 km downstream. It experiences some inundation in most years, and the whole lake and surrounding marshes fill once every 5-10 years. The Lake may be several metres deep when full. The Lake is a major breeding area for gull-billed terns *Gelochelidon nilotica* (Jaensch and Lane 1993).

Refugia

Annen Lake (see section 10.20), Wooleen Lake (10.22) and Lake Barlee (10.24) all qualify as refugia.

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Department of the Environment and Water Resources
GPO Box 787
Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

Appendix I

Vertebrate Species Potentially Occurring over the Project Area

Mammal species potentially occurring over the project area

Family	Common Name	Species	WAM
Tachyglossidae	Echidna	*Tachyglossus aculeatus*	
Dasyuridae	Kultarr	*Antechinomys laniger*	x
	Mulgara	*Dasycercus cristicauda*	x
	Wongai Ningaui	*Ningaui ridei*	x
	Southern Ningaui	*Ningaui yvonneae*	
	Wooley's Pseudantechinus	*Pseudantechinus woolleyae*	x
	Fat-tailed Dunnart	*Sminthopsis crassicaudata*	x
	Little Long-tailed Dunnart	*Sminthopsis dolichura*	x
	Hairy-footed Dunnart	*Sminthopsis hirtipes*	x
	Long-tailed Dunnart	*Sminthopsis longicaudata*	x
	Stripe-faced Dunnart	*Sminthopsis macroura*	x
	Ooldea Dunnart	*Sminthopsis ooldea*	x
Macropodidae	Western Grey Kangaroo	*Macropus fuliginosus*	
	Euro	*Macropus robustus erubescens*	x
	Red Kangaroo	*Macropus rufus*	
Emballonuridae	Common Sheathtail Bat	*Taphozous georgianus*	
	Hill's Sheathtail Bat	*Taphozous hilli*	
Vespertilionidae	Gould`s Wattled Bat	*Chalinolobus gouldii*	x
	Chocolate Wattled Bat	*Chalinolobus morio*	
	Lesser Long-eared Bat	*Nyctophilus geoffroyi*	x
	Greater Long-eared Bat	*Nyctophilus timoriensis timoriensis*	
	Inland Broad-nosed Bat	*Scotorepens balstoni*	x
	Little Broad-nosed Bat	*Scotorepens greyii*	
	Inland Forest Bat	*Vespadelus baverstocki*	x
	Southern Forest Bat	*Vespadelus regulus*	x
	Finlayson's Cave Bat	*Vespadelus finlaysoni*	x
Molossidae	Beccari's Freetail-bat	*Mormopterus beccarii*	x
	Southern Freetail-bat	*Mormopterus planiceps*	x
	White-striped Freetail-bat	*Tadarida australis*	x
Muridae	Spinifex Hopping-mouse	*Notomys alexis*	x
	Ash-grey Mouse	*Pseudomys albocinereus*	x
	Bolam's Mouse	*Pseudomys bolami*	x
	Desert Mouse	*Pseudomys desertor*	x
	Sandy Inland Mouse	*Pseudomys hermannsburgensis*	x

Bird species potentially occurring over the project area

Family	Common name	Scientific name	BA	WAM
Casuaridae	Emu	*Dromaius novaehollandiae*	H	
Megapodiidae	Malleefowl	*Leipoa ocellata*	L	x
Phasianidae	Stubble Quail	*Coturnix pectoralis*	L	
Anatidae	Plumed Whistling-Duck	*Dendrocygna eytoni*	L	
	Blue-billed Duck	*Oxyura australis*	L	
	Musk Duck	*Biziura lobata*	L	
	Freckled Duck	*Stictonetta naevosa*	L	
	Black Swan	*Cygnus atratus*	M	x
	Australian Shelduck	*Tadorna tadornoides*	M	x
	Australian Wood Duck	*Chenonetta jubata*	M	
	Pacific Black Duck	*Anas superciliosa*	M	
	Australasian Shoveler	*Anas rhynchotis*	L	
	Grey Teal	*Anas gracilis*	M	
	Chestnut Teal	*Anas castanea*	L	
	Pink-eared Duck	*Malacorhynchus membranaceus*	M	
	Hardhead	*Aythya australis*	M	
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*	M	
	Hoary-headed Grebe	*Poliocephalus poliocephalus*	M	x
	Great Crested Grebe	*Podiceps cristatus*	L	
Anhingidae	Darter	*Anhinga melanogaster*	L	
Phalacrocoracidae	Little Pied Cormorant	*Phalacrocorax melanoleucos*	M	
	Pied Cormorant	*Phalacrocorax varius*	L	
	Little Black Cormorant	*Phalacrocorax sulcirostris*	M	
	Great Cormorant	*Phalacrocorax carbo*	L	
Pelecanidae	Australian Pelican	*Pelecanus conspicillatus*	M	
Areidae	White-faced Heron	*Egretta novaehollandiae*	M	
	White-necked Heron	*Ardea pacifica*	M	x
	Great Egret	*Ardea alba*	L	
	Nankeen Night Heron	*Nycticorax caledonicus*	L	
Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	L	
	Australian White Ibis	*Threskiornis molucca*	L	
	Straw-necked Ibis	*Threskiornis spinicollis*	M	
	Royal Spoonbill	*Platalea regia*	L	
	Yellow-billed Spoonbill	*Platalea flavipes*	L	
Accipitridae	Black-shouldered Kite	*Elanus axillaris*	L	
	Square-tailed Kite	*Lophoictinia isura*	L	x
	Black-breasted Buzzard	*Hamirostra melanosternon*	L	x
	Black Kite	*Milvus migrans*	M	
	Whistling Kite	*Haliastur sphenurus*	M	
	Spotted Harrier	*Circus assimilis*	M	x
	Swamp Harrier	*Circus approximans*	L	
	Brown Goshawk	*Accipiter fasciatus*	M	
	Collared Sparrowhawk	*Accipiter cirrhocephalus*	M	x
	Wedge-tailed Eagle	*Aquila audax*	H	
	Little Eagle	*Hieraaetus morphnoides*	M	

Falconidae	Brown Falcon	*Falco berigora*	H	x
	Australian Hobby	*Falco longipennis*	M	x
	Grey Falcon	*Falco hypoleucos*	L	
	Black Falcon	*Falco subniger*	L	
	Peregrine Falcon	*Falco peregrinus*	L	
	Nankeen Kestrel	*Falco cenchroides*	H	x
Gruidae	Brolga	*Grus rubicunda*	L	
Rallidae	Baillon's Crake	*Porzana pusilla*	L	x
	Australian Spotted Crake	*Porzana fluminea*	L	
	Black-tailed Native-hen	*Gallinula ventralis*	M	
	Eurasian Coot	*Fulica atra*	M	
Otididae	Australian Bustard	*Ardeotis australis*	M	x
Turnicidae	Little Button-quail	*Turnix velox*	M	
Scolopacidae	Bar-tailed Godwit	*Limosa lapponica*	L	
	Marsh Sandpiper	*Tringa stagnatilis*	L	
	Common Greenshank	*Tringa nebularia*	L	
	Wood Sandpiper	*Tringa glareola*	L	
	Common Sandpiper	*Actitis hypoleucos*	L	
	Grey-tailed Tattler	*Heteroscelus brevipes*	L	
	Red Knot	*Calidris canutus*	L	
	Sanderling	*Calidris alba*	L	
	Red-necked Stint	*Calidris ruficollis*	L	
	Long-toed Stint	*Calidris subminuta*	L	
	Pectoral Sandpiper	*Calidris melanotos*	L	
	Sharp-tailed Sandpiper	*Calidris acuminata*	L	
	Curlew Sandpiper	*Calidris ferruginea*	L	
Burhinidae	Bush Stone-curlew	*Burhinus grallarius*	L	
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	M	
	Banded Stilt	*Cladorhynchus leucocephalus*	M	
	Red-necked Avocet	*Recurvirostra novaehollandiae*	M	
Charadriidae	Pacific Golden Plover	*Pluvialis fulva*	L	
	Red-capped Plover	*Charadrius ruficapillus*	M	
	Oriental Plover	*Charadrius veredus*	L	
	Inland Dotterel	*Peltohyas australis*	M	
	Black-fronted Dotterel	*Elseyornis melanops*	M	
	Hooded Plover	*Thinornis rubricollis*	L	
	Red-kneed Dotterel	*Erythogonys cinctus*	M	
	Banded Lapwing	*Vanellus tricolor*	M	
Glareolidae	Oriental Pratincole	*Glareola maldivarum*	L	
	Australian Pratincole	*Stiltia isabella*	L	
Laridae	Silver Gull	*Larus novaehollandiae*	L	
	Gull-billed Tern	*Sterna nilotica*	M	
	Caspian Tern	*Sterna caspia*	L	
	Whiskered Tern	*Chlidonias hybridus*	M	
	White-winged Tern	*Chlidonias leucopterus*	L	
Columbidae	Common Bronzewing	*Phaps chalcoptera*	M	x
	Crested Pigeon	*Ocyphaps lophotes*	H	x
	Spinifex Pigeon	*Geophaps plumifera*	L	
	Diamond Dove	*Geopelia cuneata*	M	
	Peaceful Dove	*Geopelia placida*	L	

Cacatuidae	Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	L	
	Galah	*Eolophus roseicapillus*	H	x
	Little Corella	*Cacatua sanguinea*	M	
	Major Mitchell's Cockatoo	*Cacatua leadbeateri*	L	
	Cockatiel	*Nymphicus hollandicus*	M	
Psittacidae	Princess Parrot	*Polytelis alexandrae*		x
	Regent Parrot	*Polytelis anthopeplus*	L	x
	Australian Ringneck	*Barnardius zonarius*	H	x
	Mulga Parrot	*Psephotus varius*	H	x
	Budgerigar	*Melopsittacus undulatus*	H	x
	Bourke's Parrot	*Neopsephotus bourkii*	M	x
	Scarlet-chested Parrot	*Neophema splendida*	L	
	Night Parrot	*Pezoporus occidentalis*		
Cuculidae	Pallid Cuckoo	*Cuculus pallidus*	M	
	Black-eared Cuckoo	*Chrysococcyx osculans*	M	
	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	M	x
Strigidae	Barking Owl	*Ninox connivens*	L	
	Southern Boobook	*Ninox novaeseelandiae*	M	x
Tytonidae	Barn Owl	*Tyto alba*	L	
Podargidae	Tawny Frogmouth	*Podargus strigoides*	M	x
Caprimulgidae	Spotted Nightjar	*Eurostopodus argus*	M	x
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*	M	x
Apodidae	Fork-tailed Swift	*Apus pacificus*	L	
Halcyonidae	Red-backed Kingfisher	*Todiramphus pyrrhopygia*	M	
	Sacred Kingfisher	*Todiramphus sanctus*	M	
	Laughing Kookaburra	*Dacelo novaeguineae*		x
Meropidae	Rainbow Bee-eater	*Merops ornatus*	M	
Climacteridae	White-browed Treecreeper	*Climacteris affinis*	M	x
	Rufous Treecreeper	*Climacteris rufa*	L	x
Maluridae	Splendid Fairy-wren	*Malurus splendens*	M	x
	Variegated Fairy-wren	*Malurus lamberti*	M	x
	White-winged Fairy-wren	*Malurus leucopterus*	M	x
	Striated Grasswren	*Amytornis striatus*	L	x
	Thick-billed Grasswren	*Amytornis textilis*		x
Pardalotidae	Red-browed Pardalote	*Pardalotus rubricatus*	L	
	Striated Pardalote	*Pardalotus striatus*	M	x
	Rufous Fieldwren	*Calamanthus campestris*	L	x
	Redthroat	*Pyrrholaemus brunneus*	M	x
	Weebill	*Smicrornis brevirostris*	M	x
	White-browed Scrubwren	*Sericornis frontalis*		x
	Western Gerygone	*Gerygone fusca*	M	x
	Inland Thornbill	*Acanthiza apicalis*	M	X
	Chestnut-rumped Thornbill	*Acanthiza uropygialis*	H	X
	Slaty-backed Thornbill	*Acanthiza robustirostris*	M	X
	Slender-billed Thornbill	*Acanthiza iredalei*	L	
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	H	X
	Southern Whiteface	*Aphelocephala leucopsis*	H	X
	Banded Whiteface	*Aphelocephala nigricincta*	L	

Meliphagidae	Red Wattlebird	*Anthochaera carunculata*	M	
	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	H	x
	Yellow-throated Miner	*Manorina flavigula*	H	x
	Singing Honeyeater	*Lichenostomus virescens*	H	x
	White-eared Honeyeater	*Lichenostomus leucotis*	M	
	Grey-headed Honeyeater	*Lichenostomus keartlandi*	L	
	Yellow-plumed Honeyeater	*Lichenostomus ornatus*	M	
	Grey-fronted Honeyeater	*Lichenostomus plumulus*	M	x
	White-plumed Honeyeater	*Lichenostomus penicillatus*	M	x
	Brown-headed Honeyeater	*Melithreptus brevirostris*	L	
	Brown Honeyeater	*Lichmera indistincta*	M	
	White-fronted Honeyeater	*Phylidonyris albifrons*	M	x
	Grey Honeyeater	*Conopophila whitei*	L	
	Black Honeyeater	*Certhionyx niger*	M	
	Pied Honeyeater	*Certhionyx variegatus*	M	x
	Crimson Chat	*Epthianura tricolor*	H	x
	Orange Chat	*Epthianura aurifrons*	M	x
	White-fronted Chat	*Epthianura albifrons*	M	
	Jacky Winter	*Microeca fascinans*	M	
	Scarlet Robin	*Petroica multicolor*	L	
	Red-capped Robin	*Petroica goodenovii*	H	
	Hooded Robin	*Melanodryas cucullata*	H	
	Southern Scrub-robin	*Drymodes brunneopygia*	L	
Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*	M	
	White-browed Babbler	*Pomatostomus superciliosus*	M	x
Cinclosomatidae	Chiming Wedgebill	*Psophodes occidentalis*	M	
	Chestnut Quail-thrush	*Cinclosoma castanotus*	L	
	Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*		
	Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*	M	x
Neosittidae	Varied Sittella	*Daphoenositta chrysoptera*	M	x
Pachycephalidae	Crested Shrike-tit	*Falcunculus frontatus*	L	
	Crested Bellbird	*Oreoica gutturalis*	H	x
	Gilbert's Whistler	*Pachycephala inornata*	L	
	Golden Whistler	*Pachycephala pectoralis*	L	
	Rufous Whistler	*Pachycephala rufiventris*	H	x
	Grey Shrike-thrush	*Colluricincla harmonica*	H	x
Dicruridae	Magpie-lark	*Grallina cyanoleuca*	H	x
	Grey Fantail	*Rhipidura fuliginosa*	M	
	Willie Wagtail	*Rhipidura leucophrys*	H	x
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	H	x
	Ground Cuckoo-shrike	*Coracina maxima*	M	
	White-winged Triller	*Lalage sueurii*	M	

Artamidae	White-breasted Woodswallow	*Artamus leucorhynchus*	L	
	Masked Woodswallow	*Artamus personatus*	M	
	White-browed Woodswallow	*Artamus superciliosus*	L	
	Black-faced Woodswallow	*Artamus cinereus*	H	
	Dusky Woodswallow	*Artamus cyanopterus*	L	
	Little Woodswallow	*Artamus minor*	M	
	Grey Butcherbird	*Cracticus torquatus*	H	
	Pied Butcherbird	*Cracticus nigrogularis*	H	x
	Australian Magpie	*Gymnorhina tibicen*	H	x
	Grey Currawong	*Strepera versicolor*	M	x
Corvidae	Australian Raven	*Corvus coronoides*	M	
	Little Crow	*Corvus bennetti*	H	x
	Torresian Crow	*Corvus orru*	M	x
Ptilonorhynchidae	Western Bowerbird	*Chlamydera guttata*	M	x
Alaudidae	Singing Bushlark	*Mirafra javanica*	L	
Motacilidae	Australian Pipit	*Anthus novaeseelandiae*	H	
Passeridae	Zebra Finch	*Taeniopygia guttata*	H	x
Dicaeidae	Mistletoebird	*Dicaeum hirundinaceum*	M	
Hirundinidae	White-backed Swallow	*Cheramoeca leucosternus*	M	x
	Welcome Swallow	*Hirundo neoxena*	H	
	Tree Martin	*Hirundo nigricans*	M	
	Fairy Martin	*Hirundo ariel*	M	x
Sylviidae	Australian Reed-Warbler	*Acrocephalus australis*	L	
	Little Grassbird	*Megalurus gramineus*	L	
	Rufous Songlark	*Cinclorhamphus mathewsi*	M	
	Brown Songlark	*Cinclorhamphus cruralis*	M	x
Zosteropidae	Silvereye	*Zosterops lateralis*	L	

BA: Species identified from Birds Australia database (H,M,L = High, Medium and Low reporting rates for bioregion)

WAM: Species identified from the Faunabase Data search of the Western Australian Museum

Reptile species potentially occurring over the project area

Family	Species	WAM
Agamidae Dragon Lizards	*Caimanops amphiboluroides*	x
	Ctenophorus caudicinctus	x
	Ctenophorus fordi	x
	Ctenophorus isolepis	x
	Ctenophorus nuchalis	x
	Ctenophorus ornatus	
	Ctenophorus reticulatus	x
	Ctenophorus salinarum	x
	Ctenophorus scutulatus	x
	Lophognathus longirostris	x
	Moloch horridus	x
	Pogona minor minor	x
	Tympanocryptis cephala	x
Gekkonidae Geckos	*Diplodactylus conspicillatus*	x
	Diplodactylus pulcher	x
	Diplodactylus elderi	
	Diplodactylus granariensis	
	Diplodactylus pulcher	
	Diplodactylus squarrosus	x
	Diplodactylus stenodactylus	x
	Gehyra purpurascens	x
	Gehyra variegata	x
	Heteronotia binoei	x
	Nephrurus vertebralis	x
	Nephrurus wheeleri	
	Rhynchoedura ornata	x
	Strophurus assimilis	
	Strophurus elderi	x
	Strophurus strophurus	x
	Strophurus wellingtonae	x
	Underwoodisaurus milii	x
Pygopodidae Legless Lizards	*Delma australis*	
	Delma butleri	x
	Delma fraseri petersoni	x
	Delma nasuta	x
	Lialis burtonis	x
	Pygopus nigriceps	x
Scincidae Skinks	*Cryptoblepharus carnabyi*	x
	Cryptoblepharus plagiocephalus	x
	Ctenotus atlas	
	Ctenotus ariadnae	x
	Ctenotus calurus	x
	Ctenotus dux	x
	Ctenotus grandis grandis	x
	Ctenotus greeri	x
	Ctenotus hanloni	
	Ctenotus helenae	x
	Ctenotus leonhardii	x

Scincidae Skinks	*Ctenotus mimetes*	
	Ctenotus pantherinus ocellifer	x
	Ctenotus quattuordecimlineatus	x
	Ctenotus schomburgkii	x
	Ctenotus severus	x
	Ctenotus uber uber	x
	Ctenotus xenopleura	
	Cyclodomorphus melanops elongatus	
	Egernia depressa	x
	Egernia formosa	x
	Egernia inornata	x
	Egernia kintorei	x
	Egernia striata	x
	Eremiascincus richardsonii	x
	Lerista bipes	x
	Lerista desertorum	x
	Lerista gerrardii	
	Lerista macropisthopus macropisthopus	
	Lerista muelleri	x
	Menetia greyii	x
	Morethia butleri	x
	Morethia obscura	
	Tiliqua multifasciata	x
	Tiliqua occipitalis	x
Varanidae Monitor Lizards	*Varanus acanthurus*	
	Varanus brevicauda	x
	Varanus caudolineatus	x
	Varanus eremius	x
	Varanus giganteus	x
	Varanus gouldii	x
	Varanus panoptes rubidus	x
	Varanus tristis tristis	x
Typhlopidae Blind Snakes	*Ramphotyphlops bituberculatus*	
	Ramphotyphlops hamatus	x
	Ramphotyphlops waitii	x
Boidae Pythons	*Antaresia stimsoni stimsoni*	x
	Aspidites ramsayi	
Elapidae Front-fanged Snakes	*Acanthophis pyrrhus*	x
	Brachyurophis fasciolata fasciolata	
	Brachyurophis semifasciata	x
	Demansia psammophis	
	Furina ornata	
	Parasuta monachus	x
	Pseudechis australis	x
	Pseudechis butleri	x
	Pseudonaja modesta	x
	Pseudonaja nuchalis	x
	Simoselaps bertholdi	x
	Suta fasciata	x
Cheluidae	*Chelodina steindachneri*	x

Amphibian species potentially occurring over the project area

Family	Species	WAM
Hylidae Tree Frogs	*Cyclorana maini*	x
	Cyclorana platycephala	x
	Littoria rubella	
Myobatrachidae Ground Frogs	*Limnodynastes spenceri*	x
	Neobatrachus aquilonius	x
	Neobatrachus centralis	x
	Neobatrachus kunapalari	x
	Neobatrachus sutor	x
	Neobatrachus wilsmorei	x
	Notaden nichollsi	x
	Pseudophryne occidentalis	x

Appendix J1

Short-range Endemic Invertebrate Delivery Tables

Autumn Survey

Invertebrate Specimens Delivered to University of Western Australia

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Destination	Date	Comments
LM 01	Spinifex Plains	Mygalomorph	LM01A	LAB-SERV Vial	Hand search	UWA Prof. York-Main	13/06/07	Found in burrow without trapdoor (entrance destroyed)
		Mygalomorph	LM01B	Yellow Lid	Hand Search	UWA Prof. York-Main	13/06/07	Trapdoor spider. Found in sand. Burrow difficult to spot (no above ground trip lines. Depth ~ 20cm below surface.
		Mygalomorph Burrows	LM01C	Takeaway Container	Hand Search	UWA Prof. York-Main	13/06/07	Number of empty burrows found and dug up.
		Possible Mygalomorph	LM01D	Yellow Lid	Hand Search	UWA Prof. York-Main	13/06/07	Spider found in webbed burrow with egg sac
		4 x Wolf Spiders	LM01E	220ml Vial	Hand Search	UWA Prof. York-Main	13/06/07	All spiders found in burrows with webbing
LM 02	Mulga Woodland	Mygalomorph	LM02A	220 ml Vial	Hand search	UWA Prof. York-Main	13/06/07	Spider found in open burrow with trip lines
		Mygalomorph	LM02B	Yellow Lid	Hand search	UWA Prof. York-Main	13/06/07	Juvenile Mygalomorph found in open burrow with trip lines
		Mygalomorph	LM02C	220ml Vial	Hand search	UWA Prof. York-Main	13/06/07	Mygalomorph found in open burrow with triplines
		Mygalomorph	LM02D	220 ml Vial	Hand search	UWA Prof. York-Main	13/06/07	Trapdoor spider found under large mulga tree. Leaves around entrance were arranged radially with trip lines. Burrow 40 cm.
		Mygalomorph	LM02E	Takeaway container	Hand search	UWA Prof. York-Main	13/06/07	Burrow of above trapdoor spider
		Spider	LM02F	Yellow Lid	Hand search	UWA Prof. York-Main	13/06/07	Black spider found with cone shaped arrangement of leaves at entrance
		Spider	LM02G	Yellow Lid	Hand search	UWA Prof. York-Main	13/06/07	Small spider found in burrow with trip lines

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Destination	Date	Comments
LM 03	Mallee over Spinifex	Mygalomorph	LM03A	Yellow Lid	Hand search	UWA Prof. York-Main	13/06/07	Trapdoor spider? Found in sand with no burrow entrance (uncovered by scraping back surface) Number of juveniles also present in burrow.
		Spiders	LM03B	220 ml Vial	Hand Search	UWA Prof. York-Main	13/06/07	2 x spiders (larger spider was found in burrow)
LM 04	Bull Spinifex Lakes Edge	Spiders	LM04A	220 ml Vial	Hand Search	UWA Prof. York-Main	13/06/07	4 x wolf spiders found in burrows with webbing
SR 05	Woodland on Calcrete	Spiders	LM05A	220 ml Vial	Hand Search	UWA Prof. York-Main	13/06/07	7 x spiders found in pit traps and burrows
Bar Stn	Barwidgee Station	Mygalomorph	Bar Stn A	LAB-SERV Vial	Hand Search	UWA Prof. York-Main	13/06/07	Trapdoor spider found under large mulga tree. Burrow ~ 40 cm deep.
		Mygalomorph burrow	Bar Stn B	Takeaway Container	Hand Search	UWA Prof. York-Main	13/06/07	Burrow of above spider

Invertebrate Specimens Delivered to the Western Australian Museum

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Destination	Date	Comments
LM 01	Spinifex Plains	Scorpion	LM01 Scorpions	220ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	3 x Scorpions found in vertebrate pit traps
LM 02	Mulga Woodland	Scorpion	LM02 Scorpion	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	1 x scorpion found in vertebrate pit trap
		Centipede	LM02 Centipede	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	3 x centipedes found in vertebrate pit traps
LM 03	Mallee over Spinifex	Scorpions	LM03 Scorpions	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	2 x scorpions found in vertebrate pit traps
		Centipedes	LM03 Centipedes	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	3 x centipedes found in vertebrate pit traps
		Snails	LM03 Snails	Small vial within 220 ml vial	Soil Sieving	WAM: Shirley Slack-Smith	22/06/07	3 samples were sieved using 1mm sieve and sorted under a compound microscope for snail shells.
LM 04	Bull Spinifex on clays	Centipede	LM04 Centipedes	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	1 x centipede found in vertebrate pit trap
		Snails	LM04 Snails	Small vial within 220 ml Vial	Soil Sieving	WAM: Shirley Slack-Smith	22/06/07	3 samples were sieved using 1mm sieve and sorted under a compound microscope for snail shells.
SR 05	Woodland on Calcrete	Millipede	LM05 Millipede	220 ml Vial	Pit trap	WAM: Mark Harvey	22/06/07	1 x millipede
		Snails	LM04 Snails	Small vial within 220 ml Vial	Soil Sieving	WAM: Shirley Slack-Smith	22/06/07	3 samples were sieved using 1mm sieve and sorted under a compound microscope for snail shells.
SR 07	Kopi Calcrete Ridge	Snails	LM04 Snails	Small vial within 220 ml vial	Soil Sieving	WAM: Shirley Slack-Smith	22/06/07	3 samples were sieved using 1mm sieve and sorted under a compound microscope for snail shells.

Appendix J2

Short-range Endemic Invertebrate Delivery Tables

Summer Survey

Short Range Endemic Study - Lake Maitland
COC Job Code: RLM-FS-0807

Site No.	Habitat	Co-ordinates	Pits Traps	Hand-searching (Mins)	Description / Notes
LM 01	Spinifex Plains	51 J 312345 7002022	7	90 x 2	
LM 02	Mulga Woodland	51 J 312554 6998923	7	90 x 2	
LM 03	Mallee over Spinifex	51 J 312691 6994795	7	90 x 2	
LM 04	Bull Spinifex on clays	51 J 309346 6997429	7	90 x 2	
LM 05	Woodland on Calcrete	51 J 307433 6999091	7	90 x 2	
LM 06	Samphire	51 J 307438 6997083	10	90 x 2	
LM 07	Kopi Calcrete Ridge	51 J 313126 6988346	10	90 x 2	

Site No.	Habitat	Potential Group	Vial No	Container	Method of capture	Destination	Date	Comments
LM 01	Spinifex Plains	Theraphosid?	A	220ml Vial	Digging	Barbara York-Main	9/12/07	Large open burrow
		Scorpion	B	Yellow Lid	Vert Pit Trap	Mark Harvey	9/12/07	
		Centipede	C	Bijou vial	Vert Pit Trap	Mark Harvey	11/12/07	
		Male Mygalomorph	D	Yellow lid	Vert Pit Trap	Barbara York-Main	12/12/07	Found in vertebrate pit trap after heavy rain (summer storm)
		Male Mygalomorph	E	Yellow lid	Vert Pit Trap	Barbara York-Main	12/12/07	Found in the same pit trap as “D”
		Male Mygalomorph	G	Bijou Vial	Vert Pit Trap	Barbara York-Main	12/12/07	Vert pit trap after night with summer storm
		Centipede	H	Bijou vial	Vert Pit Trap	Mark Harvey	12/12/07	After night of rain
		Gaius?	I	Yellow	Digging	Barbara York-Main	13/12/07	Burrow with twig lining and mug plug under door. Many spiderlings present (3 included with
		Burrow of Above	J	220 mL vial	Digging	Barbara York-Main	13/12/07	Burrow entrance with mud plug
		Mygalomorph	K	Bijou Vial	Digging	Barbara York-Main	13/12/07	Raised burrow open entrance.

LM 02	Mulga Woodland	Scorpion	A	Yellow Lid	Vert Pit trap	Mark Harvey	10/12/07	
		Gaius?	B	Yellow Lid	Digging	Barbara York-Main	10/12/07	Twig lined entrance with burrow plugged with dried mud below entrance. Total depth 56 cm
		Burrow of above	C	220 ml Vial	Digging	Barbara York-Main	10/12/07	Plugged burrow of above
		Aname?	D	Yellow Lid	Digging	Barbara York-Main	10/12/07	Open burrow under Mulga 35 cm deep
		Gaius? Burrow entrance	E	Yellow Lid	Digging	Barbara York-Main	10/12/07	Empty burrow
		Gaius?	F	Yellow Lid	Digging	Barbara York-Main	10/12/07	~ 60 cm deep with mud plug at entrance
		Entrance of above	G	Yellow lid	Digging	Barbara York-Main	10/12/07	Hard mud plug at entrance
		Scorpion	H	Yellow Lid	Vertebrate pit trap	Mark Harvey	10/12/07	
		Scorpion	I	Bijou vial	Digging	Mark Harvey	11/12/07	Found in spider burrow
		Male Mygalomorph	J	Bijou Vial	Vertebrate pit trap	Barbara York-Main	12/12/07	Vert pit trap after night summer storm
		Male Mygalomorph	K	Yellow Lid	Vertebrate pit trap	Barbara York-Main	12/12/07	Vertebrate pit trap after night storm
		Juvenile Mygalomorph	L	Bijou Vial	Vert pit trap	Barbara York-Main	12/12/07	2 x juveniles found in vert pit trap after storm

		Gaius?	M	Yellow Lid	Digging	Barbara York-Main	12/12/07	Female with approx 30 well developed spiderlings. Plugged hole
LM 03	Mallee over Spinifex	Scorpion	B	Bijou Vial	Vertebrate pit trap	Mark Harvey	10/12/07	
		Scorpion	C	220 mL vial	Vertebrate pit trap	Mark Harvey	10/12/07	2 x larger scorpions
		Scorpion	D	Bijou Vial	Vert pit trap	Mark Harvey	11/12/07	
		Male Mygalomorph	E	Yellow Lid	Vert pit Trap	Barbara York-Main	12/12/07	Found in Vertebrate pit trap after night summer storm
		Male Mygalomorph	F	Bijou Vial	Vert pit trap	Barbara York-Main	12/12/07	Found in Vertebrate Pit trap after night storm
		Centipede	G	Yellow lid	Vert pit trap	Mark Harvey	12/12/07	4 x same centipede
		Scorpion	H	Bijou Vial	Invertebrate pit trap	Mark Harvey	13/12/07	
		Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	10/12/07	
LM 04	Bull Spinifex on clays	*Cethegus*	A	Yellow Lid	Captured in web	Barbara York-Main	8/12/07	
		Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	10/12/07	

LM 05	Woodland on Calcrete	Mygalomorph	A	Yellow Lid	Digging	Barbara York-Main	10/12/07	3 x spiders. Open burrow that descends on an angle for ~5 cm and then turns straight down.
		Cethegus	B	Bijou Vial	Captured in web	Barbara York-Main	10/12/07	
		Cethegus	C	Bijou Vial	Captured in web	Barbara York-Main	10/12/07	
		Cethegus	D	Bijou Vial	Captured in web	Barbara York-Main	10/12/07	
		Centipede	F	Yellow Lid	Vert pit trap	Mark Harvey	12/12/07	
		Centipede	G	Bijou Vial	Vert pit trap	Mark Harvey	12/12/07	
		Mygalomorph (Male?)	H	Bijou Vial	Vert pit trap	Barbara York-Main	12/12/07	Caught in Vert pit trap after rain
		Mygalomorph (Male?)	I	Bijou Vial	Vert pit trap	Barbara York-Main	12/12/07	As above
		Centipede	J	Bijou Vial	Vert pit trap	Mark Harvey	12/12/07	
		Centipede	K	Bijou Vial	Invert pit trap	Mark Harvey	13/12/07	
		pseudoscorpion	L	Bijou Vial	Invert pit trap	Mark Harvey	13/12/07	
		Snails		Bijou Vial	Soil Sieving	Shirley Slack-Smith	10/12/07	

LM08	Mulga	Gaius	A	Yellow Lid	Digging	Barbara York-Main	13/12/07	
		Burrow of above	B	Yellow Lid	Digging	Barbara York-Main	13/12/07	
		Aname?	C	Yellow Lid	Digging	Barbara York-Main	13/12/07	

Appendix K

Preliminary Report to Outback Ecology on Terrestrial Snail Specimens from the Lake Maitland Area of Western Australia (Shirley Slack Smith, WAM)

Preliminary Report to Outback Ecology on Terrestrial Snail Specimens from the Lake Maitland Area of Western Australia

S.M. Slack-Smith,
Western Australian Museum
July 2007

The samples collected during the *Outback Ecology* survey of the Lake Maitland area all belong to the family Pupillidae and to the genus *Pupoides*.

Sample LM 03 - *Pupoides* ?adelaidae (Adams & Angas, 1864) - 1 broken shell

LM 04 - *Pupoides* ?adelaidae (Adams & Angas, 1864) - series

LM 05 - *Pupoides* ?adelaidae (Adams & Angas, 1864) 1 whole shell, 1 piece
Pupoides ?*myoporinae* (Tate, 1880) - series

LM 07 - *Pupoides* ?*myoporinae* (Tate, 1880) - 1 shell

Background

Pupoides ?myoporinae (Tate, 1880)
This is a sinistrally coiled species that has a wide but disjunct geographic range in Victoria/South Australia and in Western Australia (Solem 1986)

This species has not been recorded from the Lake Maitland-Wiluna area. Because of the records that exist of its occurrence to the east and west of that area and the fact that it is the only sinistrally coiled species with such a distributional range, I am fairly confident of this identification

Pupoides? adelaidae (Adams & Angas, 1864)
This is a dextrally coiled species that also has a wide geographic distribution from Victoria to the eastern wheatbelt of Western Australia **(**Solem 1986)

This species has also not been recorded from the Lake Maitland-Wiluna area but there are records of its occurrence to the east and west of that area. One other dextrally coiled and very similar species also has a southern Australian distribution but is not recorded from as far north in the eastern areas of Western Australia.

Remarks

I have no reason to believe that either of these two taxa exhibit short range endemicity. Both of the species named here – along with all other species of the genus *Pupoides* identified in the Australian fauna – are believed to occupy wide geographic ranges.

Appendix L

Summary Tables Describing Conservation Status

IUCN categories also used under the Commonwealth EPBC Act and by DEC

Status	Code	Description
Extinct	(EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild	(EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
Critically Endangered	(CR)	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.
Endangered	(EN)	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	(VU)	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Lower Risk	(LR)	A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories: o Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years. o Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable. o Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.
Data Deficient	(DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.
Not Evaluated	(NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Schedules of the Western Australian Wildlife Conservation Act 1950: Wildlife Conservation (Specially Protected Fauna) Notice.

Status	Code	Description
Schedule 1	(S1)	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	(S2)	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	(S3)	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be faunathat is in need of special protection
Schedule 4	(S4)	Fauna that is in need of special protection, otherwise than for the reasons mentioned above

Priority Fauna Codes used by the Western Australian DEC

Status	Code	Description
Priority One Taxa with few, poorly known populations on threatened lands.	(P1)	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Two Taxa with few, poorly known populations on conservation lands.	(P2)	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Three Taxa with several, poorly known populations, some on conservation lands.	(P3)	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Four Taxa in need of monitoring.	(P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority Five Taxa in need of monitoring.	(P5)	Taxa which are not considered threatened but are subject to a specific conservatin program, the cessation of which would result in the species becoming threatened within five years.

Appendix M

Spider identifications for Outback Ecology Services Short Range Endemic study: Lake Maitland (Barbara York Main, University of WA)

Report to OUTBACK by Barbara York Main

Short Range Endemic Study : Lake Maitland

COC Job Code: RLM-FS-0807

MYGALOMORPHAE – SPIDERS

BARYCHELIDAE

LMO2 L.

2 juveniles (fragments only of one). Unidentifiable

CTENIZIDAE

LMO1 G

Male ***Conothele sp. nov.***

LMO2 J

Male ***Conothele sp. nov.*** (as above)

Comments

Distributional status unknown due to lack of male specimens from outer wheatbelt and eastern Goldfields. Possibly with restricted range.

DIPLURIDAE

LMO4

Female ***Cethegus sp. nov.***

LMO5 B

Female or immature ***Cethegus sp. nov.*** **(as above)**

LMO5 C

Female ***Cethegus sp. nov.*** **(as above)**

LMO5 D (? or O?)

Female ***Cethegus sp. nov*** **(as above)**

Comment

Cethegus is widely distributed in the tropics and relictually in arid and inland regions. Only one species to date has been formally described from WA (***C. fugax*** (Simon) from the northern jarrah forest) but several other species are recognized.

Difficult to relate these specimens to known populations without males.

IDIOPIDAE

LMO1 D

Male ***Gaius villosus*** **Rainbow**

LMO1 E

Male ***Gaius villosus*** **Rainbow**

LMO1 I

Female + 3 spiderlings ***Gaius villosus*** **Rainbow**

LMO 2 B

Female ***Gaius villosus*** **Rainbow**

LMO2 F

Female ***Gaius villosus*** **Rainbow**

LMO 2 K

Male ***Gaius villosus*** **Rainbow**

LMO 2 M

Female ***Gaius villosus*** **Rainbow**

LMO 3 E

Male ***Gaius villosus*** **Rainbow**

LMO8 A

Immature ***Gaius villosus*** **Rainbow**

Comments

Gaius villosus **Rainbow** which is sometimes included in the genus *Anidiops* is a very large trapdoor spider that is widely distributed in the lower Murchison, northern and central wheatbelt and western Goldfields. It is sometimes confused with unnamed species of *Anidiops* (where the geographic range overlaps) due to female similar morphology and the characteristic twiglining burrow that incorporates a "sock' in the tube, common to both genera). However the male morphology of the two genera is distinctive hence confidence in the above identities.

NEMESIIDAE

LMO3 F

Male ***Kwonkan sp.nov***. **A**

LMO5 H

Male ***Kwonkan sp. nov*. B**

LMO I

Male ***Kwonkan sp. nov* B**

Comments

***K. sp* .A & B** above are doubtfully distinct (variation in leg spination) probably the one species.. The general morphology is distinctive from all the named species of Kwonkan (which genus is widely distributed in WA and south western SA). These three specimens have some similarity with *Kwonkan silvestre* Main (from localities farther south east eg Fraser Rge, Balladonia area) but can be distinguished on leg I spination (distinctive in males)).

The species is likely to have a restricted distribution in the area surveyed.

LMO 2 D

Female ***Aname sp*. A**

LMO 8 C

Female ***Aname sp*. A**

Comment

Possibly the *"armigera"* species group but without males cannot be unequivocal regarding identity.This group generally widespread in semi arid eg wheatbelt, western part of Goldfields.

LMO1 K

Female ***Aname sp*.B**

LMO 5 A

3 Females ***Aname sp.* B**

Comments

Relatively small specimens but clearly adult females recognizable by large protruding epigynal genital plate.

Not familiar with the "species", maybe restricted distribution; need male specimens.

SUMMARY OF SPECIES OF PARTICULAR INTEREST

The *Conothele* sp, *Cethegus* and *Aname* sp.B are all of interest. However without a review of all these genera it is difficult to make conclusive comments.
The Aname **sp. B is the most likely to have a restricted distribution.**

Non mygalomorphs included

OES questionable identity listed on Outback sheet as Idiopidae Arbanitinae. Specimen is a male Lycosidae (wolf spider).

NLWO4 (NLW-FS-0307)

Female Gallieniellidae ??
If so then probably *Meedo sp.*, widespread genus,

Appendix N

Report to Outback Ecology: Land snails from the area of Lake Maitland, Western Australia, collected by *Outback Ecology Services* in December (Shirley Slack Smith, WAM)

Report to *Outback Ecology Services*

Land snails from the area of Lake Maitland, Western Australia, collected by *Outback Ecology Services* in December, 2007

S. Slack-Smith and C. Whisson
Western Australian Museum
March 2008

Background

Specimens of land snails collected at three sites by the environmental consultancy *Outback Ecology Services* during its Lake Maitland Survey (December 2007) were submitted to the Department of Aquatic Zoology (Mollusc Section) of the Western Australian Museum for identification and comment.

Information was provided on the location and habitat of each of the seven sites examined during this survey. The specimens submitted for examination were collected from sieved soil samples from three of these sites.

Procedures

The shells of the snail specimens were examined under a dissecting microscope and compared with descriptions of relevant taxa in the published literature (Solem 1986, 1988; Smith 1992) and with specimens in the collections of the Western Australian Museum.

Results

All of the specimens submitted belong to the stylommatophoran family Pupillidae and to the genus *Pupoides* (see Table 1).

Discussion

Pupoides ?myoporinae (Tate, 1880)

Pupoides myoporinae is a sinistrally coiled species that has a wide but apparently disjunct geographic range, having been recorded from areas of Victoria and southern South Australia, and from Western Australia (from the western part of the Roe Plain to Mt Jackson and Hines Hill) (Solem 1986).

There are no published records of the occurrence of *P. myoporinae* from the Lake Maitland-Wiluna area although it has been recorded from localities to the west and to the east of that area. Because the shells collected during this survey are more similar to those of *P. myoporinae* from southern Australia than any other sinistrally-coiled species, and because its distributional range is close to that of that species, we are fairly confident of this identification.

Table 1. Locality data and mollusc species recorded during the Lake Maitland survey.

Site	Coordinates (Zone 51)		Date	Habitat	Identification	Number of Specimens
	Easting	Northing				
LM03	312691	6994795	10/12/2007	Mallee over spinifex	*Pupoides* ?*adelaidae* (Adams & Angas, 1864)	4 whole shells
LM04	309346	6997429	10/12/2007	Woodland on calcrete	*Pupoides* ?*adelaidae* (Adams & Angas, 1864)	Series
LM05	307438	6997083	10/12/2007	Samphire	*Pupoides* ?*myoporinae* (Tate, 1880)	3 whole shells
LM05	307438	6997083	10/12/2007	Samphire	*Pupoides* ?*adelaidae* (Adams & Angas, 1864)	Series

Pupoides ?adelaidae (Adams & Angas, 1864)

Pupoides adelaidae is a dextrally coiled species that also has a wide geographic distribution from Victoria to the eastern wheatbelt of Western Australia **(**Solem 1986)

There are no published records of this species from the Lake Maitland-Wiluna area but there are records of its occurrence to the west and north-west of that area. Solem (1986) also recognised a form which he designated as *Pupoides* aff. *adelaidae* from the Shark Bay-North West Cape area. Another dextrally coiled and very similar species, *P. beltianus* (Tate, 1894) has a Central Australian distribution extending westward into Western Australia (Solem 1988) but has not been recorded from as far south as the Lake Maitland area.

The shells of the specimens from this survey most closely resemble those of *P. adelaidae*, but differ slightly from those of specimens from southern Australia and from the areas near to the west coast.

Remarks

We have no reason to believe that either of these two taxa exhibit short range endemicity. Both of the species named here – along with all other species of the genus *Pupoides* identified in the Australian fauna – are believed to occupy wide geographic ranges.

However, due to the paucity of records of *Pupoides* species in the Lake Maitland area, we can not give definite identifications for the specimens taken in this survey, nor do we have any idea of the degree of isolation of populations of these taxa. Therefore there is no way in which an estimate of the existence of short range endemic populations might occur.

In addition, we do not have information concerning the spatial relationship between the sites surveyed and the location and boundaries of the site proposed for development. From the small size of the sample, it does appear that the taxon *P.* ?*adelaidae* is more widespread in this locality than is *P.* ?*myoporinae* and is also adapted to a variety of habitats. However we cannot pass any opinion on the possibility of threat to the population/populations of the taxa sampled during this survey.

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Mega Lake Maitland Ltd

Lake Maitland Project

Terrestrial Fauna Habitat Assessment

June 2010

Outback Ecology Services
1/71 Troy Terrace
Jolimont WA 6014
Ph: +61 (08) 9388 8799
Fax: +61 (08) 9388 8633
admin@outbackecology.com

Mega Lake Maitland Pty Ltd
Lake Maitland Project

Terrestrial Fauna Habitat Assessment

Distribution:

Company	Copies	Contact Name
Mega Uranium Ltd	1 electronic copy	Robin Jones

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Executive Summary

Mega Lake Maitland Pty Ltd (Mega) commissioned Outback Ecology to undertake a terrestrial fauna survey of two proposed infrastructure areas for the Lake Maitland Project (the Project). The Project is located approximately 100 km to the south-east of Wiluna and 30 km to the north of the existing Bronzewing Gold Project in the Murchison region of Western Australia **(Figure 1).** Infrastructure area A is 1,767 hectares (ha) and Infrastructure area B is 2,336 ha. Collectively, the two infrastructure areas form the Study area for this assessment **(Figure 2).**

The specific objectives for the terrestrial fauna assessment were:

- Develop an inventory of terrestrial vertebrate fauna species and terrestrial invertebrate short-range endemic (SRE) species identified within the Study area, or likely to be present within the Study area;
- Identify terrestrial vertebrate fauna species of conservation significance potentially occurring within the Study area;
- Identify and describe the broad vertebrate fauna habitat and potential invertebrate SRE habitat occurring within the Study area;
- Identify and describe any sensitive fauna habitats, or habitats of particular conservation significance occurring within the Study area;
- Assess findings in the regional context by comparisons with available data from other localities within the bioregion;
- Assess current impacts and potential impacts on terrestrial fauna and fauna habitats from the infrastructure areas; and
- Recommend general strategies to minimise potential impacts of construction and operation of the Infrastructure areas on fauna and fauna habitats.

This report documents the results of a Level 1 survey which involved a review of relevant literature and databases, and a reconnaissance survey to verify the results from the desktop survey. The survey was conducted from the 14 to the 21 October 2009 and incorporated habitat assessments for vertebrate fauna and SRE fauna, as well as spotlighting and targeted searches for species of conservation significance.

Thirteen broad fauna habitats were identified from the Study area and surrounds during the survey. These habitats are mostly widespread and common throughout the Murchison bioregion, with the following possible exceptions: Lake Edge Spinifex, Claypan and Kopi Dune

A total of 50 terrestrial vertebrate fauna species were recorded within the Study area during the survey. These comprise nine mammal (four native), 31 bird and 10 native reptile species.

Based on database search findings and a review of relevant literature, it was found that a total of 307 terrestrial vertebrate fauna species have the potential to occur within the Study area. These comprise 43 mammals (32 native and 11 introduced), 168 birds, 87 native reptiles and nine amphibian species.

Fourteen conservation significant fauna species potentially occur within the Study area, comprising:

- Five species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* and WA *Wildlife Conservation Act*: the Mulgara (*Dasycercus cristicauda* - Vulnerable and Schedule 1), Malleefowl (*Leipoa ocellata* - Vulnerable and Schedule 1), Slender-billed Thornbill (*Acanthiza iredalei iredalei* – Vulnerable), Major Mitchell's Cockatoo (*Cacatua leadbeateri* - Schedule 4) and Peregrine Falcon (*Falco peregrinus* - Schedule 4);
- Four priority species listed under the WA Department of Environment and Conservation (DEC) Priority Species List: the Australian Bustard (*Ardeotis australis* - P4), Bush Stone-curlew (*Burhinus grallarius* - P4), the Grey Falcon (*Falco hypoleucos* - P4) and the Striated Grasswren (*Amytornis striatus striatus* – P4); and
- Five species listed as Migratory under the EPBC Act: the Fork-tailed Swift (*Apus pacificus pacificus*), Rainbow Bee-eater (*Merops ornatus*), Great Egret (*Ardea alba*), Oriental Plover (*Charadrius veredus*) and Common Sandpiper (*Actitis hypoleucos*)

Of these species, the Rainbow Bee-eater was recorded during this survey, and the Mulgara and Bush Stone-curlew were recorded during the previous surveys at Lake Maitland (Outback Ecology 2008).

The SRE invertebrate fauna component of this assessment mapped potential SRE habitat within the Study area and evaluated the potential for the occurrence of SRE species based on these habitats. Additionally, invertebrate species recorded during the Lake Maitland Baseline Terrestrial Fauna Surveys were evaluated for their potential to be SRE species based on their habitat associations.

Four habitats were found to meet the criteria of potential SRE habitat on the basis of: Sheltered Habitats and Microhabitats or Isolated Habitats within the Study area. These habitats include: Samphire Flats, Lake Edge Spinifex, Claypan and Kopi Dune habitats. Of these habitats, all have a low potential to support SRE species.

No known SRE invertebrate species were recorded during the Lake Maitland Baseline Terrestrial Fauna Surveys conducted in 2007 (Outback Ecology, 2008). However, six invertebrate species (four mygalomorph spiders and two scorpions) had identifications that were not conclusive due to either, a lack of taxonomic knowledge, or a lack of knowledge regarding the distribution of these species. These species were: *Conothele* sp nov, *Aname* sp. B, *Kwonkan* sp. nov A and B, *Cethegus* sp. nov, *Urodacus* sp. maitland 1 and *Urodacus* sp. maitland 2. Of these species, only the scorpion *Urodacus* sp. maitland 1 appeared to be restricted to a single habitat type (Mulga Woodland/Shrubland Plain). None of the other invertebrate species were found to be restricted to a single habitat type and none were restricted to any of the potential SRE habitats mentioned above. With consideration to the results of the previous surveys and the habitat assessments from this assessment, it appears unlikely that these potential SRE species would have ranges restricted to the Study area. Therefore appears unlikely that any of these species would be substantially impacted by proposed development within the Study area.

The Priority 2 mygalomorph spider *Kwonkan moriarii* listed under the WA Department of Environment and Conservation (DEC) Priority Species List has been previously recorded 65 km southwest of the Study area in 1962. This species was not recorded during this or any previous survey at Lake Maitland and no other records of this species exist except the type specimen.

General management recommendations are provided as a guideline for reducing the impacts of the proposed infrastructure areas on fauna and habitat within the Study area.

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1. INTRODUCTION

1.1 Project Background and Location

Mega Lake Maitland Pty Ltd (Mega) commissioned Outback Ecology to undertake a terrestrial fauna survey of two proposed infrastructure area options for the Lake Maitland Project (the Project). The Project is located approximately 100 km to the south-east of Wiluna and 30 km to the north of the existing Bronzewing Gold Project in the Murchison region of Western Australia (**Figure 1**). The two proposed infrastructure areas are located on the east and west sides of Lake Maitland. Infrastructure area A is 1,767 hectares (ha) and Infrastructure area B is 2,336 ha. Collectively, the two infrastructure areas form the Study area for this assessment **(Figure 2).**

1.2 Report Scope and Objectives

This report documents the results of a terrestrial vertebrate fauna survey conducted from 14 October to 21 October, 2009. The survey was designed and conducted as far as practicable in accordance with the WA Environmental Protection Authority's (EPA's) Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002), Guidance Statement No. 56 Terrestrial Fauna Surveys *for Environmental Impact Assessment in Western Australia* (EPA, 2004) and EPA Guidance No. 20, *Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA, 2009).

The specific objectives for the terrestrial fauna assessment were:

- Develop an inventory of terrestrial vertebrate fauna species and terrestrial invertebrate short-range endemic (SRE) species identified within the Study area, or likely to be present within the Study area;
- Identify terrestrial vertebrate fauna species of conservation significance potentially occurring over the Study area;
- Identify and describe the broad vertebrate fauna habitat and potential invertebrate SRE habitat occurring within the Study area;
- Identify and describe any sensitive fauna habitats, or habitats of particular conservation significance occurring over the Study area;
- Assess findings in the regional context by comparisons with available data from other localities within the bioregion;
- Assess current impacts and potential impacts on terrestrial fauna and fauna habitats from the Infrastructure areas; and
- Recommend general strategies to minimise potential impacts of development on the Infrastructure areas on fauna and fauna habitats.

Figure 1: Regional location of the Lake Maitland Uranium Project

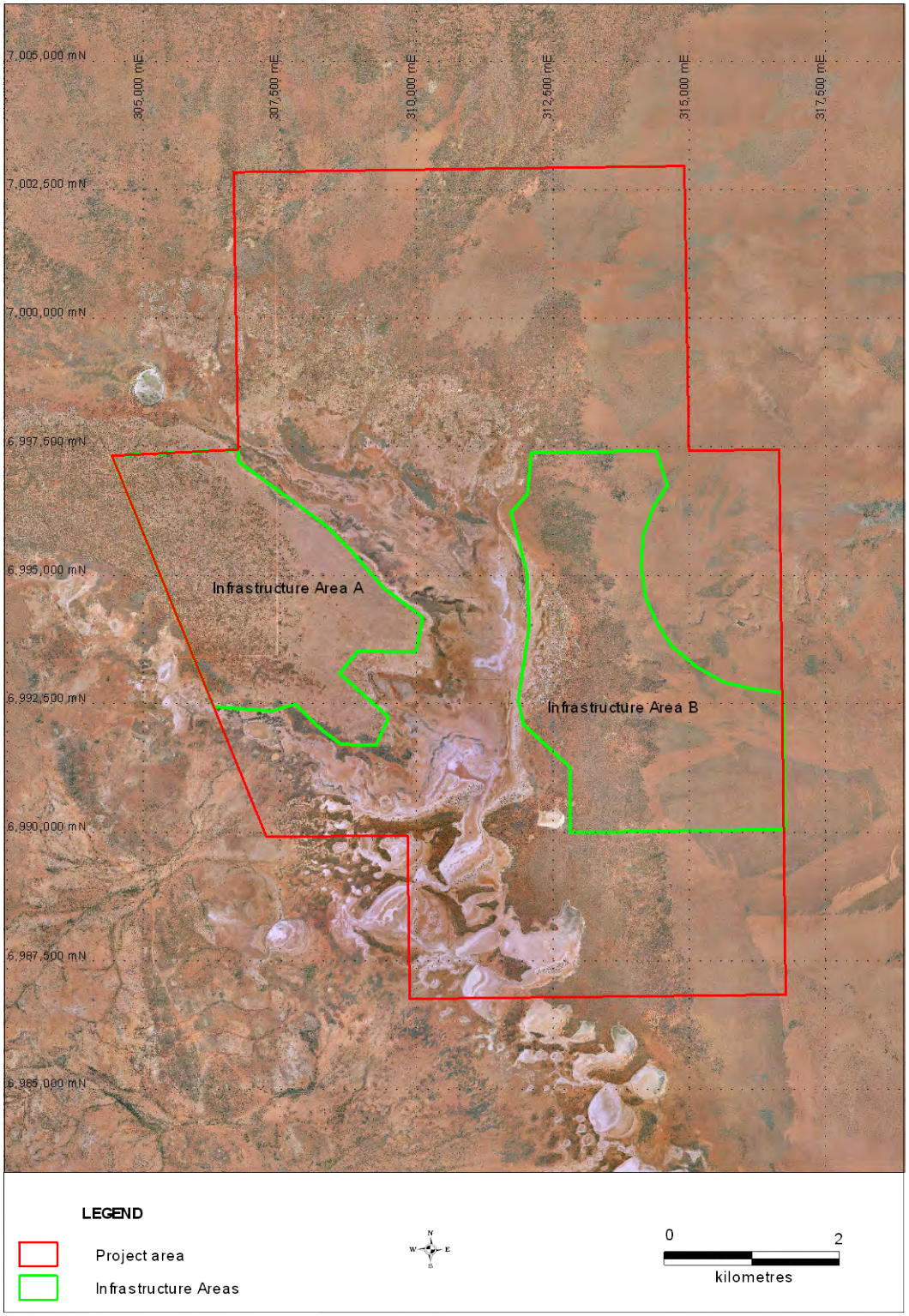

Figure 2: Infrastructure Areas A and B

2. EXISTING ENVIRONMENT

2.1 Climate

The Murchison region is characterised as having an arid climate, with summer and winter rain and an annual rainfall in the range of 200 mm (Beard, 1990; Gilligan, 1994). However, rainfall over the Study area is unreliable, with zero rainfall potentially recordable in any month (Gilligan, 1994). Summer weather in the region is influenced by anticyclonic systems to the south-east, which result in a pattern of clear skies and easterly winds (Gilligan, 1994). The region borders the southern end of the Intertropic Convergence Zone and, as a consequence, thunderstorm activity and summer rainfall is generated (Gilligan, 1994). While summer rainfall is a feature of the region, most years have a dry spell lasting four to six months, typically commencing around October (Gilligan, 1994).

Winter weather patterns are directly influenced by the anticyclonic system, which results in the generation of westerly winds and rain-bearing frontal systems (Gilligan, 1994). Winter rains are usually heaviest around late May into August, and subside during the months of September and October as the anticyclonic conditions stabilise (Gilligan, 1994).

The nearest Bureau of Meteorology (BOM) weather stations to Lake Maitland are Yeelirrie and Leinster. The Yeelirrie weather station is located approximately 98 km west of Lake Maitland. The Leinster weather station is located approximately 100 km south-west of Lake Maitland. Data has been collected at Leinster for 13 years, whereas rainfall data has been collected at Yeelirrie since 1928 with temperature data collected since 1973. Data from Yeelirrie were selected to give a better representation of long-term regional climate patterns. Significant variation in rainfall is noted across the area, and as such, data provided should be used as a guide only.

Monthly mean maximum temperature at Yeelirrie ranges from a high of 37.9 ^{0}C during January to a low of 19.3 ^{0}C in July (**Figure 3**). The highest temperature at Yeelirrie was 46 ^{0}C recorded in February 1991 while the lowest was -5.1 ^{0}C recorded in July 2000 (BOM, 2009). Mean monthly rainfall at Yeelirrie ranges from a high of 31.5 mm in March to a low of 4.2 mm in September (**Figure 3**). Mean annual rainfall recorded at Yeelirrie is 237 mm (BOM, 2009). Zero rainfall has been recorded during each month of the year while peak falls as high as 211 mm (April, 1992) have been recorded within a month (BOM, 2009). Annual rainfall recorded has ranged from a low of 42.8 mm in 1950 to a peak of 506.8 mm in 1975 (BOM, 2009).

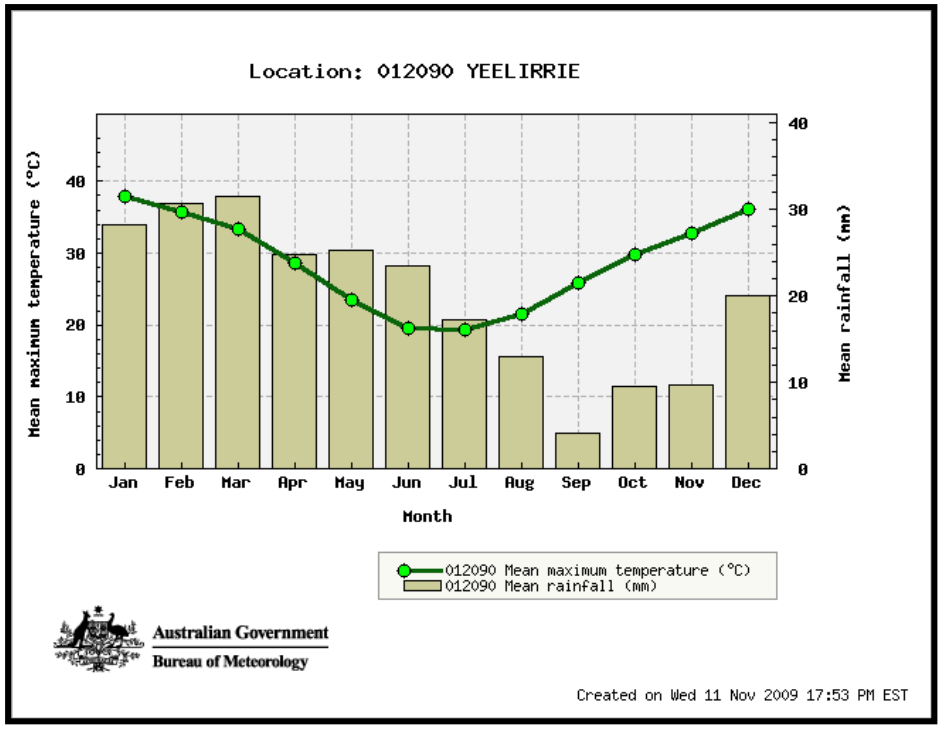

Figure 3: Climate data for Yeelirrie station (BOM, 2009) Murchison Biogeographic Region

The Study area is situated in the semi-arid to arid Eyrean Sub-region, one of three very broad sub-regions defined by Heatwole (1987) covering the entire Australian continent, with the others being the tropical Torresian sub-region and the temperate Bassian sub-regions.

Thackway and Cresswell (1995) describe a more refined system of 85 'biogeographic regions' (bioregions) covering the whole of Australia; the result of collaboration between all state conservation agencies with co-ordination by the Australian Government Department of Environment and Heritage [now the Department of Environment, Water, Heritage and the Arts (DEWHA)]. Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The Lake Maitland Project is located within the Murchison bioregion (Australian Natural Resource Atlas [ANRA], 2007) in Western Australia. The Murchison covers an area of 278,360 km^2 with mining and grazing as the two main land uses (Morton *et al.* 2004). The Murchison bioregion is further delineated into two sub-regions; the Eastern Murchison and the Western Murchison. The Study area is located within the Eastern Murchison (MUR1) sub-region (**Figure 4**) characterised by Cowan (2001) as:

> *"internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake systems are associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains are widespread. Vegetation is dominated by Mulga Woodlands often rich in ephemerals, hummock grasslands, saltbush shrublands and Halosarcia (now Tecticornia) shrublands".*

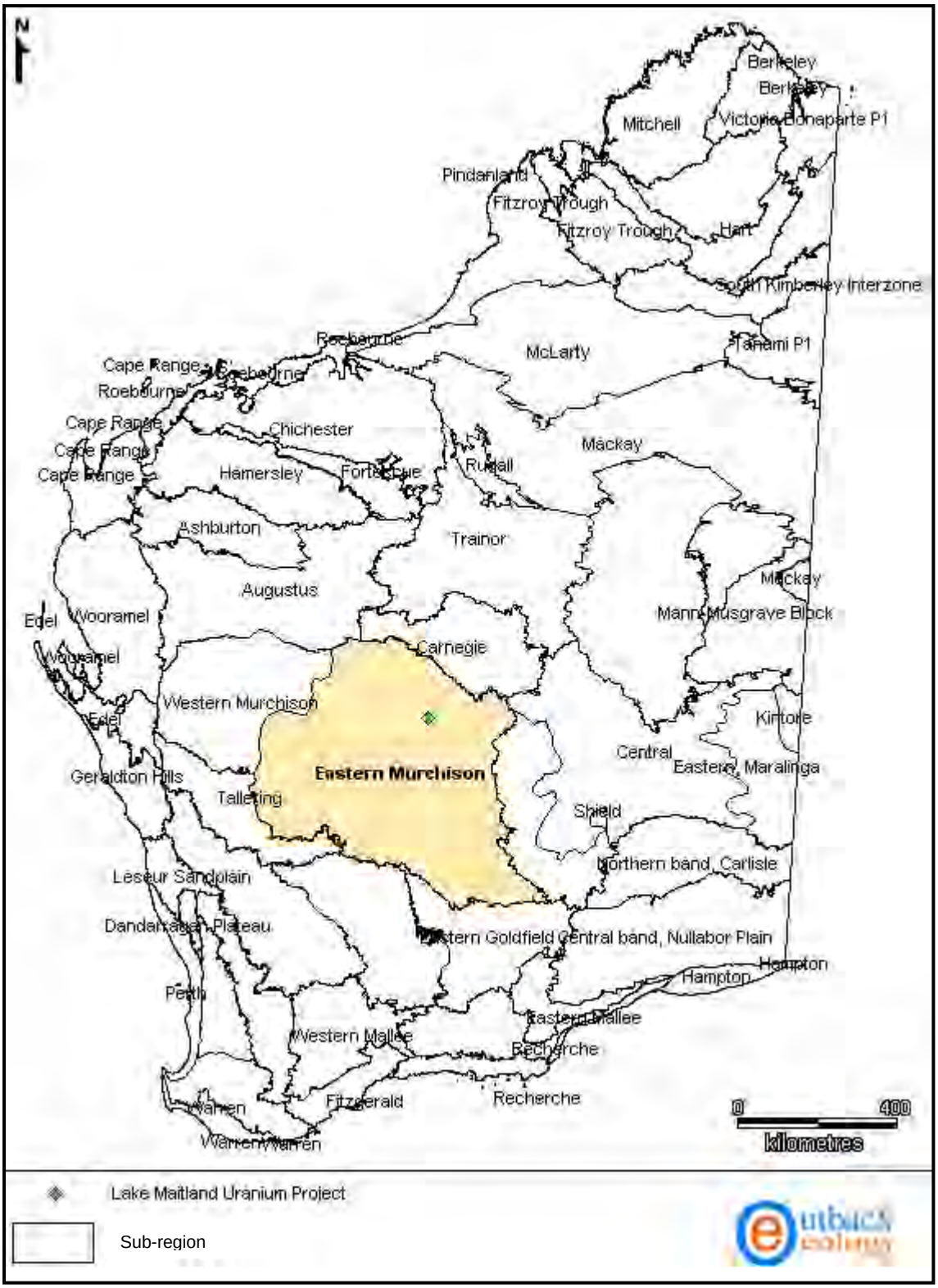

Figure 4: Location of the Study area within the Eastern Murchison (MUR1) subregion

2.2 Land Systems of the Study Area

The Western Australian Department of Agriculture completed a regional survey of land systems occurring within the Murchison to develop a comprehensive description of biophysical resources and to provide an assessment of the condition of the soils and the vegetation of the north-eastern Goldfields (Pringle *et al.*, 1994). A component of the survey was the mapping of land types, land units and land systems of the Murchison including the Project area.

The Infrastructure Area B is located predominantly over the Bullimore land system. However, the Mileura, and to a lesser degree, the Darlot and Melaleuca land systems also occur. The Infrastructure Area A is located predominantly over the Mileura and Cunyu land systems. However, a small portion of the West Infrastructure area also occurs over the Darlot land system. The Bullimore land system is represented by extensive Spinifex sandplains, whereas the Mileura and Cunya land systems are represented by calcrete platforms and support halophytic and *Acacia* shrublands respectively.

A summary table has been provided in **Table 1** and the distribution of the land systems are shown in relation to the Project area in **Figure 5**.

Table 1 Summary of land systems over the Study area (Pringle *et al* 1994)

Land Type	Land System (Mapping Unit)	Description	Total and % of north –eastern Goldfields	Occurrence over Infrastructure areas
Sandplains with Spinifex hummock grasslands, *Acacia* shrublands, heath and eucalypts	Bullimore (RGEBLM)	Extensive sand plains supporting Spinifex hummock grasslands	24,013 km² 24%	Infrastructure Area B
Calcreted drainage plains with mixed halophytic and non- halophytic shrublands	Mileura (RGEMIL)	Saline and non-saline calcreted river plains, with clayey flood plains interrupted by raised calcrete platforms supporting diverse and very variable tall shrublands, mixed halophytic shrublands and shrubby grasslands	550 km² 0.6%	Infrastructure Area A Infrastructure Area B (minor occurrence)
	Melaleuca (RGEMEL)	Sandy-surfaced plains and calcareous plains supporting Spinifex or mulga wanderrie shrublands	267 km² 0.3%	Infrastructure Area B (very minor occurrence)
	Cunyu (RGECUN)	Calcrete platforms and intervening alluvial floors and minor areas of alluvial plains, including channels with acacia shrublands and minor halophytic shrublands	310 km² 0.3%	Infrastructure area A

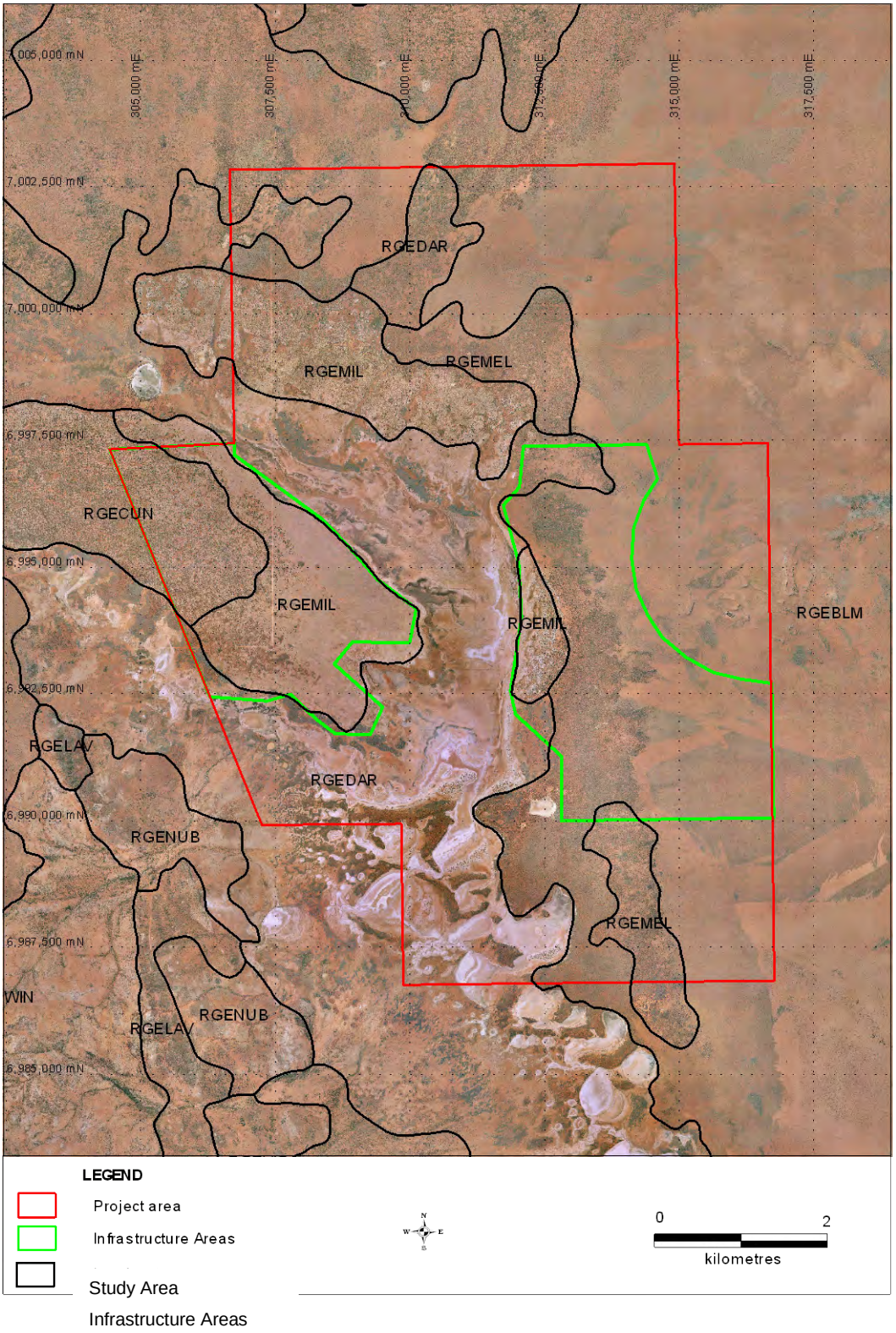

Figure 5: Land systems over the Infrastructure Areas A and B

2.3 **Land Use**

2.3.1 Pastoral

The Project is situated on the Barwidgee Pastoral Lease, which is currently leased by Mega. Barwidgee has been stocked since the 1930s (Beard, 1975), and the grazing of both cattle and Damara sheep currently occurs within selected areas of the lease, including the Study area. In addition to grazing by cattle, there are high numbers of both Red Kangaroos (*Macropus rufus*) and Euros (*M. robustus*) (National Land and Water Audit [NLWRA], 2002).

2.3.2 Mining

The Lake Maitland uranium deposit was discovered by Asarco Australia Pty Ltd in 1972. The deposit was drilled by Mt Isa Mines Ltd (now Xstrata Ltd) and Esso Exploration Ltd in the 1980s and 1990s and by Mega Lake Maitland in late 2005. The uranium resource has been inferred as a 100 ppm U_3O_8 cut-off, of 32.7 million tones at 0.03 % U_3O_8 (23.7 million pounds U_3O_8) (JORC and NI-43-101 compliant) (Mega Uranium, 2007). The Lake Maitland Study area is located within 25 km of View Resource's Bronzewing Gold Mine, which is also located on the Barwidgee Pastoral Lease.

3. SURVEY ASSESSMENT AND METHODS

3.1 Database Searches

Database searches were undertaken prior to the field surveys to develop a list of potential bird, reptile, mammal and amphibian species for the Study area. Search areas were defined by a fixed point that was centred on the Study area and covered a 75 km radius (the 'search area'). Database searches of these areas were made using the following databases and internet tools:

- Threatened and Priority Fauna Database held by the WA Department of Environment and Conservation (DEC) (2009a);
- NatureMap database (DEC, 2009b);
- Environmental Reporting Tool of the DEWHA (2009a);
- Protected Matters Search Tool of DEWHA (2009b)
- The Australian Wetlands Database of the DEWHA (2009c);
- Birds Australia (2009) database;
- Australian Museum (2009) database; and
- Species Profile and Threats Database (SPRAT) (DEWHA, 2009d).

3.2 Previous Surveys over the Study Area

A literature review was undertaken to provide a list of mammal, bird, reptile and amphibian species that have the potential to occur within the Study area. The following surveys were previously conducted in the Study area:

- Outback Ecology (2008). Lake Maitland Baseline Terrestrial Fauna Surveys;
- Halpern Glick Maunsell (1997). Barwidgee Pastoral Lease Mulgara *Dasycercus cristicauda* Survey; and
- Hall, N.J., McKenzie, N.L. and Keighery, G.J. (eds). (1994). The Biological survey of the Eastern Goldfields of Western Australia. Part 10. Sandstone - Sir Samuel and Laverton - Leonora Study areas.

3.2.1 Lake Maitland Baseline Terrestrial Fauna Surveys. (Outback Ecology, 2008).

The Baseline Terrestrial Fauna Surveys of Lake Maitland was conducted from the 7 to 16 May 2007 (autumn survey) and the 7 to 13 December 2007 (summer survey). Seven broad habitats were identified and surveyed during the assessment, including: Spinifex Plains, Mulga Woodland, Mallee over Spinifex, Lake Edge Spinifex, Woodland on Calcrete Flats, Samphire Flats and Kopi Ridge. The assessment incorporated the following survey techniques to target mammal, bird, reptiles, amphibian and terrestrial short-range endemic (SRE) invertebrate species:

- Searches for evidence of species (such as tracks, scats, burrows and diggings);
- Systematic trapping using funnel, cage, Elliott and pitfall trapping methods;
- Microhabitat searching for smaller vertebrate animals and SRE invertebrates;
- Bird surveys;
- Opportunistic surveys;
- Spotlighting for nocturnal animals;
- AnaBat recordings; and

- Habitat assessments.

A total of 123 vertebrate species were recorded during the surveys, including 24 mammals (17 native), 60 birds, 39 reptiles. No amphibian species were detected during this survey.

The Mulgara (*Dasycercus cristicauda),* listed as threatened under Commonwealth legislation and Schedule 1 under state legislation, was recorded during both surveys. The Priority 4 Bush Stone-curlew (*Burhinus grallarius)* was recorded during the autumn survey.

During the SRE component of the survey, the following taxonomic groups were targeted:

- Mygalomorph Spiders (Mygalomorphae);
- Pseudoscorpions (Pseudoscorpionida);
- Scorpions (Scorpionida);
- Millipedes (Myriopods);
- Terrestrial Molluscs (Gastropoda).

From these potential SRE groups, a total of 16 distinguishable invertebrate species were collected, including seven mygalomorph spiders, six scorpions, one pseudoscorpion and two terrestrial snail species. Some of the collected specimens were either immature or female and consequently could not be identified down to species level.

Of the species identified, four mygalomorph spider species and two scorpion species were identified as possible SRE species. These species and associated habitats are discussed in **Section 4.3.3.**

3.2.2 Barwidgee Pastoral Lease Mulgara *Dasycercus cristicauda* Survey. (Halpern Glick Maunsell, 1997).

The assessment of the status of the Mulgara (*Dasycercus cristicauda*) on the Barwidgee Pastoral Station was undertaken and comprised systematic searches of suitable habitat and follow up trapping. Identification of potential Mulgara habitat was achieved using the Land Systems maps collated by Agriculture WA. The Bullimore Land System was identified as potentially encompassing core habitat for the Mulgara. Preliminary assessment of habitat variables indicates that nearly pure stands of mature clumps of Spinifex with large intervening spaces constitutes suitable habitat for Mulgaras. Relatively little overstorey was also found to be an important habitat indicator for this species.

Trapping using medium sized Elliot traps was undertaken from the 25 August to 3 October 1997 at three survey sites: Charlies Well, Sisters Well and Wanjarri Border. The two well survey sites were located 5 km east of Lake Maitland and the Wanjarri survey site was located 25 km to the southwest of Lake Maitland. A total trapping effort of 1,117 trapping nights was conducted and this resulted in the capture of eight individuals.

3.2.3 The Biological survey of the Eastern Goldfields of Western Australia. Part 10. Sandstone - Sir Samuel and Laverton - Leonora Study areas. Hall, N.J., McKenzie, N.L. and Keighery, G.J. (eds). (1994).

The Sandstone – Sir Samuel and the Laverton – Leonora Biological Study areas are diagonally adjacent to one another and were surveyed from January 1980 to August 1982 and October 1987 to September 1992. The Lake Maitland Study area lies within the Sir Samuel Biological Study area however the results for both of the Biological Study areas are combined in the survey report. The trapping sites within the Sir Samuel Biological Study area were located 40 km southwest of the Lake Maitland Study area and the trapping sites for the Leonora Biological Study area are located 165 km southeast of the Lake Maitland Study area.

Ten landform units were recognised from the Biological Study areas with the most extensive including: Sandplains and Broad Valleys, Salt Lake Features, Calcareous Plains bordering salt lakes and undulating plains. The main vegetation community consisted of low woodlands of *Acacia aneura* (Mulga). *Eucalyptus* species with an understorey of hummock grasses (*Triodia*) were dominant on deep sands. Tall and low shrublands occurred in limited areas, generally in association with salt lake dunes.

Variations of the following trapping methods were undertaken at fourteen sites over the two Biological Study areas. Each site incorporated the following sampling methods:

- Mammals (Nine elliott, nine break-backs and three cage traps);
- Bird searches;
- Reptile searches; and
- Fenced 50 metre pit line of six pits.

A total of 175 vertebrate species were recorded during the survey, including 26 (18 native) mammal, 54 reptile, three frog and 92 bird species from the Biological Study areas.

3.3 Previous Surveys surrounding the Study Area

Additional studies have been conducted in the surrounds which provide useful contextual information for this assessment. These include:

- Outback Ecology (2006). Bronzewing–Mount McClure Desktop Vertebrate Fauna Assessment and Reconnaissance Survey of the Venus Project;
- Ninox Wildlife Consulting (1993). Draft Vertebrate Fauna Assessment of the proposed Bronzewing Gold Project; and
- CALM (1996). Department of Conservation and Land Management (now Department of Environment and Conservation). Wanjarri Nature Reserve Management Plan 1996-2006.

3.3.1 Desktop Vertebrate Fauna Assessment and Reconnaissance Survey of the Venus Project (Outback Ecology, 2006).

The desktop and reconnissance survery of the Venus Project (Bronzewing-Mt McClure) (30 km south west of the Study area) was conducted during June 2006. A Level 1 fauna survey was deemed appropriate considering the scale and nature of the proposed works.

Three broad habitat types were identified from the project area, including mulga on minor/pebbly slopes, low hills with shallow soils, and rocky hills with outcrops.

A total of 265 native fauna species were identified as potentially occurring at the Venus Project, comprising 43 mammals (32 native), 141 birds, 72 reptiles and nine frog species.

Conservation significant bird species identified as potentially occurring at the Venus Project included the Slender-billed Thornbill, Striated Grasswren, Malleefowl, Australian Bustard, Bush Stone-curlew, Night Parrot, Princess Parrot, Major Mitchells Cockatoo, Peregrine Falcon, Grey Falcon, Barking Owl, Rainbow Bee-eater and Fork-tailed Swift. Conservation significant reptiles that were identified as potentially occurring in the project area comprised of the Woma Python and the Great Desert Skink. Conservation significant mammals identified as potentially occurring included the Mulgara and the Long-tailed Dunnart.

3.3.2 Draft Vertebrate Fauna Assessment of the proposed Bronzewing Gold Project. (Ninox Wildlife Consulting, 1993).

The Bronzewing Gold Project is located 30 km south of the Infrastructure areas and is proposed to be joined to the Lake Maitland Project by an as yet undetermined Haulage route option. The fauna assessment which was conducted over three days during January 1993 consisted of a fauna habitat assessment and recordings of opportunistic fauna sightings. During the survey a total of 50 birds, nine mammals (four native), four reptiles and no amphibians were recorded. No conservation significant species were recorded from the Bronzewing Gold Project, however from the habitats present there was potential for four conservation significant bird species to occur. These were the Peregrine Falcon (*Falco peregrinus*), Grey Falcon (*Falco hypoleucos*), Scarlet-chested Parrot (*Neophema splendida*) and Grey Honeyeater (*Conopophila whitei*).

3.3.3 Wanjarri Nature Reserve Management Plan 1996-2006. (CALM, 1996).

The Wanjarri Nature Reserve is located 40 km west of the Study area and had been destocked since 1971. The main landforms that occur within the Nature Reserve include: Breakaways, Drainage Lines, Broad Valleys, Sandplains, Dunefields, Low Granite Hills and Undulating Plains. Threatened fauna recorded on the Reserve include the Mulgara (*Dasycercus cristicauda*), Mallee Fowl (*Leipoa ocellata*) and Grey Honeyeater (*Conophila whitei*). The Mallee Fowl has not been recorded on the reserve since 1969 and the Grey Honeyeater has not been recorded on the reserve since 1972. The Mulgara was recorded in 1994 (two years before the Management Plan was released). The Spinifex sandplains have been identified as important habitat for the Mulgara.

3.4 **Reconnaissance Survey**

A reconnaissance survey was conducted over the Study area to verify the accuracy of the desktop survey, and to further delineate and characterise the fauna and faunal assemblages of the area and identify potential impacts of the construction and use of the infrastructure areas.

3.4.1 Survey Timing and Weather

The survey was undertaken from October 14 – 21, 2009. Maximum temperatures during the surveys ranged between 31.9ºC and 38ºC, with minima between 9.8ºC and 18ºC (BOM, 2009). The average minimum and maximum temperatures during the survey period were 15.2ºC and 34.2ºC respectively. No rainfall was recorded at the Yeelirrie weather station during the survey period (BOM, 2009).

Weather conditions experienced during the survey was considered appropriate since temperatures were warm enough for reptiles to be active without being too hot to inhibit bird and mammal activity.

3.4.2 Vertebrate Habitat Assessment

Prior to the survey, broad vertebrate fauna habitats present within the Study area were identified via consideration of existing survey reports (**Section 3.2**), aerial imagery and topography. During the field survey, these habitat types were confirmed in the field and habitat assessment sites were chosen in representative areas within each of the proposed infrastructure areas. A habitat assessment was conducted at each site to determine the quality and complexity of the habitat provided for vertebrate fauna, with a focus on species of conservation significance.

The following parameters were noted as part of the habitat assessment: landscape features, estimate of litter cover percentage and type, soils, outcropping, estimate percentage of bare ground and types of disturbance (eg. evidence of fire, tracks); and the levels of disturbance in terms of the effect that it has had on the vegetation (eg. density of overstorey vegetation, density of shrubs).

During the reconnaissance survey, 11 broad fauna habitats were identified as occurring within the Study area. Thirty seven representative survey sites were chosen to ascertain the types of broad fauna habitats found within the Lake Maitland Study area. This included Infrastructure Area B (13 sites), Infrastructure Area A (11 sites) and 13 sites (**Figure 6).**

Eleven broad fauna habitats were identified over the Study area and surrounds:

- Mulga Woodland/Shrubland Plain;
- Calcrete Plain;
- Woodland/Shrubland on Calcrete Flats;
- Shrubland on Sandplain;
- Spinifex Sandplain;
- Mallee Spinifex Sandplain;
- Samphire Flats;
- Lake Edge Spinifex;
- Claypan; and
- Kopi Dune.

Of these habitats, several have been previously been assessed during the Terrestrial Fauna Baseline Surveys during 2007 (Outback Ecology 2008). These survey sites were re-assessed as part of this habitat assessment and their associated site names for this assessment are included in **Table 2** below.

Table 2: Site Names from the Habitat assessment and the previous Level 2 survey

Habitat	Terrestrial Baseline Fauna Survey site names (Outback Ecology 2008)	Associated Habitat Assessment site names for this survey
Spinifex Sandplain	LM01	S1
Mulga Woodland/Shrubland Plain	LM02	S2
Mallee Spinifex Sandplain	LM03	E1
Lake Edge Spinifex	LM04	S9
Woodland on Calcrete Flats	LM05	S11
Samphire Flats	LM06	S10
Kopi Dune	LM07	S3

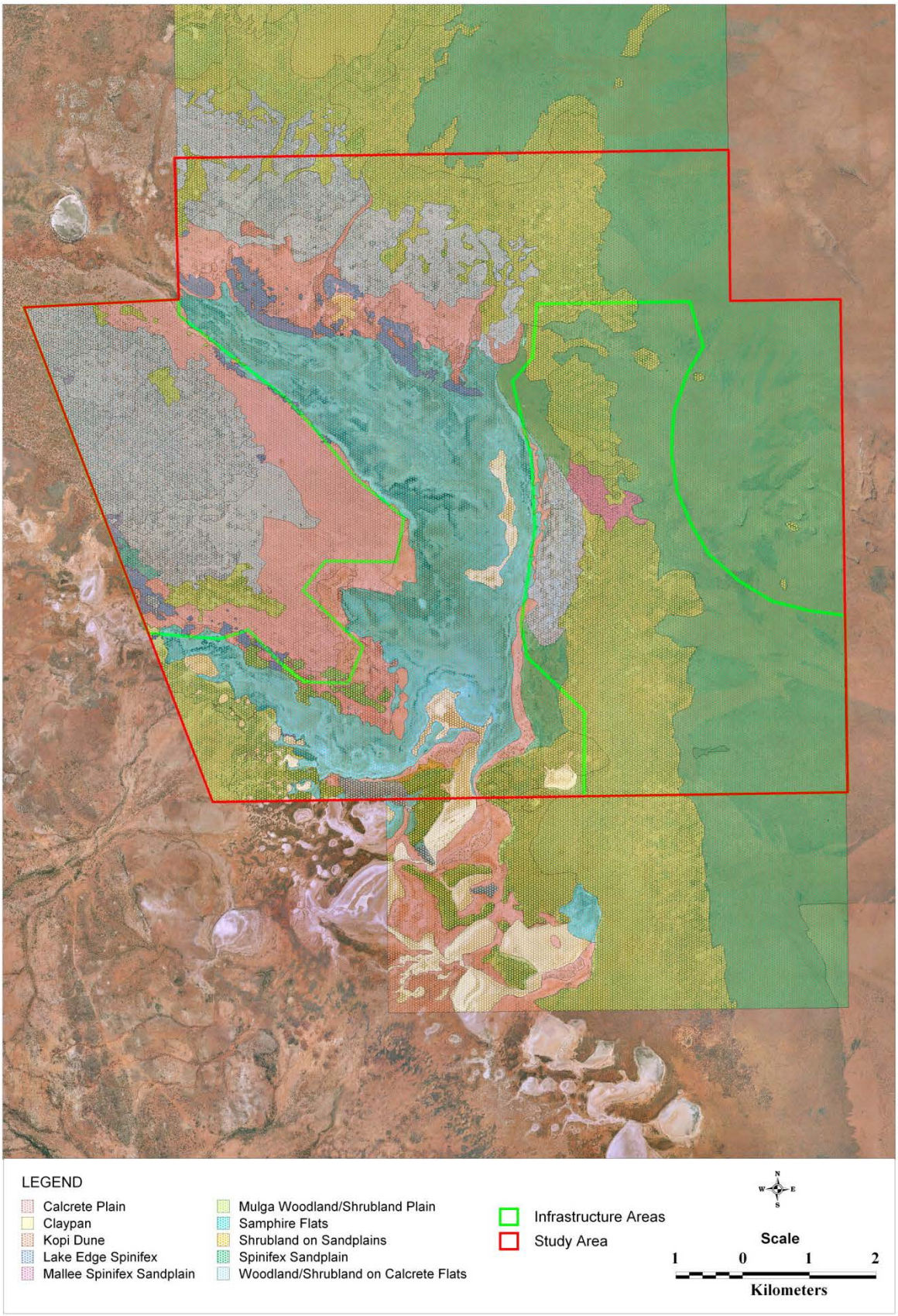

Figure 6: Fauna habitat map of the A and B Infrastructure areas

Infrastructure Area B was predominantly composed of Spinifex Sandplain and Mulga Woodland/Shrubland plain habitats with smaller sections of the following habitats: Mallee Spinifex Sandplain, Samphire Flats and Woodland/Shrubland on Calcrete Flats. Infrastructure Area A was predominantly composed of Calcrete Plain and Woodland/Shrubland on Calcrete Flats habitats with a very small section of Shrubland on Sandplain.

Each of the habitat tyopes encountered during the field surveys of the Study Area are provided below.

Mulga Woodland/Shrubland Plain

This habitat is extensive throughout the landscape to the south west and east of Lake Maitland and appears to be well connected. These areas typically support close to scattered Mulga (*Acacia aneura*) shrublands on loamy and hardpan plains. Associated species and understorey typically consists of *Acacia ramulosa*, *A. tetrgonophylla*, *Ptilotus obovatus*, *Senna artemesioides*, *Sclerolaena eracantha*, and *Maireana triptera* and wanderrie and Spinifex grasses (**Figure 6**). This habitat occurs in a north-south band within the Infrastructure Area B.

A Level 2 intensive trapping program has been previously undertaken in this habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant fauna were recorded from this habitat at Lake Maitland.

Plate 1: Mulga Woodland/Shrubland plain

Characteristics of this habitat vary depending upon elevation in the landscape. Lower lying areas tended to have an understory dominated by chenopods and the open plains tended to vary between unvegetated hardpan plains, to ones with varying cover by wanderrie grasses or Spinifex grasses. The density and height of the Mulga also tended to vary in the landscape in relation to topography and substrate. As a consequence, the percentage of bare ground ranged from approximately 15 to 90% depending largely upon the cover by grasses beneath the Mulga. Live vegetation cover also tended to range substantially from 5% to 80% depending upon the density of Mulga and of understory shrubs. Litter cover (leaf litter, branches and logs) was consistently low at approximately 0% to 8%. Litter origin was predominantly from the surrounding shrubs and trees with a large portion also having being deposited via sheet flow during high rainfall events.

Vegetation communities, such as shrubs and mulga overstorey, provide important microhabitats for bird, reptile and mammal species. Litter (leaves, branches and logs) is utilised by many vertebrate fauna species including fossorial reptiles, amphibians and small mammals (Cogger, 2000 and Strahan, 2005). Small shrubs are utilised by smaller woodland birds including Honeyeaters, Woodswallows and Cuckoo-shrikes (Pizzey and Knight 2007). Avian species found in this habitat during the survey include the Yellow-throated Miner (*Manorina flavigula*), Rufous whistler (*Pachycephala rufiventris*) and Crested Bell Bird (*Oreoica gutturalis*) amongst others (**Attachment B**).

Mulga Woodland/Shrubland habitats tend to support soft substrates that provide easy digging for many reptile and mammal species known to occur in the area including the Echidna (*Tachyglossus aculeatus*), Lozenge-marked Dragon (*Ctenophorus scutulatus*) and the Bearded Dragon (*Pogona minor minor*) (**Attachment B**) (Cogger, 2000; Van Dyck and Strahan, 2008).

Calcrete Plain

This habitat appears to be relatively common to the west and north of Lake Maitland and makes up approximately 33% of the Infrastructure Area A. This habitat comprised heavily grazed wanderrie grasses on calcrete platforms with shallow red loam soils (**Plate 2**). Erosion by wind and by sheet flow from water was evident, however well formed cryptogramic crusts have helped to reduce the severity of this erosion. Grazing pressure was predominantly from Euros (*Marcopus robustus*) and Red Kangaroos (*Macropus rufus*) which were observed in high numbers during nocturnal surveys of this habitat. This habitat aligns closely with the Mileura land system (Pringle *et al*., 1994).

Plate 2: Calcrete Plain

Habitat characteristics were as follows. Bare ground was approximately 90% to 98%, live vegetation cover ranged from 3% to 10%. No litter cover (leaf litter, branches and logs) was present.

Calcrete Plains provide attractive grazing areas from domestic and native animals such as the Euro and Red Kangaroo rendering it highly susceptible to overgrazing and consequent degradation (Pringle *et al*., 1994). If grazing pressure were to be reduced, there is potential for the grasses to recover and support a number of grazing and grain eating species that would also rely on the increased cover of the grasses from predators. Avian examples include the Zebra Finch (*Taeniopygia guttata*), Mulga Parrot (*Psephotus varius*), Budgerigar (*Melopsittacus undulates*) and Cockatiel (*Nymphicus hollandicus*) (Pizzey and Knight 2001) (**Attachment B**).l

Mammal species currently include the Euro and Red Kangaroo but have potential to include smaller species with the return of grasses such as the Sandy Inland Mouse (*Pseudomys hermannsburgensis*) and Desert Mouse (*Pseudomys desertor*) (Cogger, 2000, and Strahan, 2005) (**Attachment B**).

Woodland/Shrubland on Calcrete Plain

The Woodland/Shrubland on calcrete plain makes up approximately 65% of the Infrastructure Area A and 10% of Infrastructure Area B. This habitat typically consists of level plains with calcrete rubble and red earth. The vegetation tended to be dominated by *Casuarina obesa* scattered to moderately close Mulga and mixed *Acacia* spp. over *Atriplex* spp. and *Maireana* spp. This habitat aligns closely with the Cunyu land system (Pringle *et al*., 1994) which extends westwards from the Infrastructure Area A. This habitat

tended to have moderately dense vegetation in Infrastructure Area A area, however the vegetation in Infrastructure Area B tended to be more sparse and interspersed by halophytic vegetation.

Plate 3: Woodland/Shrubland on Calcrete Plain

A Level 2 intensive trapping program has been previously undertaken in this habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant fauna were recorded in this habitat during the Level 2 assessment.

Habitat characteristics were as follows. Bare ground is approximately 80% to 90%, live vegetation cover ranges from 10% to 20%. Litter cover (leaf litter, branches and logs) is approximately 5%. Litter origin is predominantly from the surrounding shrubs and trees.

The taller trees of *Casuarina obesa* and the understory of Mulga and mixed *Acacia* provide important habitats for birds while the fallen branches and logs provide important cover for reptiles, and small mammals (Cogger, 2000; Strahan, 2005). Small shrubs are utilised by smaller woodland birds including Honeyeaters, Woodswallows and Cuckoo-shrikes (Pizzey and Knight 2007). Avian species found in this habitat during the survey include the Yellow-throated Miner (*Manorina flavigula*), Blackfaced Cuckoo-shrike (*Coracina novaehollandiae*) and Chestnut-rumped Thornbill (*Acanthiza uropygialis*) amongst others (**Attachment B**)

The cover provided by fallen logs of *C. obesa* form important habitat for many mammal and reptile species including the Echidna (*Tachyglossus aculeatus*), Jan's Banded Snake (*Simoselaps berthodi*) and Pygmy Spiny-tailed Skink (*Egernia depressa*) (**Attachment B**) (Cogger, 2000; Van Dyck and Strahan, 2008).

Shrubland on Sandplain

This habitat was found only to occur in narrow bands along the southern edge of Infrastructure Area A where it made up approximately 2% of the total area. This habitat typically consisted of sandy banks or sandplains with deep earthy red sand supporting a sparse shrubland of *Scaevola spinescens* and *Sida fibulifera* over chenopod shrubland of *Atriplex amnicola*, *Sclerolaena spp*. over open tussock grassland of *Enneapogon caerulescens* and *Panicum effusum*. This habitat is uncommon in the Study area and is not extensive or well connected in the landscape. This habitat only appears to occur in a patchy distribution within the Darlot land system (Pringle *et al*., 1994).

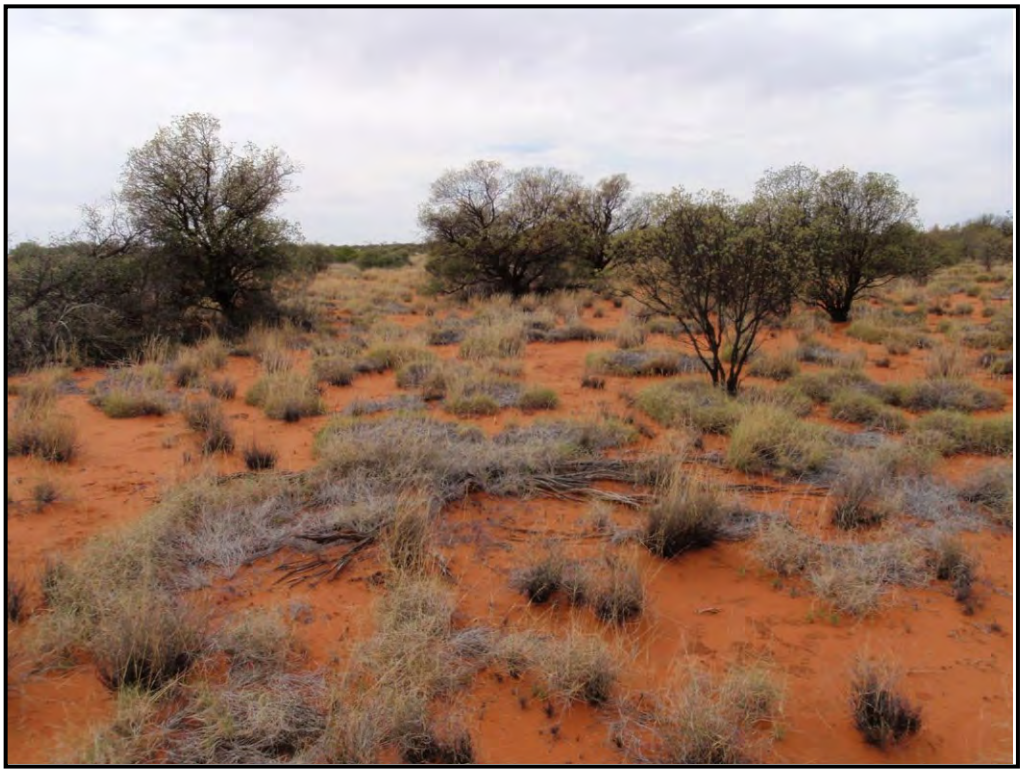

Plate 4: Shrubland on Sandplain

Habitat characteristics were as follows. Bare ground was approximately 30% to 40%, live vegetation cover ranges from 45% to 70%. Litter cover (leaf litter, branches and logs) was approximately 15%. Litter origin was predominantly from the surrounding shrubs and trees.

The mixed shrubland provides habitat for smaller birds such as the White-winged Fairy-wren (*Malurus leucopterus*), White-plumed Honeyeater (*Lichenostomus penicillatus*) and the White-fronted Honeyeater (*Phylidonyris albifrons*) amongst others (**Attachement A**). The deep sandy soil provides suitable for habitat for burrowing mammals and burrowing reptile species such as dragons and Varanids (Cogger, 2000 and Strahan, 2005). Mammal and reptile species found in shrublands with sandplains include the Stripe-faced Dunnart (*Sminthopsis macroura*) and Central Netted Dragon (*Ctenophorus nuchalis*).

Spinifex Sandplain

The Spinifex sandplains are a very broad and common feature of the landscape to the east of Lake Maitland and make up approximately 40% of Infrastructure Area B. This habitat is typified as having extensive deep sandplains supporting Spinifex hummock grasslands (**Plate 5)**. Other vegetation occasionally includes open mallee woodland of *Eucalyptus eremicola* subsp. *peeneri* over sparse shrubland of *Acacia sibina* over hummock grassland of *Triodia basedowii*. This habitat is highly flammable and numerous fire scars with different stages of regeneration are visible in the aerial photograph (**Figure 2**). Although this habitat is very common, very few areas of this habitat had mature Spinifex due to the frequency of fires.

Plate 5: Spinifex Sandplain

A Level 2 intensive trapping program has been previously undertaken in this habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). The Mulgara which is Vulnerable and Schedule 1 was recorded in this habitat during both the autumn and spring components of the Level 2 survey.

Habitat characteristics were as follows. Bare ground was approximately 50% to 90%, live vegetation cover ranges from 18% to 40%. Litter cover (leaf litter, branches and logs) was approximately 2%. The percentage of bare ground and live vegetation was highly variable in this assessment depending upon how recently the area had been burned.

Spinifex sandplains would provide important feeding and breeding grounds for reptiles including many *Ctenotus* species, the Long-nosed Delma (*Delma nasuta*), Sandplain Gecko (*Diplodactylus stenodacytlus*),

and ground dwelling mammals including the Stripe-faced Dunnart (*Sminthopsis macroura*) and the Wongai Ningaui (*Ningaui ridei*) (Wilson and Swan, 2008; Cogger, 2000) (**Attachment B**).

Mallee Spinifex Sandplain

The Mallee Spinifex Sandplain habitat occurs over a small central area of approximately 2% within Infrastructure Area B. The vegetation typically comprised low woodland of Mallee (*Eucalyptus eremicola*) and Mulga over a low scrub of *Hakea preissii*, *Eremophila oldfieldii* and *Acacia ayersiana* over Spinifex on a deep red sandplains. This habitat appeared to be uncommon in the landscape.

Plate 6: Mallee Spinifex Sandplain

A Level 2 intensive trapping program has been previously undertaken in this habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant fauna species were recorded in this habitat during the Level 2 assessment.

Habitat characteristics were as follows. Bare ground was typically 40%, live vegetation cover was typically 40%. Litter cover (leaf litter, branches and logs) was approximately 10%. Litter origin was predominantly from the surrounding Mallee and Mulga.

The low woodland of Mallee would provide important habitat for woodland birds including Honeyeaters, Woodswallows, Cuckoo-shrikes and parrots (Pizzey and Knight 2007). While the Spinifex and deep sand would provide important feeding and breeding grounds for reptiles such as dragon and geckos as well as ground dwelling mammals such as Spinifex Hopping Mouse (*Notomys alexis*) and Desert Mouse (*Pseudomys desertor*) (Wilson and Swan, 2008; Cogger, 2000) (**Attachment B).**

Samphire Flats

The Samphire Flats habitat occurs over a large area that is Lake Maitland, however only a small area of this habitat is within the Study area for this assessment. The habitat is typified by three halophytic vegetation types that have different salinity and substrate tolerances. This vegetation consisted primarily of a sparse shrubland of *Scaevola collaris over* a*chenopod shrubland of Tecticornia halocnemoides subsp. halocnemoides, Tecticornia indica subsp. aff. bidens and Tecticornia aff. undulata over open tussock grassland of Aristida contorta, Eragrostis lanipes*.

Plate 7: Samphire Flats

The Samphire Flats habitat occurs on the eastern edge of the Infrastructure Area A and then traverses approximately 1 km of this habitat to the south of the Infrastructure Area A. The Samphire Flats habitat is common and widespread in the vicinity of Lake Maitland. This habitat has been previously assessed (active searching, avian censusing and night searching) during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant fauna were recorded from this habitat during the Level 2 assessment.

Habitat characteristics were as follows. Bare ground was typically 25% to 85%, live vegetation cover was typically 15% to 75%. Litter cover was mostly made up of branches from dead *Tecticornia* plants. The percentage of bare ground and vegetation cover was quite variable across different sections of the lake and within the different vegetation types of this habitat.

Saline alluvial plains have low fauna species richness due to the lack of shelter in the form of leaf litter, bark and woody debris (Cogger, 2000 and Strahan, 2005). Burrowing reptiles such as Dragon species

utilise the softer substrate (Cogger, 2000 and Strahan, 2005). The lack of fresh water, even in ephemeral form, discourages the presence of amphibians (Cogger, 2000).

Saline alluvial plains are generally poor in bird species and diversity. Small shrubs may be utilised by smaller woodland birds including Honeyeaters, Woodswallows and Cuckoo-shrikes (Pizzey and Knight 2007). Chenopod shrubland habitats tend to support soft substrates that provide easy digging for many reptile and mammal species, including the Fat-tailed Gecko (*Diplodactylus conspicillatus*) (Cogger 2000; Van Dyck and Strahan 2008) (**Attachment B**).

The Slender-billed Thornbill (*Acanthiza iredalei iredalei*) is listed as Vulnerable under the Environment Protection and Biodiversity Conservation (EPBC) Act (1999) and is one of the few species that occurs exclusively in Samphire habitat, usually bordering salt lakes (Johnstone and Storr, 2004). Targeted searches were conducted for this species within the Samphire Flats habitat; however it was not recorded during this survey or during the previous baseline fauna surveys.

Lake Edge Spinifex

The Lake Edge Spinifex habitat is uncommon in the landscape and tends to fringe the Samphire Flats habitat. The vegetation is comprised almost exclusively of Spinifex (*Triodia basedowii*) hummock grassland with some very low grasses of *Eragrostis* spp., *Enneapogon caerulscens* and occasional low shrubs of *Cratystylis subspinescens* and *Lyceum australe* (**Plate 8**). The substrate tends to be composed of sandy alluviums on calcretes. This habitat tends to occur as a band between the two calcrete habitats described above and the Samphire habitat.

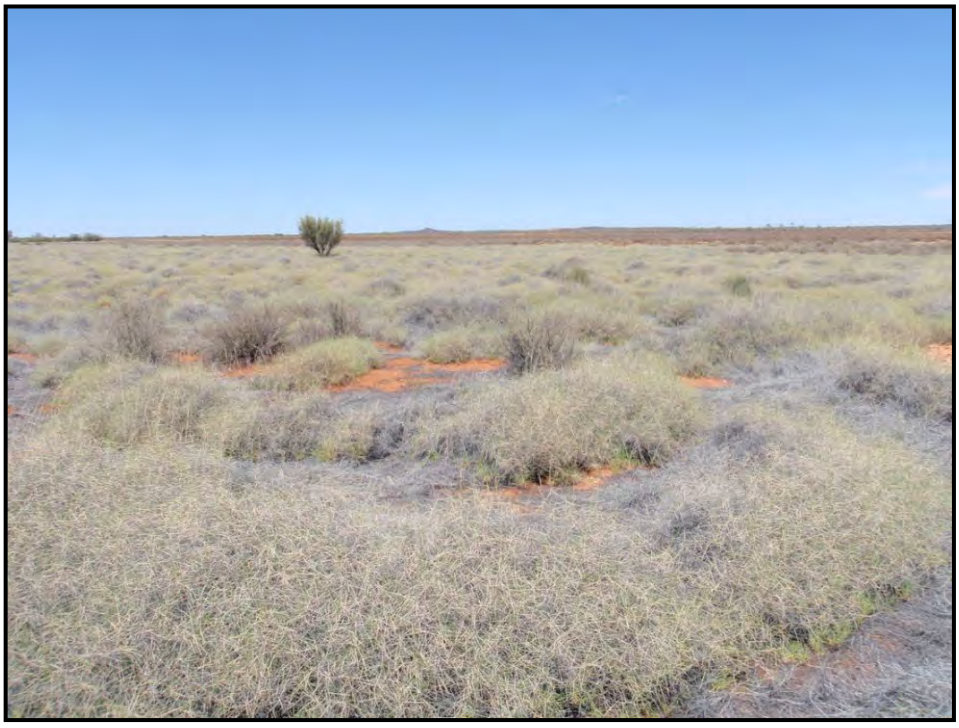

Plate 8: Lake Edge Spinifex

A Level 2 intensive trapping program has been previously undertaken in this habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant species were recorded from this habitat during the Level 2 assessment.

Habitat characteristics were as follows. Bare ground was typically 5% to 20%, live vegetation cover was typically 79% to 95%. No litter cover was present at this site. Cryptogamic crusts were present between the hummocks of Spinifex.

The low vegetation cover provided limited habitat potential for avian species, however the mature Spinifex would provide habitat for reptile and mammal species that use Spinifex for shelter. It is unlikely that this habitat is important for conservation significant species.

Claypan

The Claypan habitat is small and no direct impacts are expected to result from the development of either Infrastructure Areas A or B. Claypans are estimated to make up 3% of the Darlot land system and the Darlot land system is estimated to make up 1.3% of the Northeast Goldfields survey area (Pringle *et al*., 1994).

Plate 9: Claypan

This habitat was found to be important for water birds and may be utilised by migratory shorebirds. To assist in the conservation of migratory shorebirds, Australia has entered into three bilateral, international agreements: *Japan-Australia Migratory Bird Agreement* (JAMBA), *China-Australia Migratory Bird Agreement* (CAMBA) and the *Republic of Korea -Australia Migratory Bird Agreement* (ROKAMBA).

Migratory wading birds that may use the claypan habitat during periods of inundation include the Great Egret (*Ardea alba modesta*), Oriental Plover (*Charadrius veredus*) and Common Sandpiper (*Actitis hypoleucos*).

Avifauna censusing was undertaking at in this habitat however no conservation significant species or migratory species were found.

Kopi Dunes

The Kopi Dune habitat is uncommon in the landscape (1% of the Darlot land system [Pringle *et al*., 1994]) and tends to form on the leeward sides of salt lakes. The dunes are mainly encrusted gypsiferous sediments which support large *Eucalyptus* sp. and a sparse understory or *Lawrensia helmsii*. This habitat was found to occur within scattered locations within the Study area. Active searching, avian censusing and night searching) was undertaken during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). No conservation significant fauna were recorded from this habitat during the Level 2 assessment.

Plate 10: Kopi Dune

The hard substrate and the limited vegetation would tend to make this habitat unsuitable for many reptile and mammal species. The larger Eucalypts may be suitable for nesting and roosting by some avian species.

3.4.3 Targeted Survey Methods

Targeted searches were undertaken for vertebrate species of conservation significance that were identified from the desktop study as potentially occurring within the Study area. Targeted searches for conservation significant fauna were conducted using systematic searching, spotlighting or call playbacks (**Table 3**).

Table 3: Methods used to target conservation significant species

Group	Common Name	Scientific Name	Conservation status			Method		
			EPBC Act 1999	WC Act 1950	DEC Priority	Systematic Searching	Spotlighting	Call Playback
Mammals	Mulgara	*Dasycercus cristicauda*	VU	S1	-	X	X	-
	Greater Bilby	*Macrotis lagotis*	VU	S1	-	X	X	-
	Southern Marsupial Mole	*Notoryctes typhlops*	VU	S1	-	X	-	-
	Long-tailed Dunnart	*Sminthopsis longicaudata*	-	-	P4	X	-	-
Birds	Night Parrot	*Pezoporus occidentalis*	EN	S1	-	X	-	-
	Malleefowl	*Leipoa ocellata*	VU	S1	-	X	-	-
	Slender-billed Thornbill	*Acanthiza iredalei iredalei*	VU	-	-	X	-	X
	Princess Parrot	*Polytelis alexandrae*	VU	-	-	X	-	-
	Major Mitchell's Cockatoo	*Cacatua leadbeateri*	-	S4	-	X	-	-
	Peregrine Falcon	*Falco peregrinus*	-	S4	-	X	-	-
	Striated Grasswren	*Amytornis striatus striatus*	-	-	P4	X	-	-
	Australian Bustard	*Ardeotis australis*	-	-	P4	X	-	-
	Bush Stone-curlew	*Burhinus grallarius*	-	-	P4	X	X	X
	Grey Falcon	*Falco hypoleucos*	-	-	P4	X	-	-
	Scarlet-chested Parrot	*Neophema splendida*			P4	X		
	Barking Owl	*Ninox connivens connivens*			P2	X		X
	Masked Owl	*Tyto novaehollandiae*	-	-	P3	X	-	X
Reptiles	Woma	*Aspidites ramsayi*	-	S4	P1	X	X	-
	Yellow-bellied Black Snake	*Pseudechis butleri*			Regionally significant	X		
	Great Desert Skink	*Egernia kintorei*	VU	S1	-	X	-	-

Systematic targeted searches were undertaken in the Infrastructure Areas A and B (**Figure 7**). During these searches, all fauna habitats within the targeted area such as rock boulders, crevices, underneath Spinifex and vegetation, leaf litter, tree hollows and underneath bark were searched for evidence of fauna species.

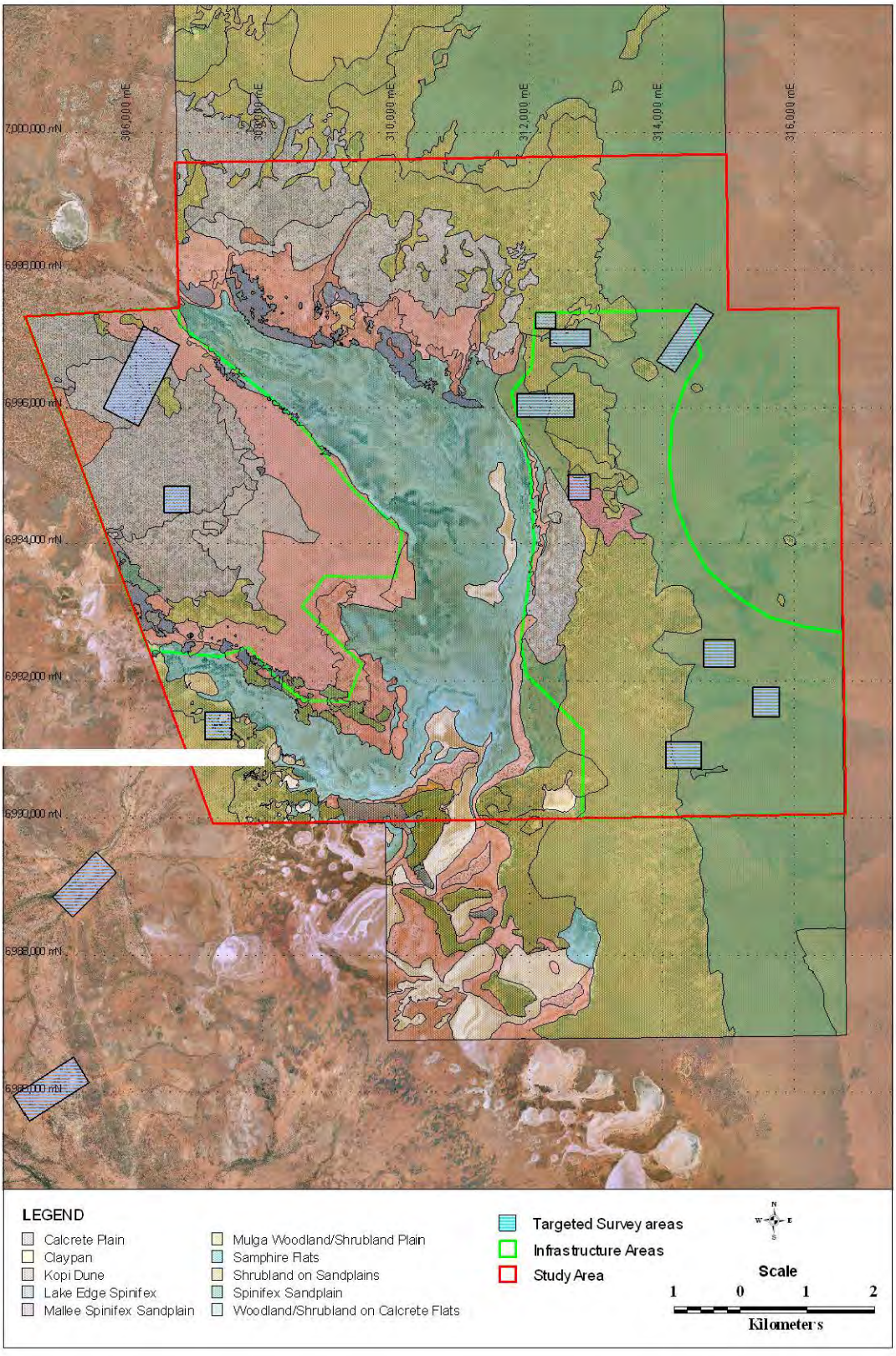

Figure 7: Targeted searches conducted in the Infrastructure areas A and B

Spotlighting

Spotlighting was undertaken over a period of two nights in selected habitats thought to be conducive to nocturnal species. A hand held spotlight and car headlights were used to target nocturnal species on the tracks and the habitat surrounding the tracks while driving between sites. Hand held portable spotlights were also used to perform targeted spotlighting in areas indicated in **Figure 8**. This technique was used to supplement the road spotlighting and locate additional nocturnal species which may not have been seen from the car.

Spotlighting was aimed at targeting nocturnally active species such as Bush Stone-curlew (*Burhinus grallarius*), owls, nightjars, frogs and nocturnal gecko species. Spotlighting was conducted for 660 minutes (three people) on the 18 October and for 340 minutes (two people) on 19 October in the Infrastructure Areas A and B.

In conjunction with spotlighting, 'call playback' was conducted at each site indicated in Figure 8 to target nocturnal bird species such as the Bush Stone-curlew, Masked Owl and the Barking Owl. Recorded bird calls were played at loud volume through speakers. A period of ten minutes silence was then undertaken to determine if any of these species were responding to the call play back. This procedure was repeated three times for each site.

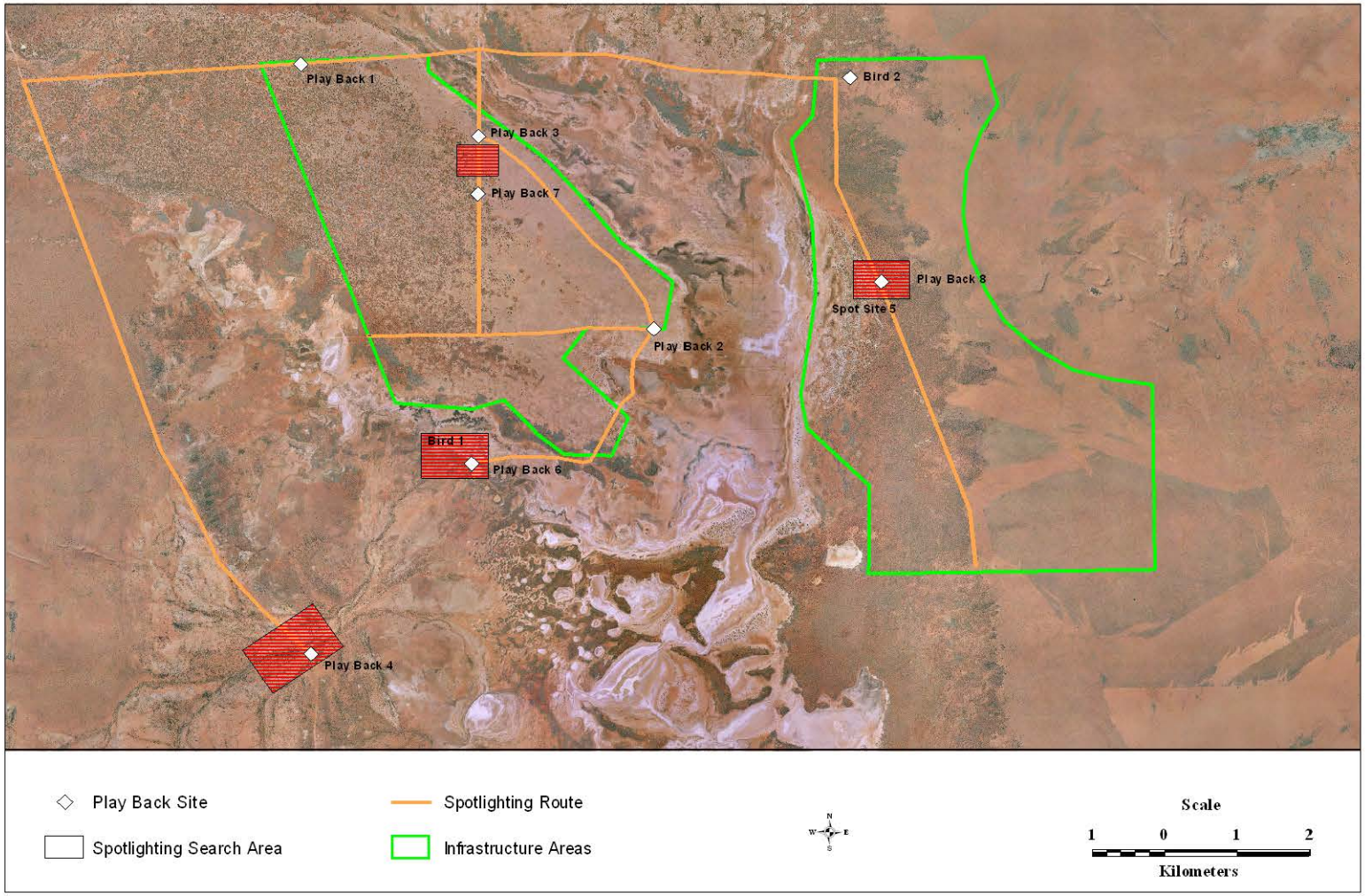

Figure 8: Spotlighting searches and call playback conducted at the Infrastructure Areas A and B

3.4.4 Terrestrial Invertebrate Habitat Assessment

SRE taxa are those with restricted distributional ranges (usually less than 10,000km2) and are generally characterised by poor dispersal, heavy reliance on discontinuous habitats, low growth rates, and low fecundity (Harvey 2002). As with many invertebrate species, SRE taxa are often poorly studied and the status of some species may be due to a lack of knowledge and documentation of their distribution, rather than true short-range endemism. Several common habitat factors are favoured by SRE invertebrates; primarily more mesic areas that offer protection from heat, desiccation and predators, and provide a source of moisture.

The following SRE invertebrate groups have the potential to occur within the region: Mygalomorph spiders; Pseudoscorpions, Terrestrial molluscs; Slaters, Scorpions; Millipedes and Schizomids.

Potential habitat for the above groups within the region is likely to be associated with:

- Sheltered Habitats and Microhabitats. SREs are most likely to be encountered in sheltered relatively mesic environments such as slopes with south-west facing aspects, rock piles and outcrops, drainage systems, deep gullies and other similar habitats (EPA, 2009).
- Isolated Habitats. Habitat isolates are more likely to support SREs than extensive swathes of continuous habitats. Examples of habitat isolates include exposed dolomites or calcretes, granite outcrops and the Banded Ironstone Formations (BIF) of the Mid-west and Goldfields (EPA, 2009).

SRE habitat assessments were conducted at the same sites as the vertebrate fauna habitat assessments. The SRE habitat assessments were conducted at each site to determine the quality and complexity of the habitat for each of the above listed invertebrate groups with a focus on the connectivity and extensiveness of the habitat within the landscape.

The SRE habitat assessment incorporated the following:

- A standardised Habitat Assessment Field Sheet was completed for each site;
- The assessment consisted of a set area of approximately 50 x 50 m; and
- Information recorded consisted of: landscape position, outcropping, soil type, broad vegetation type, litter cover, existing disturbance, physical connectivity and extensiveness within the landscape.

Of the habitats identified as occurring within the Study area, four met the criteria of potential SRE habitat on the basis of: Sheltered Habitats and Microhabitats or Isolated Habitats (**Error! Reference source not found.**).

Table 4: Potential SRE Habitats

Potential SRE Habitats	Potential to support SRE Species
Samphire Flats	Low
Lake Edge Spinifex	Low
Claypan	Low
Kopi Dune	Low

These broad habitat types are discussed below in relation to the potential occurrence of SRE species and are mapped in **Figure 9**.

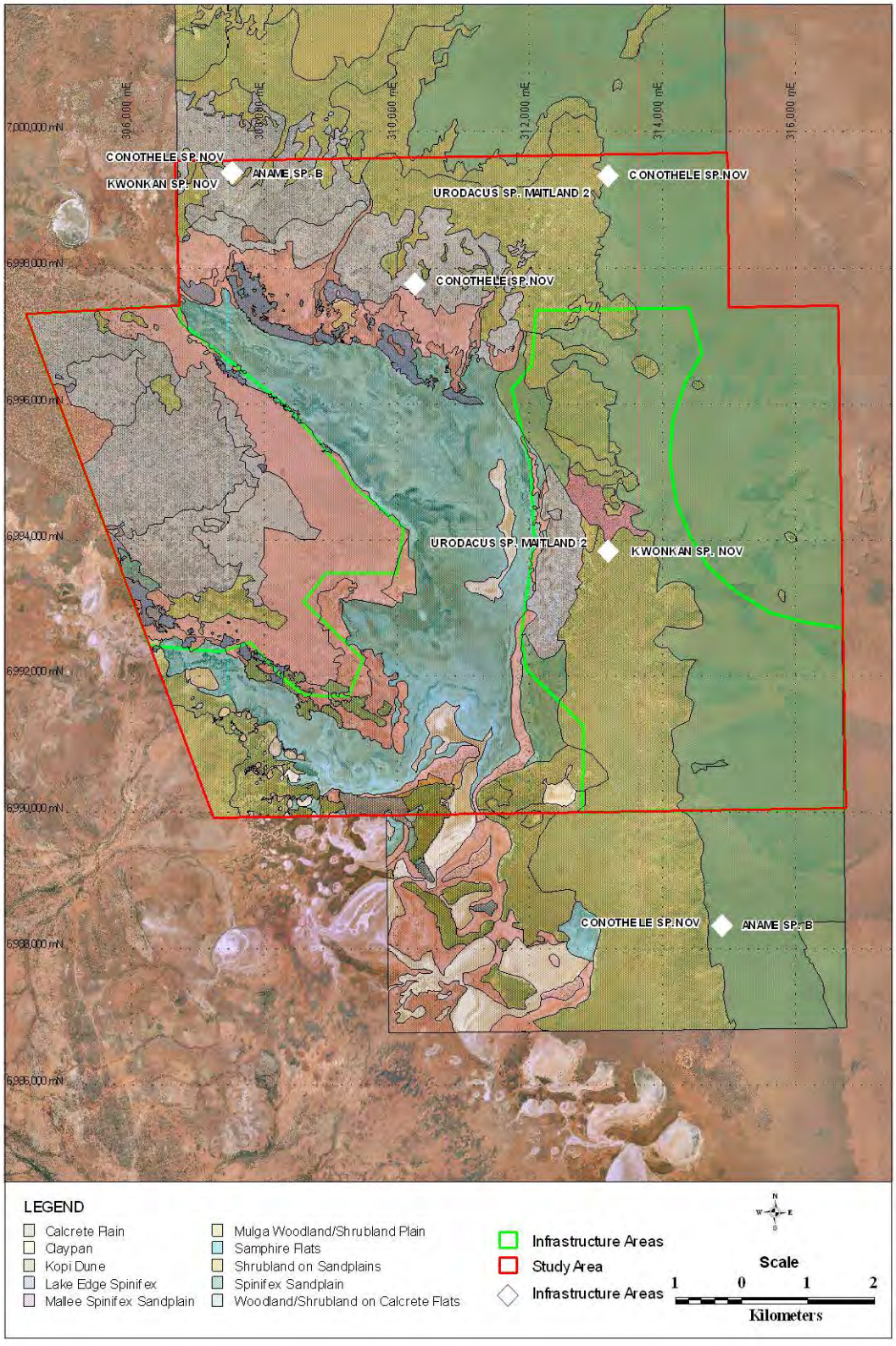

Figure 9: Habitat map showing the distribution of potential SRE habitat within and surrounding the Study area

Samphire Flats

The Samphire Flats habitat was considered to have a low potential to support SRE species. The Samphire Flats habitat occurs to the south of the proposed Infrastructure Area A. Terrestrial invertebrate communities have been shown to be associated with saline wetlands in the wheatbelt region of WA. These Samphire Flats habitats have been found to contain apparent SRE species (Durrant and Guthrie, 2004). However, soil sieving and a targeted search for SRE species that was conducted in the Samphire Flats habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys did not find any potential SRE invertebrate species (Outback Ecology 2008).

Lake Edge Spinifex

The Lake Edge Spinifex Habitat was considered to have a low potential to support SRE species. The Lake Edge Spinifex habitat is proposed to be intersected by proposed Infrastructure Area A. This habitat has potential to support SRE species on the basis that the habitat is restricted to the fringes of salt lakes and is therefore isolated from similar habitat on other salt lakes in the region. During the Lake Maitland Baseline Terrestrial Fauna Surveys, pit trapping and targeted searching was undertaken for SRE invertebrates within the Lake Edge Spinifex habitat and one possible SRE mygalomorph spider was collected (see Section 4.5.3). Lake Edge Spinifex was considered to have a low potential to support SRE species on the basis that it is dry and exposed and therefore does not offer the mesic qualities often attributed to SRE habitat.

Claypan

The Claypan habitat was considered to have a low potential to support SRE species. The Claypan habitat is unlikely to be directly impacted buy the proposed development. Indirect impacts associated with sedimentation and erosion may however occur. This habitat has potential to support SRE species on the basis they are typically isolated from other claypans. However, this habitat is considered unlikely to support terrestrial SRE species on the basis that it is devoid of vegetation and would typcally undergo periods of inundation for weeks or months at a time making it unsuitable for terrestrial SRE species.

Kopi Dunes

The Kopi Dune habitat occurs in the area south of the Study area. The Kopi Dunes have some potential to support SRE species on the basis that the dunes form a very distinct habitat that would be isolated from similar habitat at other salt lakes. However, because the dunes are so lacking in vegetation and appear to have very limited mesic qualities, it appears unlikely that the Kopi Dunes would support SRE species. Soil sieving and targeted searching for SRE species was conducted in the Kopi Dunes habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys and no SRE invertebrates were found (Outback Ecology 2008).

3.5 **Taxonomy and Nomenclature**

Nomenclature and taxonomy of all vertebrate fauna species follows that of the Western Australian Museum (WAM) provided in the *Checklist of the Vertebrates of Western Australia* for amphibians, reptiles and mammals (WAM, 2008). While, bird nomenclature and taxonomy follows the Birds Australia *Checklist of Australian Birds*, based on Christidis and Boles (2008). Common names for reptiles are consistent with Wilson and Swan (2008).

4. RESULTS AND DISCUSSION

4.1 Terrestrial Vertebrate Fauna Species

A total of 307 terrestrial vertebrate fauna species have the potential to occur within the Study area, comprising 43 mammal (32 native and 11 introduced), 168 bird, 87 native reptile and nine amphibian species. A summary of vertebrate fauna species previously recorded during terrestrial fauna surveys and database searches conducted over the Study area is presented in **Table 5**, with a complete list of species recorded presented in **Attachment B**.

Species lists of terrestrial fauna recorded, or potentially occurring, in the Study area are provided in the following sections. Lists have been prepared based on published information relevant to the area, and information obtained from database searches.

Table 5: Vertebrate fauna species richness recorded during previous studies and database searches within the Study area

Fauna	Previous Studies						Total Species Richness for Studies	Total Species Richness for Database Searches	Total
	Outback Ecology (2009)	*Outback Ecology* (2008)	*Outback Ecology* (2006)	*Halpern Glick Maunsell* (1997)	*Hall, McKenzie and Keighery* (1994)	*Ninox* (1993)			
Native Mammals	4	17	32	3	18	4	32	15	32
Native Birds	31	60	138	0	92	50	148	120	165
Reptiles	10	39	72	0	54	4	83	44	87
Amphibians	0	0	9	0	3	0	9	2	9
Introduced Fauna	5	7	14	1	8	5	14	5	14
Total Native Fauna	45	116	251	3	167	58	272	181	293
Total Fauna	50	123	265	4	175	63	286	186	307

4.1.1 Mammals

There are 47 mammal species known from the Murchison bioregion with 20 of these mammals now extinct (eg Lesser Stick-nest Rat, Short-tailed Hopping Mouse and Long-tailed Hopping Mouse) (ANRA, 2007). Although the Murchison bioregion has a low index of faunal attrition (loss of species richness) of 0.45 many species have declined in the bioregion (ANRA, 2007). The faunal contraction index (extent to which the range inhabited by a particular species has contracted) is 0.4. This suggests that many of the species comprising the Murchison bioregion's original mammal fauna have contracted from a high proportion of the regions they originally occurred in (ANRA, 2007).

A total of 43 mammals (32 native) have previously been recorded, or potentially occur, within or surrounding the Study area. All these species have the potential to occur within the Study area (**Attachment B**). A total of nine mammals (four native) were recorded during the reconnaissance survey by Outback Ecology (2009) (**Attachment B**).

4.1.2 Birds

A total of 168 birds (165 native) have previously been recorded, or potentially occur, within and surrounding the Study area. Some of these species would only be present irregularly, either as nomads or migrants occurring during their summer migration or during particular climatic conditions (**Attachment B**). A total of 31 native birds were recorded during the reconnaissance survey by Outback Ecology (2009) (**Attachment B**).

4.1.3 Reptiles

A total of 87 reptiles have previously been recorded, or potentially occur, within or surrounding the Study area. All of these species have the potential to occur within the Study area (**Attachment B**). A total of ten native reptiles were recorded during the reconnaissance survey by Outback Ecology (2009) (**Attachment B**).

4.1.4 Amphibians

Nine amphibians have previously been recorded, or potentially occur, within and surrounding the Study area. All of these species have the potential to occur within the Study area (**Attachment B**). No amphibians were recorded during the reconnaissance survey by Outback Ecology (2009) (**Attachment B**).

4.1.5 Introduced Vertebrate Fauna

Findings of the desktop study show that thirteen introduced species have the potential to occur within the Study area, namely the House Mouse, Fox, Dingo, Feral Cat, European Rabbit, Horse, Donkey, Dromedary Camel, Cattle, Goat, Sheep, Rock Dove, Spotted Turtle-dove and Laughing Turtle-dove.

4.2 Conservation Significant Species

This section provides a summary of the occurrence of conservation significant fauna species previously recorded or potentially occurring in the Study area. The locations of conservation significant species recorded at Lake Maitland are shown in **Figure 10**. This includes observations of the Rainbow Bee-eater

from the reconnaissance survey, and the location where Mulgara were trapped during both of the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology 2008). This figure excludes the Bush Stone-curlew which was heard while in the Samphire Flats habitat, as the location of the bird was not able to be defined due to it being some distance from the survey team (Outback Ecology 2008).

The conservation significance of terrestrial vertebrate fauna potentially occurring, within the Study area is described in the following sections, including:

- Threatened fauna species listed under the EPBC Act, and declared threatened fauna and other specially protected fauna listed under the WC Act (**Section *4.4.1***).
- Priority fauna recognised by the DEC (**Section *4.4.2***).
- Species not listed under any Acts, but considered of conservation significance due to patterns of distribution (for instance bioregional endemics - **Section *4.4.3***).
- Migratory species listed under the *EPBC Act* and international agreements which include the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals) (**Section *4.4.4***).

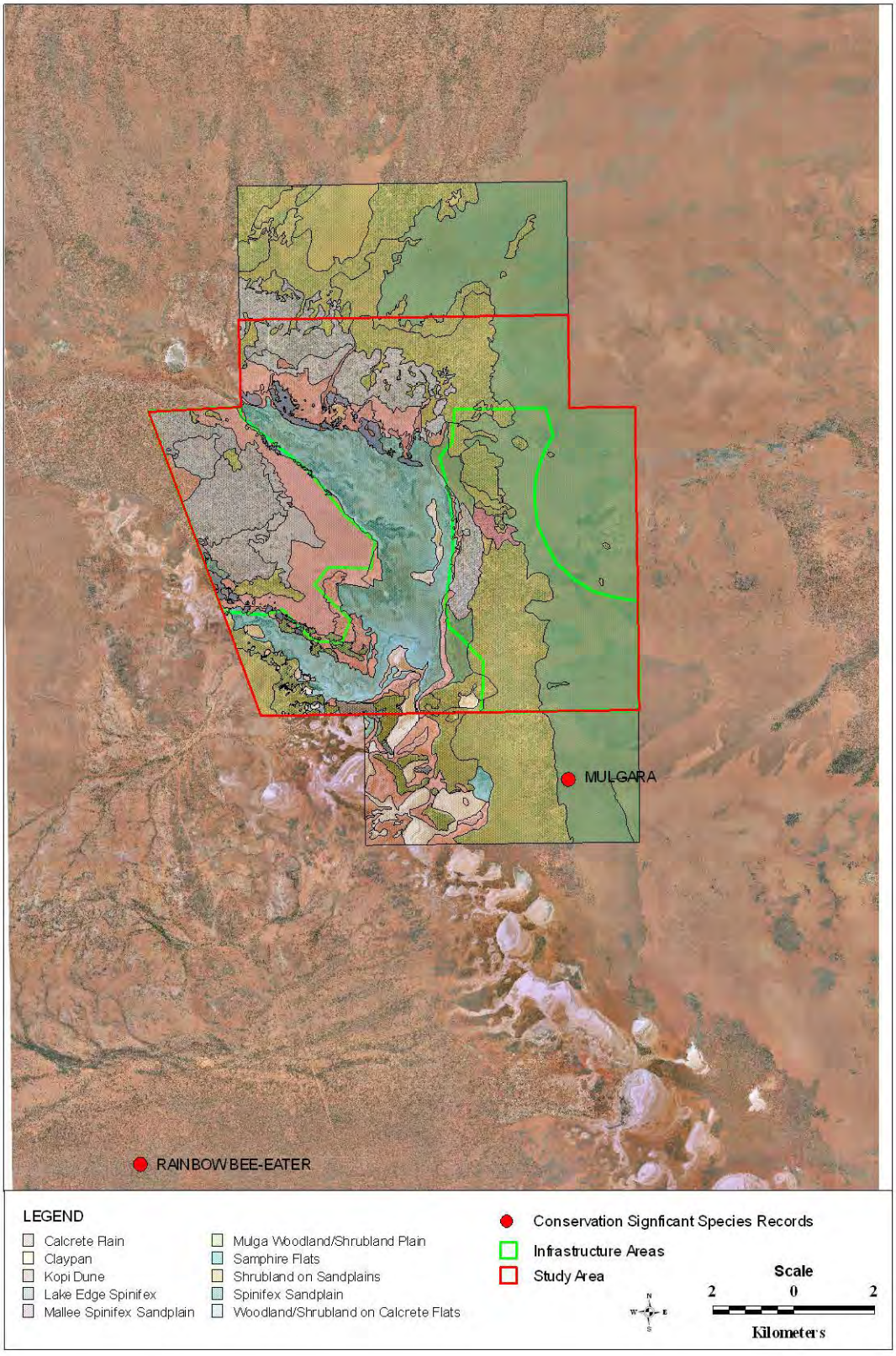

Figure 10: Conservation significant fauna species that have been recorded within the vicinity of the Study area (excluding the Bush-Stone-curlew)

4.2.1 Threatened Fauna Species

Rare fauna species threatened with extinction are formally recognised as having a high conservation value and are therefore protected by law under Commonwealth and State legislation. Rare fauna are protected at a Federal level under the EPBC Act and at the State level under the WC Act 1950. Definitions of Conservation Significance are outlined in (**Attachment C**). Five fauna species listed as threatened under the EPBC Act and/or the WC Act possibly occur over the Study area (**Table 6)** and are discussed below.

Table 6: Threatened species potentially occurring over the Study area

Scientific Name	Common Name	Conservation Status[1]		Record Source	
		EPBC Act	WC Act	Study	Database
Mammals					
Dasycercus cristicauda	Mulgara	VU	S1	BCD	GHKL
Birds					
Leipoa ocellata	Malleefowl	VU	S1	C	GHKL
Acanthiza iredalei iredalei	Slender-billed Thornbill	VU		C	KL
Cacatua leadbeateri	Major Mitchell's Cockatoo		S4	C	
Falco hypoleucos	Peregrine Falcon		S4	C	I

EPBC Act: EX Extinct, E Endangered, VU Vulnerable

WC Act: Schedule 1, S2, S3, S4

B Outback Ecology (2008). Lake Maitland Terrestrial Fauna Surveys.

C Outback Ecology (2006). Desktop Vertebrate Fauna assessment and reconnaissance Survey of the Venus Project.

D Halpern Glick Maunsell (1997). Barwidgee Pastoral Lease Mulgara *Dasycercus cristicauda* Survey.

G DEC (2009a). Threatened Species Search.

H DEC (2009b). NatureMap.

I Birds Australia (2009).

K DEWHA (2009a). Environmental Reporting Tool

L DEWHA (2009b). Protected Matters Report

- **Mulgara (*Dasycercus cristicauda*)**

This species inhabits sandplains dominated by *Triodia* spp. (Halpern Glick Maunsell, 1997). The Mulgara is infrequently recorded, in part due to boom-bust lifecycles, contracting to core habitat areas in lean times, and expanding rapidly after favourable conditions prevail (Gibson and McKenzie, 2005). The Bullimore Land System which is made up of sandplains frequently dominated by Spinifex was identified as potentially encompassing core habitat for the Mulgara (Halpern Glick Maunsell, 1997).

Mulgara have been trapped on three occasions within the Spinifex Sandplains habitat (**Figure 10**) 1.6 km south of the Infrastructure Area B (within Mega Uranium's tenements) during 2007 (Outback Ecology, 2008). The Mulgara has also been previously recorded within the Barwidgee Pastoral Lease in 1997 (Halpern Glick Maunsell, 1997 and DEC, 2009a) which overlies Mega Uranium's Lake Maitland tenements. The Mulgara has also been found at the Wanjarri Nature Reserve (approximately 40 km west of the Study area) in 1996 (DEC, 2009a and CALM, 1996), Barwidgee Pastoral Lease in 1998, Mt. Keith in 1997

(approximately 15 km north of the Study area), Mount Keith mine site in 1998 (approximately 15 km north of the Study area), the Sir Samuel Study area in 2004 (approximately 40 km south-west of this Study area), Honeymoon Well in 2006 and 2007 (approximately 70 km northwest of the Study area), and Wiluna in 2007 (approximately 104 km north-west of the Study area) (DEC, 2009a).

Although no conclusive evidence of Mulgara presence was recorded during this survey of the Study area, the close proximity of the area to the previous records of occurrence (Outback Ecology, 2008) suggests that the Mulgara is likely to occur in unburned sections of the Spinifex Sandplans habitat which occurs within the Infrastructure Area B.

- **Malleefowl (*Leipoa ocellata*)**

The Malleefowl is a large ground-dwelling bird that builds large and distinctive mounds of soil and litter within which its eggs are incubated. Malleefowl distribution is fragmented and scattered through semi-arid rangelands and the eastern Wheatbelt of south-western Australia (Garnett and Crowley, 2000). The known distribution of the Malleefowl occurs over the Study area (Blakers *et al*. 1984; Barrett *et al*. 2003; Marchant and Higgins, 1993). Primary habitat consists of Mallee eucalypt woodlands and shrublands as well as dry forests dominated by other eucalypts and woodlands (Garnett and Crowley, 2000).

Tracks of the Mallefowl have been found at the Wanjarri Nature Reserve (located approximately 40 km west of the Study area) in 1997 (DEC, 2009a). This species has also been sighted at Mount Keith (1998) and Yandal Station in 2001 (located approximately 15 km north of the Study area (DEC, 2009a).

Although no evidence of Malleefowl was found during targeted searches during this assessment or during the previous surveys of Lake Maitland, this species potentially occurs over wooded areas within the Study area.

- **Slender-billed Thornbill (*Acanthiza iredalei iredalei*)**

The Slender-billed Thornbill's habitat is saltbush communities and samphire flats associated with salt lake systems. Suitable habitat occurs over the Study area and, although targeted searches failed to record this speciesthe presence of suitable habitat suggests this species has potential to occur. Although listed by the Commonwealth, as well as in South Australia and the Northern Territory, this species is not listed under WA legislation. It is thought that populations in northern South Australia and east of the Flinders Ranges, and possibly those that occur north-west of Lake Gairdner, are most likely to be in decline (DEWHA, 2009a). This species potentially occurs in suitable saltbush and samphire habitat found in the Study area.

- **Major Mitchell's Cockatoo (*Cacatua leadbeateri*)**

This species is listed on Schedule 1 under the *WC Act*. The Major Mitchell Cockatoo's distribution is both widespread and disjunct in arid and semi-arid zones (Johnstone and Storr, 1998). The Study area lies outside the species distribution as identified by Johnstone and Storr (1998). However it is possible that this species occurs in the area intermittently.

- **Peregrine Falcon (*Falco peregrinus*)**

The Peregrine Falcon is an uncommon species found throughout Australia and Tasmania (Pizzey and Knight 2007). This species inhabits cliffs, along coast lines, rivers and ranges, wooded water courses, wetlands and lakes (Johnstone and Storr, 1998). There is a Birds Australia listing of the Peregrine Falcon occurring within 75 km of the Study area (Birds Australia, 2009). This species may overfly the Study area from time to time, however is unlikely to rely on habitat within the Study area.

4.2.2 Threatened Fauna Considered Unlikely to Occur within the Study Area

From the database searches and literature reviews a number of threatened fauna have historically been recorded as occurring within the vicinity of the Study area. Those species whose habitats are not considered to occur in or adjacent to the Study area, together with those species now considered extinct within the region are considered unlikely to occur over the Study area. Therefore threatened fauna species that are considered unlikely to occur over the Study Area are listed in **Table 7**.

Table 7: Threatened fauna species considered unlikely to occur over the Study area

Scientific Name	Common Name	Conservation Status[1]	
		EPBC Act	WC Act
Mammals			
Macrotis lagotis	Greater Bilby	VU	S1
Notoryctes typhlops	Southern Marsupial Mole	EN	S1
Birds			
Pzoporus occidentalis	Night Parrot	EN	S1
Polytelis alexandrae	Princess Parrot	VU	
Reptiles			
Egernia kintorei	Great Desert Skink	VU	S1

EPBC Act: EX Extinct, E Endangered, VU Vulnerable WC Act: Schedule 1, S2, S3, S4

- **Greater Bilby (*Macrotis lagotis)***

This species is listed as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC Act*. Once found throughout arid and semi-arid regions of Australia, the Greater Bilby now remains patchily distributed in isolated populations throughout the Tanami Desert, Broome, Warburton, south-west Queensland, NSW and north-east of Alice Springs (Menkhorst and Knight, 2004). The Greater Bilby occupy a range of inland habitats including grasslands, cracking clays, desert sand plains, dunefields, hummock grassland and massive red earths with *Acacia* shrublands (Van Dyck and Strahan, 2008). The Greater Bilby is considered to no longer occur in the Eastern Murchison subregion (ANRA, 2007).

- **Southern Marsupial Mole (*Notoryctes typholops*)**

This species is listed as Endangered under the *EPBC Act* and Schedule 1 under the *WC Act.* The Southern Marsupial Mole occupies arid areas to the east of the Study area, living underground in sand dunes, inter-dunal flats and sandy soils along river flats (Van Dyck and Strahan, 2008). The Southern

Marsupial Mole is unlikely to occur over the Study area because the area is outside of its known distribution and because there is a lack of suitable habitat.

- **Night Parrot (*Pzoporus occidentalis*)**

The Endangered Night Parrot is extremely rare and only sporadic records exist. Although it has been associated with hummock grasslands in the past, particularly dense clumps of mature Spinifex, its preferred habitat may be samphire flats and saltbush associated with salt lake systems (Blakers *et al.* 1984), or a juxtaposition of mature Spinifex and chenopod (saltbush) habitats (FMG, 2005 and DEC, 2009c). Although these habitats occur over the Study area, most of the recent records for this species are from the Pilbara (DEC, 2009c). The species is not expected to occur in the Study area.

- **Princess Parrot (*Polytelis alexandrae*)**

This species is listed as Vulnerable under the *EPBC Act*. The Princess Parrot is an inhabitant of the arid interior of Australia in lightly wooded habitats, particularly dunal areas of deserts from the Great Sandy Desert through the Gibson Desert and into the Great Victoria Desert (Johnstone and Storr, 1998). This species is unlikely to occur over the Study area due to the lack of suitable habitat and because the Study area is outside its known primary range.

- **Great Desert Skink (*Egernia kintorei)***

This species is listed as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC Act*. The Great Desert Skink occurs on red sandplains and sand ridges supporting Spinifex (Wilson and Swan, 2008). The current distribution of the Great Desert Skink consists of seven isolated populations in Australia. Three of these populations occur in the eastern interior of Western Australia in the Gibson and Great Sandy Desert regions approximately 1200 km north of Kalgoorlie at Patjarr, Lake Mackay and Rudall River National Park (SPRAT, 2008 and Pearson *et al*, 2001). The Great Desert Skink was caught in the Wanjarri Reserve in 1964 (DEC, 2009a). However it is unlikely that the Great Desert Skink would occur over the Study area as the species' current contracted core distribution is a substantial distance from the Study area.

4.2.3 Priority Fauna Species

DEC recognises species not listed under the WC Act but for which there is some concern, and has produced a supplementary list of 'Priority' fauna. Definitions of Priority fauna are listed in **Attachment C**.

There are four priority fauna species that have the potential to occur over the Study area: the Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*), the Grey Falcon (*Falco hypoleucos*) and the Striated Grasswren (*Acanthiza iredalei iredalei*) (**Table 8**), and these are discussed below.

Table 8: Priority species possibly occurring over the Study area

Scientific Name	Common Name	Conservation Status[1]		Record Source	
		EPBC Act	Priority	Study	Database
Birds					
Ardeotis australis	Australian Bustard		P4	CEF	GHI
Burhinus grallarius	Bush Stone-curlew		P4	BCF	GI
Falco hypoleucos	Grey Falcon		P4	C	
Acanthiza iredalei iredalei	Striated Grasswren		P4	C	GH

DEC Priority Species List: Priority 1, P1,P2,P3, P4

B Outback Ecology (2008). Lake Maitland Terrestrial Fauna Surveys.

C Outback Ecology (2006). Desktop Vertebrate Fauna assessment and reconnaissance Survey of the Venus Project.

E Ninox (1993). Vertebrate Fauna Assessment of the proposed Bronzewing Gold Project.

G DEC (2009a). Threatened Species Search.

H DEC (2009b). NatureMap.

I Birds Australia (2009).

- **Australian Bustard (*Ardeotis australis*)**

The Australian Bustard inhabits open dry woodlands of Mulga, arid shrublands and tussock grasslands supporting Spinifex species (Johnstone and Storr 1998; Morcombe 2003) along with grasslands and drainage areas particularly after a series of years of above average rainfall (Johnstone and Storr, 2004). This species was recorded in 1993 at Bronzewing Mine Site located approximately 30 km south of the Study area (Ninox, 1993) and during a biological survey of the Eastern Goldfields (Hall *et al,* 1994). Other sightings include, Lake Violet in 1974 (located approximately 97 north-west of the Study area), and Wanjarri Reserve in 1983, 1985 and 1987 (DEC, 2009a). This species potentially occurs within the above-mentioned habitats present in the Study area.

- **Bush Stone-curlew (*Burhinus grallarius*)**

The Bush Stone-curlew is a ground-nesting bird that is known to be predated by foxes (Johnstone and Storr 2004). The species is found in open woodlands of Mallee and Mulga, grasslands and sandplains supporting Spinifex (Pizzey and Knight, 2007; Johnstone and Storr, 1998). This species was recorded within the Samphire Flats habitat during the Lake Maitland Baseline Terrestrial Fauna Surveys (Outback Ecology, 2008). This species has also been recorded at Mt Keith in 1985 and within the Sir Samuel Study area in 1998 (DEC, 2009a, Hall *et al*., 1994). This species potentially occurs within the above mentioned habitats present in the Study area.

- **Grey Falcon (*Falco hypoleucos)***

The Grey Falcon occurs primarily in the northern half of Australia inhabiting open woodland areas on coastal and riverine plains in the arid and semi-arid interior of the country (Johnstone and Storr, 1998; Morcombe, 2003). Suitable nesting habitat for this species exists within the Study area and therefore this species potentially occurs over the Study area.

- **Striated Grasswren (*Amytornis striatus striatus*)**

The Striated Grasswren is found over a variety of habitats including Spinifex communities, with or without an overstorey of shrubs, on sandy or loamy plains and *Acacia* shrublands. The species once occurred in the vicinity of the Study area and two relatively old records from 1979 and 1987 are contained within the Threatened and Priority Fauna Database from Wanjarri Nature Reserve 40 km west of the Study area (DEC, 2009a and **Attachment D**). It now occurs as scattered but widespread populations in the Gibson Desert and Little Sandy Desert (Higgins, *et al* 2001). Suitable habitat is present in the Study area, and therefore this species potentially occurs.

There are six Priority fauna species that are considered unlikely to occur over the Study area (**Table 9**), and these are discussed below.

Table 9: Priority fauna species considered unlikely to occur over the Study area

Scientific Name	Common Name	Priority Status
Mammals		
Sminthopsis longicaudata	Long-tailed Dunnart	P4
Birds		
Polytelis alexandrae	Princess Parrot	P4
Neophema splendida	Scarlet-chested Parrot	P4
Ninox connivens connivens	Barking Owl	P2
Tyto novaehollandiae	Masked Owl	P3
Reptiles		
Aspidites ramsayi	Woma	P1

- **Long-tailed Dunnart (*Sminthopsis longicaudata)***

The Long-tailed Dunnart (*Sminthopsis longicaudata*) has been collected intermittently in various locations, primarily to the north of the Study area (DEC, 2009c). It occurs in rocky habitats (Strahan, 2005) and may be rarely captured due to the difficulties of installing pit traps in these areas. Suitable habitat does not occur over the Study area, therefore this species is unlikely to occur here.

- **Princess Parrot (*Polytelis alexandrae*)**

The Princess Parrot is discussed previously in **Section 4.4.1**

- **Scarlet-chested Parrot (*Neophema splendida*)**

The Scarlet-chested Parrot occurs over open *Eucalyptus* woodland in the Great Victorian Desert. (Johnstone and Storr, 1998). The town of Laverton is located on the western extreme of its distribution (Johnstone and Storr, 1998). As the Study area is located approximately 230 km north-west of Laverton it is unlikely this species will occur.

- **Barking Owl (*Ninox connivens connivens*)**

The Barking Owl prefers dry sclerophyll woodlands associated with riparian vegetation in the south-west and on the forest edges in the south-east (Johnstone and Storr, 1998). Based on available information and known records the Barking Owl is considered unlikely to occur within the Study area as the area is outside its usual range.

- **Masked Owl (*Tyto novaehollandiae)***

The Masked Owl in WA is primarily found in the south-west. However, scattered records have been made in the arid zone including at Yandal Station (Higgins, 1999), as well as unconfirmed sightings from Wanjarri Nature Reserve (Higgins, 1999). The veracity of records have been compromised due to confusion with the more common Barn Owl *(Tyto alba*). There appears to be limited suitable nesting habitat for the Masked Owl within the Study area. Although this species may forage in the Study area from time to time, it is unlikely to be reliant on habitat within the area as extensive areas of similar habitat occur in the surrounds.

- **Woma (*Aspidites ramsayi*)**

The Woma python occurs throughout arid zones of Australia with a disjunct south-west population in Western Australia that is now rare (and may be taxonomically differentiated from the desert 'form'). In the south-west it appears to favour sandplain habitats (Storr *et al.* 2002), though few records exist. The Study area is situated outside of the northern limit of the south-west distribution and it is unlikely that this species occurs.

4.2.4 Locally and Regionally Significant Species

Other species of conservational significance include endemics, those with restricted or fragmented ranges, or those that are at the extremes limits of their known distribution.

- **Yellow-bellied Black Snake (*Pseudechis butleri*)**

The only vertebrate fauna species known to be endemic to the Eastern Murchison subregion is the Yellow-bellied Black Snake (Cowan, 2001). The Yellow-bellied Black Snake is found in Mulga woodlands and shrublands (Wilson and Swan, 2008). The Study area is well within this species known range (DEC, 2009c).

4.2.5 Migratory Bird Species

Migratory species is a term used to depict species that migrate to areas outside Australia for part of the year (eg. waders/shorebirds that breed/nest within the Northern Hemisphere). The annual migration of shorebirds to Australia is a significant event which occurs around August to September each year. Migratory shorebirds from the East-Asian Australasian Flyway make their way towards the south coast of Western Australia in search of foraging grounds, before heading through to New Zealand and Antarctica.

To assist in the conservation of migratory shorebirds, Australia has entered into three bilateral, international agreements: *Japan-Australia Migratory Bird Agreement* (JAMBA), *China-Australia Migratory Bird*

Agreement (CAMBA) and the *Republic of Korea -Australia Migratory Bird Agreement* (ROKAMBA). These treaties ensure that each country commits to conservation measures that will protect bird species migrating between the countries. Migratory shorebirds are also listed under the EPBC Act 1999 and the *Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals)*.

Five migratory bird species potentially occur in the Study area and surrounds (**Table 10**). Many of these species may occur irregularly or on an annual basis during their summer migration to Western Australia.

Table 10: Migratory Species potentially occurring over the Study area

Scientific Name	Common Name	Conservation Significance		Source
		Migratory Agreements and Conventions)	Federal (EPBC Act) Listing	
Apus pacificus pacificus	Fork-tailed Swift	JAMBA/CAMBA/ROKAMBA	M	CKL
Merops ornatus	Rainbow Bee-eater		M	ACIKL
Ardea alba	Great Egret		M	KL
Charadrius veredus	Oriental Plover	JAMBA/ROKAMBA and Bonn	M	KL
Actitis hypoleucos	Common Sandpiper	JAMBA/CAMBA/ROKAMBA and Bonn	M	F

M Migratory

A Outback Ecology (2009). Current Study.

C Outback Ecology (2006). Desktop Vertebrate Fauna assessment and reconnaissance Survey of the Venus Project.

I Birds Australia (2009).

F Hall, N. J./ McKenzie, N. L. and Keighery, G. J. (eds). (1994). The Biological survey of the Eastern Goldfields of Western Australia. Part 10. Sandstone - Sir Samuel and Laverton - Leonora Study areas.

K DEWHA (2009a). Environmental Reporting Tool

L DEWHA (2009b). Protected Matters Report

- **Fork-tailed *Swift (Apus pacificus)***

The Fork-tailed Swift is a nomadic species that may be seen before and after storm fronts or tropical cyclonic events that are associated with an increase in insect activity which the species feeds on (Johnstone and Storr, 2004). This species may overfly the Study area from time to time, but is unlikely to be dependant upon habitats within the study area.

- **Rainbow Bee-eater *(Merops ornatus***

The Rainbow Bee-eater occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Morcombe, 2003). This species will occupy drainage lines and riverine areas (Johnstone and Storr 1998). There is a Birds Australia listing of the Rainbow Bee-eater occurring over the Study area surrounds (Birds

Australia, 2009). The Rainbow Bee-eater was recorded within the Study area in the Mulga Spinifex Sandplain habitat.

- **Great Egret (*Ardea alba modesta*)**

This species is associated with inland rivers and lakes that contain surface water. This species is highly mobile and can be found throughout most of the western fringes of the State in coastal areas and towards the semi-arid interior (Johnstone and Storr, 1998). This species may overfly the Study area from time to time and small groups may utilise the Claypan habitat adjacent the Infrastructure areas.

- **Oriental Plover (*Charadrius veredus*)**

This species favours dry grasslands, particularly shorter grassland areas or recently burnt areas, rarely feeding in wet habitats but may occupy mudflats or beaches to roost when warm conditions prevail (Geering *et al*., 2007). This species may overfly the Study area from time to time and small groups may utilise the Claypan found adjacent the Infrastructure areas.

- **Common Sandpiper (*Actitis hypoleucos*)**

The Common Sandpiper breeds over most of Eurasia then migrates to Africa, south Asia, New Guinea, Australia and occasionally New Zealand. The flyway population of this species is estimated to be 25,000-100,000 with the Australian population estimate of 3,000 (Geering *et al.* 2007). The Common Sandpiper is frequently found on rocky creeks, channels, dams, waterways in mangroves or saltmarsh, intertidal mudflats and rocky or sandy beaches around coastal Australia (Geering *et al.* 2007). This species may overfly the Study area from time to time and small groups may utilise the Claypan found adjacent the Infrastructure areas.

4.3 Terrestrial Short Range Endemic Invertebrate Fauna

4.3.1 Short-range Endemism

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale (Allen *et al*. 2002). Short-range endemic (SRE) species have restricted distributional ranges, usually less than 10,000 km^2 and are generally characterised by poor dispersal, heavy reliance on discontinuous habitats, low growth rates, and low fecundity (Harvey 2002).

A number of invertebrate groups have been identified as containing SRE species, such as mygalomorph spiders (Mygalomorphae), pseudoscorpions (Pseudoscorpionida), scorpions (Scorpionida), millipedes (Myriapods), slaters (Isopoda), schizomids (Schizomida) and terrestrial molluscs (Gastropoda) (Harvey, 2002; EPA, 2009).

In WA, it is postulated that many terrestrial SRE invertebrate fauna species have Gondwana origins and are relics of previously widespread species common to the southern hemisphere continents (Gondwanaland) during the Mesozoic and early Tertiary periods. The fragmentation, drifting apart and aridification of the continents has resulted in many species having restricted ranges dependant upon particular habitat requirements (EPA, 2009; Main, 1999, 1976; Harvey, 2002).

A species' endemism is shaped by a range of factors such as climate variation, ecological specificity (e.g. habitat preference and physiology), life history attributes (e.g. reproductive strategies and dispersal capabilities), geological history and abiotic and biotic interactions (Ponder and Colgan, 2002; Main, 1982).

4.3.2 SRE Invertebrate Groups

Considering the existing environment within the Study area **(Section 2)** and the results of the database and literature review **(Section 3.1 – 3.3),** the following invertebrate groups which are prone to short-range endemism have potential to occur within the Study area:

- Mygalomorph Spiders (Mygalomorphae);
- Pseudoscorpions (Pseudoscorpionida);
- Scorpions (Scorpionida);
- Millipedes (Myriopods);
- Slaters (Isopoda);
- Schizomids (Schizomida); and
- Terrestrial Molluscs (Gastropoda).

These groups are discussed below.

Mygalomorph Spiders
Phylum ***ARTHROPODA***
Class **ARACHNIDA**
Order **ARANEAE**
Sub-order **MYGALOMORPHA**

Harvey (2002) indicates that many mygalomorph spiders exhibit patterns of short-range endemism. Mygalomorph spiders comprise of the trapdoor and funnel web spiders and are represented in Western Australia by eight families (Main, 2005). A large proportion of Mygalomorph Spider species are unnamed (Main, 2002).

In arid and semi-arid areas, mygalomorph spiders have been known to dig deep burrows [up to 60 centimetres (cm) deep] (Brunet, 1996), and feed at night when the temperature is lower and humidity is higher (Main, 1982). Nest micro-climate (e.g. soil moisture and temperature) is an important factor in mygalomorph spider burrow suitability (after Main, 1982). Most mygalomorph spiders are sedentary and tend to live their entire lives within a single burrow (Main, 1982). Mygalomorph spiders are unlikely to establish new burrows, in the event their burrows are removed (Main, 2002).

Mygalomorph spiders are sexually dimorphic, and as such both male and females are usually needed for specific identifications (Main, 2002; Framenau and Yoo, 2006). Mature males may abandon the burrow when finding a mate, and can be caught in pitfall traps at these times (Main, 1982).

Pseudoscorpions

Phylum ***ARTHROPODA***

Class **ARACHNIDA**

Order **PSEUDOSCORPIONES**

The Pseudoscorpion Order is likely to contain SRE taxa (EPA, 2009). Pseudoscorpions inhabit leaf litter and under rocks and the bark of trees (Harvey and Yen, 1989). Similarly to scorpions, all pseudoscorpions are predators and feed on small invertebrates (Harvey and Yen, 1989) and are generally only active during the night or in dark places during the day (Australian Museum, 2008).

In some species of pseudoscorpion, it is common for individuals to cling to larger animals (usually insects), resulting in the pseudoscorpion being transported across distances (Harvey and Yen, 1989). The sexes are separate in pseudoscorpions (Harvey and Yen, 1989).

Scorpions

Phylum **ARTHROPODA**

Class **ARACHNIDA**

Order **SCORPIONES**

Scorpions are found all over Australia and inhabit under rocks and logs, in burrows and few inhabit under the bark of trees, especially eucalypts (Harvey and Yen, 1989). Scorpions are predators and feed on beetles, millipedes and spiders (Harvey and Yen, 1989). Scorpions are generally only active during the night or in dark places during the day (Australian Museum, 2008). Scorpions are typically solitary and the sexes are separate (Australian Museum, 2008; Harvey and Yen, 1989). Females give birth to live young (Harvey and Yen, 1989).

Although many scorpions have adaptations to live in arid conditions, there are some scorpions that are dependant upon conditions that are more humid and sheltered (Ruppert & Barnes, 1994) and it is these species that have the highest potential to be SRE species.

Millipedes

Phylum **ARTHROPODA**

Class **DIPLOPODA**

Order **CHORDEUMATIDA, POLYDESMIDA**

Harvey (2002) indicates that many millipedes from the order Chordeumatida are short-range endemics (after Shear and Mesibov, 1997). Most millipedes are detritivores (Sierwald and Bond, 2007), obtaining nutrients from consumption of decomposing organic matter. Millipedes are susceptible to desiccation, their movement tends to be limited and they are unlikely to be transported by larger animals (Sierwald and Bond, 2007).

Slaters

Phylum **ARTHROPODA**

Class **MALACOSTRACA**

Order **ISOPODA**

Slaters are terrestrial isopods that belong to the suborder Oniscoidea, which are considered likely to contain SRE taxa (EPA, 2009). They generally live beneath stones, bark and leaf litter across a variety of climates from the tropics through to deserts (Ruppert & Barnes, 1994). This group of arthropods tend to possess fewer adaptations to reduce water loss in comparison to other terrestrial arthropods (Ruppert & Barnes, 1994). This subsequently implies that slaters tend to be dependant on more moist and sheltered conditions.

Schizomids

Phylum ***ARTHROPODA***

Class **ARACHNIDA**

Order **SCHIZOMIDA**

Schizomids are small arachnids mostly less than 3 mm in length (Ruppert & Barnes 1994). They use only six legs for walking and the front two legs serve as sensory organs (Ruppert & Barnes 1994). Schizomids feed on other invertebrates which are dissected with robust chelicerae (Harvey, 1988). They tend to inhabit leaf litter, wood, beneath stones and in soil where they can avoid desiccation (Harvey, 1988). They tend to be dependant on more moist and sheltered conditions with some species having adapted to subterranean environments.

Terrestrial Molluscs

Phylum **MOLLUSCA**

Class **GASTROPODA**

Order **ARCHAEOGASTROPODA, SORBEOCONCHA, EUPULMONATA, STYLOMMATOPHORA**

Harvey (2002) indicates that many snails of the order Archaeogastropoda are short-range endemics. Numerous snails from the orders Sorbeoconcha and Eupulmonata are also short-range endemics (after Ponder, et. al., 1993 and Miller, et. al., 1999).

Snails of the order Archaeogastropoda are herbivorous and can be found amongst leaf litter, rocks or in trees (Harvey and Yen, 1989). The sexes are separate in the order Archaeogastropoda (Harvey and Yen, 1989).

Land snails prefer moist habitats, though some species of order Archaeogastropoda are found in areas that are only occasionally moist (Harvey and Yen, 1989). Land snails require a source of calcium for shell construction, usually sourced from soil or rock (Slack-Smith, 2002).

4.3.3 Potential occurrence of SREs within the Study area

The Lake Maitland Baseline Terrestrial Fauna Surveys conducted in May and December 2007 included surveying for terrestrial SRE invertebrates. Of the specimens collected, there were six species (four mygalomorph spiders and two scorpions) where identifications were not conclusive due to either a lack of taxonomic knowledge or a lack of knowledge regarding the distribution of the species. These species are therefore considered as possible SRE species for the purposes of this assessment and are discussed below in relation to habitat **(Table 11),** habitat mapping **(Figure 11; Section 3.4.2)** and in relation to potential SRE habitats **(Section 3.4.4).**

In addition, the other SRE invertebrate groups mentioned in Section 4.5.2 that were not recorded during the Lake Maitland Baseline Surveys are discussed below in relation to their potential to occur in the habitats identified and discussed in **Section 3.4.4.**

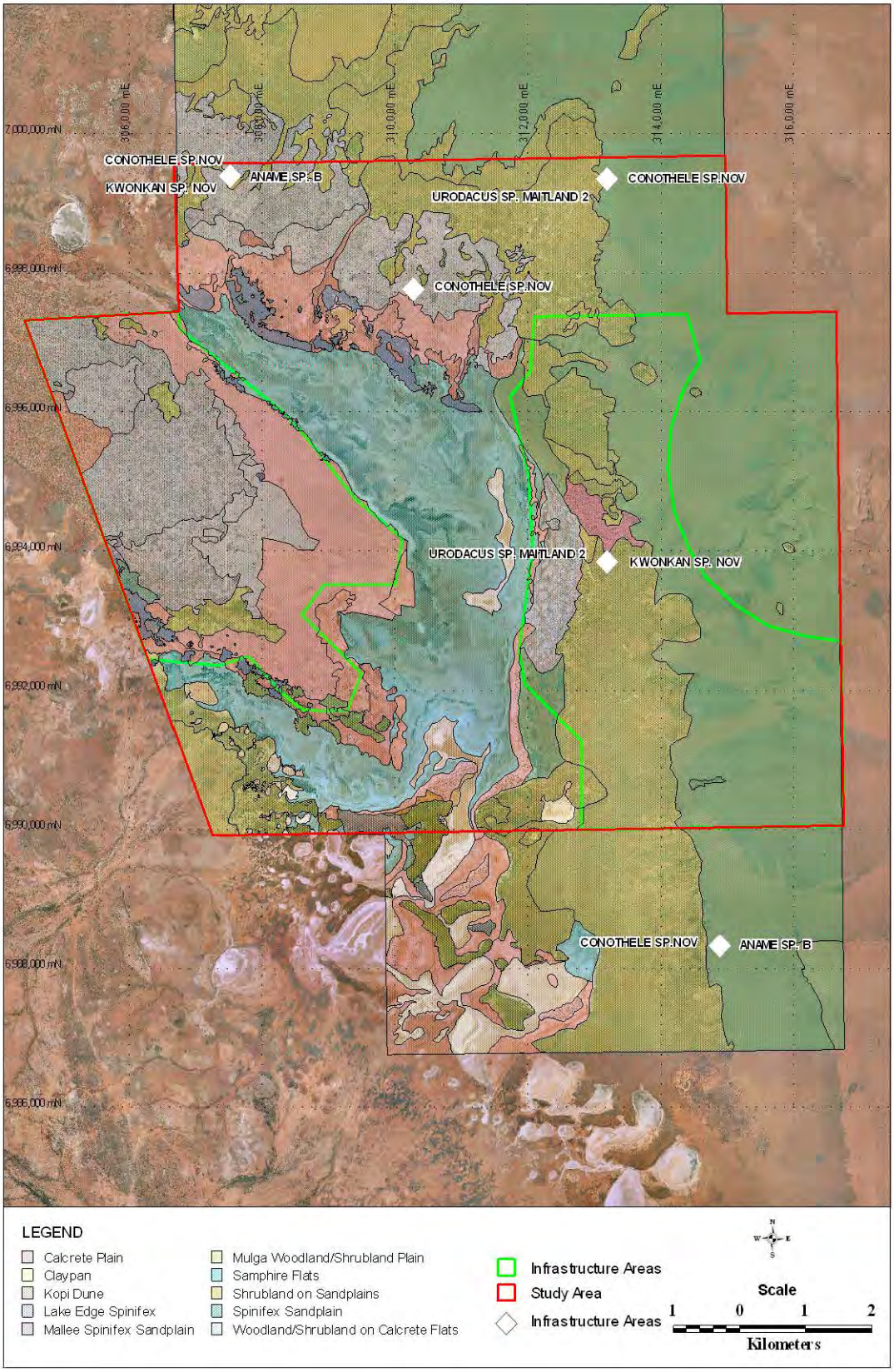

Figure 11: Occurrence of potential SRE species within and surrounding the Study area

Table 11: Potential SRE Species recorded at Lake Maitland and Associated Habitats

Habitat Types	Potential SRE Species					
	Conothele sp. nov	*Aname* sp. B	*Kwonkan* sp. nov A & B	*Cethegus* sp. nov	*Urodacus* sp. maitland 1	*Urodacus* sp. maitland 2
Spinifex Sandplain	**X**	**X**				
Mulga Woodland/Shrubland Plain	**X**				**X**	**X**
Mallee Spinifex Sandplain			**X**			**X**
Lake Edge Spinifex				**X**		
Woodland/Shrubland on Calcrete Flats		**X**	**X**	**X**		

Mygalomorph Spiders

Seven identifiable species of mygalomorph spider were collected during the Lake Maitland Baseline Terrestrial Fauna Surveys. Of these, two species were known to have a wide distribution: *Selenocosmia sterlingi* and *Gaius villosus*. Another species *Aname* sp A is suspected to belong to the "armigera" species group which is considered to be generally widespread in semi arid regions (male specimens would be required for confirmation) (Main 2008).

The other four species of mygalomorph spider have been considered as possible SRE species because there is either a lack of knowledge regarding their distribution or because a review of the genera is required (Main 2008). These species are discussed below:

Conothele sp. nov

This mygalomorph spider was identified by Main (2008) as a possible SRE species because there was a lack of knowledge regarding its distribution. Specimens were collected from two habitats: Spinifex Sandplains and the Mulga Woodland/Shrubland Plain (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Spinifex Sandplain habitat is extensive to the east of Lake Maitland both within and outside the Infrastructure Area B. Habitat mapping also indicates that the Mulga Woodand/Shrubland Plain occurs as a north south band within the Infrastructure Area B and to the south west of Lake Maitland.

This species is not restricted to one habitat and neither of the habitats appear to be likely SRE habitats **(Section 3.4.4).** Additionally, since both habitats in which this species occurs are extensive outside the Study area, it appears unlikely that *Conothele* sp. nov will be substantially impacted by proposed developments in the Study area.

Aname sp. B

This mygalomorph spider has been considered as a possible SRE species because of a lack of knowledge regarding the species and its distribution (Main 2008). Specimens were collected from two habitats: Spinifex Sandplains and Woodland/Shrubland on Calcrete Flats (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Spinifex Sandplain habitat is extensive to the east of Lake Maitland both within and outside the Infrastructure Area B. The Woodland/Shrubland on Calcrete Flats appears to be relatively common to the west and north of Lake Maitland and makes up approximately 33 % of infrastructure Area A.

This species is not restricted to one habitat and neither of the habitats appear to be suitable SRE habitats **(Section 3.4.4**). Additionally, since both habitats in which this species occurs are extensive outside the Study area, it appears unlikely that *Aname* sp. B will be substantially impacted by developments within the Study area.

Kwonkan sp. nov

The mygalomorph spider specimens identified as *Kwonkan* sp. nov A and *Kwonkan* sp. nov B are probably the same species (Main 2008) and have been considered as the same species within this report. Main (2008) reports that it is likely that this species has a restricted distribution in the area surveyed. The specimens were collected from two habitats: Mallee Spinifex Sandplain and Woodland/Shrubland on Calcrete Flats (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Mallee Spinifex Sandplain habitat occurs over a small central area of approximately 6% within the Infrastructure Area B and appears to be relatively uncommon in the landscape. The Woodland/Shrubland on Calcrete Flats appears to be relatively common to the west and north of Lake Maitland and makes up approximately 33% of infrastructure Area A.

Since this species is not restricted to one habitat and since neither of these habitats are likely to be SRE habitats **(Section 3.4.4),** it appears unlikely that *Kwonkan* sp. nov will be substantially impacted by developments within the Study area.

Cethegus sp. nov

It is uncertain whether this species of mygalomorph spider is a SRE due to a lack of male specimens (Main 2008). Specimens of this species were collected from two habitats: Lake Edge Spinifex Habitat and Woodland/Shrubland on Calcrete Flats (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Lake Edge Spinifex Habitat is somewhat restricted in its distribution as it forms a band between the Samphire habitat and the calcrete habitats (Woodland/Shrubland on Calcrete and Calcrete Plains). The Woodland/Shrubland on Calcrete Flats appears to be relatively common to the west and north of Lake Maitland and makes up approximately 33 % of infrastructure Area A. The Lake Edge Spinifex has been raised as a potential SRE habitat because of it restricted distribution **(Section 3.4.4)** however, it is unlikely to be suitable SRE habitat because it lacks mesic qualities that are considered important.

Since this species is not restricted to one habitat and since the Woodland/Shrubland on Calcrete Flats habitat is extensive outside the Study area, it appears unlikely that *Cethegus* sp. nov will be substantially impacted by proposed developments in the Study area.

One mygalomorph spider was identified as potentially occurring in the Study area as a result of the DEC database search. The species *Kwonkan moriartii* is listed at Priority 2 and was collected from Kathleen Valley, approximately 65 km southwest of the Study area in 1962. *Kwonkan moriartii* was not recorded during the Lake Maitland Baseline Terrestrial Fauna Surveys and appears unlikely to occur in the Study area since there are no other records of this species except the type specimen

Mygalomorph spiders have been found to inhabit a variety of habitats within the vicinity of Lake Maitland, however none were found to be restricted to a single habitat and only one species (*Cethegus* sp. nov) was found to occur in a potential SRE habitat (Lake Edge Spinifex) as identified in **Section 3.4.4.** In general, the Lake Edge Spinifex habitat was considered to have a low potential to support SRE species as the habitat appears to be too dry and exposed to support species with restricted habitat requirements.

Pseudoscorpions

During the baseline terrestrial fauna survey the only pseudoscorpion species collected was *Indolpium* sp.. This species is not considered to be an SRE (Mark Harvey pers. comm., 2008). Specimens of this species were collected from two habitats: Lake Edge Spinifex and Woodland/Shrubland on Calcrete Flats.

Of the potential SRE habitats **(Section 3.4.4),** the Drainage Line habitat provides the highest potential to support pseudoscorpions. This is because the Drainage Line habitat tends to concentrate water which often supports Mulga *(Acacia aneura)* groves. These groves contribute leaf litter which in turn decomposes and supports invertebrates which could be preyed upon by pseudoscorpions.

Scorpions

During the baseline terrestrial fauna survey five scorpion species were collected. Three of these species: *Lychas 'adonis'*, *L. annulatus* and *Urodacus yaschenkoi,* were considered to be common and widely distributed (Harvey pers. comm., 2008). The species *Urodacus* sp. maitland 1 and *Urodacus* sp. maitland 2 were considered possible SRE species since the genus contained numerous unnamed species with variable morphologies (Harvey pers. Comm., 2008).

Urodacus sp. maitland 1

Two specimens of this species were collected from the Mulga Woodland/Shrubland Plain (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Mulga Woodland/Shrubland Plain habitat occurs as a north south band within the Infrastructure Area B and to the South-West of Lake Maitland.

Since the Mulga Woodland/Shrubland Plain habitat does not appear to be a potential SRE habitat **(Section 3.4.4)** and since this species is likely to have a range in association with this habitat which is extensive

outside the Study area, it appears unlikely that *Urodacus* sp. maitland 1 will be substantially impacted by developments within the Study area.

Urodacus sp. maitland 2

Two specimens of this species were collected from the Mulga Woodland/Shrubland Plain and the Mallee Spinifex Sandplain habitats (**Figure 11; Table 11**). Habitat mapping (**Figure 6**) indicates that the Mulga Woodland/Shrubland Plain habitat occurs as a north south band within the Infrastructure Area B and to the south west of Lake Maitland. The Mallee Spinifex Sandplain habitat occurs over a small central area of approximately 6% within the Infrastructure Area B and appears to be relatively uncommon in the landscape.

This species is not restricted to one habitat and neither of the habitats appear to be SRE habitats **(Section 3.4.4).** Additionally, since both habitats in which this species occurs are extensive outside the Study area, it appears unlikely that *Urodacus* sp. maitland 2 will be substantially impacted by proposed developments in the Study area.

Of the potential SRE habitats **(Section 3.4.4),** the Drainage Line habitat provides the highest potential to support scorpions. This is because the Drainage Line habitat tends to concentrate water which often supports Mulga *(Acacia aneura)* groves. These groves contribute leaf litter which in turn decomposes and supports invertebrates which are preyed upon by scorpions. Additionally, the claylaom substrate provides suitable substrate for burrowing by scorpions with scorpion burrows being recorded during the habitat assessment.

Millipedes

No millipedes were recorded during the baseline terrestrial fauna survey.

Although Drainage Lines tend to have higher levels of leaf litter than the surrounding landscape, the high susceptibility of millipedes to desiccation means that it is unlikely that this habitat has conditions that have enough moisture or shelter to support millipedes. Other potential SRE habitats identified in **Section 3.4.4** are not likely to be suitable habitat for millipedes.

Slaters

Slaters were not collected during the baseline fauna survey.

Of the potential SRE habitats **(Section 3.4.4),** the Drainage Line habitat provides the highest potential to support slaters. This is because the Drainage Line habitat tends to concentrate water which often supports Mulga *(Acacia aneura)* groves. These groves contribute leaf litter which in turn decomposes and supports detritivores such as slaters.

Schizomids

Schizomids were not collected during the baseline fauna survey.

Of the potential SRE habitats **(Section 3.4.4**), the Drainage Line habitat provides the highest potential to support schizomids. This is because the Drainage Line habitat tends to concentrate water which often supports Mulga *(Acacia aneura)* groves. These groves tend to be cooler than the surrounds and contribute leaf litter which in turn decomposes and supports invertebrates which are preyed upon by schizomids.

Terrestrial Molluscs

During the baseline terrestrial fauna survey two species of terrestrial mollusc were collected. *Pupoides adelaidae* was collected from the Mallee Spinifex Sandplain, Lake Edge Spinifex and Woodland/Shrubland on Calcrete Flats habitat types. *Pupoides myoporinae* was collected from the Woodland/Shrubland on Calcrete Flats and the Kopi Dune habitats. Both species of terrestrial snail have wide geographic ranges (Slack-Smith 2008).

Although some species of snail inhabit very dry habitats (such as those recorded during the baseline fauna survey), those with potential to have restricted ranges are likely to inhabit more moist and protected habitats. Drainage Lines offer some potential for snails to result in restricted distributions due to the presence of leaf litter and comparatively more moist conditions.

4.4 Limitations and Constraints

A number of factors can influence the design and intensity of a fauna survey. The EPA (2004) lists possible limitations and constraints that can impinge on the adequacy of fauna surveys. These are assessed in (**Table 12**) in relation to this vertebrate fauna survey. All fauna surveys are limited to some degree by time and seasonal factors and in an ideal situation several surveys would be undertaken over a number of years encompassing different seasons. Nevertheless, all the factors identified by the EPA (2004) were considered.

Table 12: Summary of potential fauna survey constraints

Aspect	Constraint	Comment Regarding This Survey
Competency/experience of consultants	No	Members of the survey team were fauna specialists employed by Outback Ecology and have many years experience undertaking fauna surveys of this kind in WA.
Scope	No	All broad vertebrate and SRE habitats were assessed using standardised assessment sheets.
Proportion of fauna identified	No	Further survey work is likely to increase the number of species recorded since this was only a Level 1 assessment. However, previous survey work in the area has resulted in a substantial knowledge base appropriate for a Level 1 survey to be applied in this situation.

Aspect	Constraint	Comment Regarding This Survey
Information sources (e.g. historic or recent)	No	Relatively well surveyed region- predominantly regional surveys and those undertaken for mining operations. Recent surveys have been undertaken in close proximity to the Study area.
Proportion of task achieved, and further work which might be needed	No	All components of the Level 1 survey were completed including a high number of habitat assessments as well as targeted searching and spotlighting.
Timing / weather / season / cycle	No	No rainfall occurred during the survey and the weather was warm and which is optimal for reptile and mammal activity as well as clear warm nights.
Disturbances	No	Trapping did not occur so this was not a major concern. Disturbance in the Study areas at the time of the survey was minimal.
Intensity	No	A high number of 69 habitat assessments were completed over the Study area. In addition, targeted sampling was undertaken using spotlighting and call playback and Avifauna censusing. This is adequate intensity given the requirements of a Level 1 Survey.
Completeness	No	Survey was complete. All major habitats with potential to be impacted by the proposed developments were assessed for their potential to support vertebrate and SRE invertebrate fauna species.
Resources	No	Resources were adequate to carry out the survey satisfactorily. The two participants were competent in identification habitat likely to support vertebrate and invertebrate species as well as species encountered during the survey.
Remoteness / access problems	No	Access was very good throughout the Study area.
Availability of contextual information	No	Information is available for the IBRA subregion including, NatureMap, DEC lists, National Land and Water Resources Audit, as well as regional fauna surveys.

5. POTENTIAL IMPACTS

This section assesses the potential impacts of the Infrastructure Areas A and B on terrestrial fauna. Generally, potential impacts are associated with:

- habitat removal/modification (**Section 5.1**);
- noise (**Section 5.3**);
- light (**Section 5.4**);
- introduced flora (**Section 5.5**); and
- introduced fauna (**Section 5.6**).

5.1 Habitat Removal/Modification

The proposed Infrastructure area development would result in the removal of habitat via land clearance resulting in increased edge effects and fauna habitat fragmentation. The following broad habitat types may be disturbed as a result of the proposed project:

- Mulga Woodland/Shrubland Plain;
- Calcrete Plain;
- Woodland/Shrubland on Calcrete Flats;
- Shrubland on Sandplain;
- Spinifex Sandplain;
- Mallee Spinifex Sandplain;
- Samphire Flats;
- Lake Edge Spinifex;
- Claypan; and
- Kopi Dune.

Most of these habitats are widely represented throughout the Murchison region (ANRA, 2007) with the possible exceptions:

- Lake Edge Spinifex;
- Claypan; and
- Kopi Dune.

Additionally, some of these habitats deserve special attention in regards to the type of impact which has potential to occur such as within the Spinifex Sandplain habitat:

Lake Edge Spinifex

This habitat is an uncommon habitat in the vicinity of Lake Maitland and is separated from similar habitat along other salt lake systems. The area of this habitat that is likely to be cleared is a small percentage of the overall area of this habitat which fringes Lake Maitland.

Claypan

The claypan is unlikely to be directly impacted by the proposed development of the Infrasturcture areas. However indirect impacts associated with sedimentation may impact this habitat. During periods of inundation, the claypan has the potential to be utilised by small groups of migratory wading birds. Construction activities associated with the Infrastructure areas with uncontrolled erosion and sedimentation would have a substantial impact on this habitat.

Kopi Dune

The Kopi Dune habitat is uncommon in the landscape, however it is unlikely to be impacted by proposed developments as it occurs at the peripheral edges of the Study area.

Spinifex Sandplain

The Spinifex Sandplains are extensive to the east of Lake Maitland however they have been severely impacted by broad scale fires. Since this habitat tends to highly flammable and since the threatened Mulgara has been recorded in this habitat at Lake Maitland **(Section 5.6),** it is important to minimise the risk of large scale fires where possible.

Land clearance of any habitat may result in the direct loss of individuals through clearance activities, the most likely species at risk are those which inhabit subterranean habitats (e.g. fossorial reptiles and mygalomorph spiders) or have low mobility (e.g. small reptiles and many ground dwelling invertebrates). Nesting birds and their young may also be directly impacted, although this potential impact can be reduced by considering the timing of clearance activities. Mobile fauna able to avoid direct impact will be displaced into the surrounding habitat.

Excessive creation of dust has the potential to affect vegetation and alter fauna habitats. Dust suppression methods would help to reduce the impacts of dust on vegetation and fauna habitats.

5.2 Fauna and Noise

Development within the Study area is likely to generate constant noise due to machinery, heavy and light vehicles and the presence of people. The effects of noise on wildlife have been well studied, although responses vary depending on the species and on the age and sex of the individual animal [see Radle (2007) for a comprehensive summary].

General responses to noise across a wide variety of animal species range from interruptions in feeding and resting behaviour to complete abandonment of an area. Noise may lead to reduced population densities in small mammals, nest failure in birds and abandoning of roost sites and a reduced hunting efficiency in bats due to disturbance of their echolocation system. Constant levels of noise also interfere with species communication. Species which may be especially at risk of disturbed communication are those that use calls to communicate over larger distances such as the Bush Stone-curlew, which is listed Priority 4.

It is advisable to keep noise to a minimum during night-time hours to reduce its impact on faunal communities. Additionally, noise attenuation devices (mufflers) are recommended to be fitted to all vehicles to minimise noise during diurnal activities.

5.3 Fauna and Light

Development within the Study area is likely to result in an increase in exposure of fauna to artificial light. Artificial light from the Project area may have detrimental effects on resident bird, mammal and reptile species, as it may interfere with biological and behavioural activities that are governed by the length of day or photoperiod, including reproduction, dormancy, foraging and migration (Bradshaw and Holzapfel, 2007, Corre *et al.*, 2002). Bird *et al*. (2004) found that nocturnal mice exposed to artificial light exploited fewer food patches compared to mice exposed to areas of less light, while nocturnal frogs exposed to artificial light have been known to suspend normal feeding and reproductive behaviour (Harder, 2002).

Excessive light is likely to have an adverse effect on the natural foraging behaviour of bats which are attracted to artificial light sources. To reduce the impact of artificial light on faunal communities particularly during night-time hours, lights should be designed to illuminate designated areas such as roads, rather than poorly designed lights that illuminate the night sky.

5.4 Fauna and Introduced Flora

Environmental weeds may be brought in by mobile mining equipment. These can have a negative impact on fauna species as they alter the composition of vegetation communities and their associated faunal habitat value. It is therefore important to implement management strategies to reduce the occurrence and spread of weeds during mining operations.

5.5 Introduced Fauna

Thirteen introduced species have the potential to occur within the Study area, namely the House Mouse, Fox, Dingo, Feral Cat, European Rabbit, Horse, Donkey, Dromedary Camel, Cattle, Goat, Sheep, Rock Dove, Spotted Turtle-dove and Laughing Turtle-dove.

Predation of native fauna by the Feral Cat is listed as key threatening process under the EPBC Act. Developments at the mine site may attract more individuals of the feral animals previously recorded, and attract additional feral animals that have not been previously recorded. Management measures to prevent and control the increase of feral species numbers and the attraction of any new feral species include proper hygiene practices, appropriate disposal of wastes and control programs.

5.6 Conservation Significant Species

The occurrence of conservation significant species within the Study area is discussed in **Section 4.3**. The likely impacts within the Study area from a local and regional perspective on conservation significant species are detailed below.

- **Mulgara (*Dasycercus cristicauda*)**

The Mulgara is likely to occur in the Spinifex Sandplains habitat and has been recorded within close proximity of the Infrastructure Area B. Although this habitat is very common in the landscape, Spinifex communities of the appropriate structure, and at the appropriate pyric successional sequence, are required to support Mulgara. Spinifex communities are prone to inappropriate fire management, and in particular frequent broadscale fires are recognised as a current threatening process for the Mulgara (ANRA 2007). Much of the Spinifex Sandplans habitat to the east of Lake Maitland has been burned and large portions are mostly void of vegetation.

Although clearing is likely to impact only a small percentage of the Spinifex Sandplains habitat, continued inappropriate fire management is likely to impact large areas of this habitat and may result in the loss of the local Mulgara population. Additionally, feral predators (foxes and cats) have been recognised as a threatening process for the Mulgara (ANRA 2007) and any increases in feral predators may increase pressure on the existing population.

- **Malleefowl (*Leipoa ocellata*)**

Although no Malleefowl were found during targeted searches at Lake Maitland, there is potential for this species to occur over wooded areas within and surrounding the Study area. The primary wooded habitats within the Study area are: Mulga Woodland/Shrubland Plain, Woodland/Shrubland on Calcrete Flats, Mulga Spinifex Sandplain and Mallee Spinifex Sandplain. The Mulga Woodlands/Shrublands Plain and Woodland/Shrubland on Calcrete Flats are well represented across the Murchison and are relatively well represented within the Study area. The other wooded habitats occur in separate areas within Study area.

Since the potential for this species to occur is relatively low and since similar habitat exists in the surrounding area, it appears unlikely that the Malleefowl will be impacted by proposed development within the Study area. However, in the unikely event that mounds are found in proximity to the Project area, they should not be disturbed and should be flagged and coordinates recorded for future monitoring. If Malleefowl are found to occur near areas of vehicle operation e.g haul roads, then appropriate signage may help to reduce potential mortalities.

- **Slender-billed Thornbill (*Acanthiza iredalei iredalei*)**

The Slender-billed Thornbill potentially occurs in saltbush communities and Samphire Flats associated with salt lake systems. The Samphire Flat habitat mainly occurs between Infrastructure areas Areas A and B, and within a small section of the Infrastructure Area B. These habitats are found scattered throughout the Murchison.

A small section of this habitat occurs in the northern end of the Infrastructure Area B which constitutes only a small portion of this habitat in the vicinity of Lake Maitland. Given the small area of this habitat within the Study area, it appears unlikely the Slender-billed Thornbill will be significantly impacted by developments within the Study area.

- **Major Mitchell's Cockatoo (*Cacatua leadbeateri*)**

The Major Mitchell's Cockatoo potentially occurs in Woodland/Shrubland on Calcrete Flats and Mallee Spinifex Sandplains habitats. The Woodlands/Shrublands on Calcrete Flats occurs both within and to the northwest of the Infrastructure Area A and the Mallee Spinifex habitat occurs in a small section of the Infrastructure Area B. Given the small area of the Mallee Spinifex habitat and the extensive occurrence of the Woodlands/Shrublands on Calcrete Flats inside and outside the Infrastructure Area A, it appears unlikely that the Major Mitchell's Cockatoo will be significantly impacted by proposed developments within the Study area. However disturbance to mature *Eucalyptus* trees with hollows should be avoided where possible.

- **Peregrine Falcon (*Falco peregrinus*)**

The Peregrine Falcon may potentially overfly the Study area from time to time, however is unlikely to rely on habitat within the Study area.

- **Australian Bustard (*Ardeotis australis*)**

The Australian Bustard potentially occurs over open dry woodlands of Mulga, arid shrublands and tussock grasslands supporting Spinifex species along with grasslands and drainage areas, within the Study area. This species is unlikely to be dependant on the Study area for survival due to their high mobility, their wide distribution and the availability of similar habitat in close proximity to the site.

- **Bush Stone-curlew (*Burhinus grallarius*)**

The Bush Stone-curlew has been recorded at Lake Maitland (Outback Ecology 2009), Mt Keith and within the Sir Samuel Study area (Hall *et al*. 1994). The species is found in open woodlands of Mallee and Mulga, dry water courses, grasslands and sandplains supporting Spinifex (Pizzey and Knight 2007; Johnstone and Storr 1998). Although this species has been previously recorded at Lake Maitland, this species is unlikely to be dependant on the Study area for survival due to their high mobility, their wide distribution and the availability of similar habitat in close proximity to the site.

- **Grey Falcon (*Falco hypoleucos)***

The Grey Falcon prefers to nest in *Eucalypt* woodlands on drainage lines (Prizzey and Knight 2007) and therefore potential habitat may occur along the Mallee Spinifex Sandplain habitat within the Study area. However, very few eucalypts occur within this habitat and this habitat makes up a very small portion of the Study area. Given the small area of habitat and that it is not particularly suitable for nesting by this species; it appears unlikely that the Grey Falcon would be significantly impacted by proposed developments within the Study area.

- **Striated Grasswren (*Amytornis striatus striatus*)**

The Striated Grasswren has been recorded at the Wanjarri Reserve 40 km west of the Study area in 1979 and 1987. This species is found over a variety of habitats including Spinifex communities, with or without an overstorey of shrubs, on sandy or loamy plains and *Acacia* shrublands. Spinifex communities occur in the Infrastructure Area B, however they have been repetitively burned by inappropriate fire regimes.

Acacia shrublands are extensive inside and surrounding the Study area. If this species does still occur in the area, it is unlikely to be dependant upon the habitats that occur only within the Study area and is therefore unlikely to be substantially impacted by proposed developments within the Study area.

- **Fork-tailed *Swift (Apus pacificus)***

The Fork-tailed Swift may overfly the Study area from time to time without specifically utilising the habitats present. This species is unlikely to be affected by developments within the Study area due to its highly mobile nature.

- **Rainbow Bee-eater *(Merops ornatus)***

The Rainbow Bee-eater was recorded to the south of the Study area. This species is known to inhabit a variety of habitats which typically include lightly wooded areas preferably near water (Johnstone and Storr, 1998). With respect to the Study area, this would include the Mallee Spinfex Sandplain habitats. Only a small section of the Mallee Spinfex Sandplain habitat is likely to be impacted by either of the proposed Infrastructure area options. Additionally, the Rainbow Bee-eater is likely to utilise other habitats in the surrounding area and is therefore unlikely to be substantially impacted by proposed developments in the Study area.

- **Great Egret (*Ardea alba modesta*)**

This species is associated with inland rivers and lakes that contain surface water. This species may overfly the Study area from time to time and small groups may utilise the Claypans found near the Infrastructure areas. Therefore indirect disturbance from erosion and sedimentation to the Claypan habitats has the potential to impact individuals or small groups of this species. Groundwater drawdown and dewatering may affect the natural availability of surface water to this species. Additionally, artificial water supplies such as the TSF may attract this species and appropriate deterrent devices should be used where required.

- **Oriental Plover (*Charadrius veredus*)**

This species favours dry grasslands, particularly shorter grassland areas or recently burnt areas, rarely feeding in wet habitats but may occupy mudflats or beaches to roost when warm conditions prevail (Geering *et al* 2007). This species may overfly the Study area from time to time and small groups may utilise the Claypan habiiats adjacent to the Infrastructure area. Therefore, erosion and sedimentation disturbance to the Claypan habitat has the potential to impact individuals or small groups. Groundwater drawdown and dewatering may affect the natural availability of surface water to this species. Additionally, artificial water supplies such as the TSF may attract this species and appropriate deterrent devices should be used where required.

- **Common Sandpiper (*Actitis hypoleucos*)**

This species may overfly the Study area from time to time and small groups may utilise the Claypan found adjacent the Infrastructure options. Therefore disturbance to Claypan habitats has the potential to impact upon individuals or small groups. Groundwater drawdown and dewatering may affect the natural availability of surface water to this species. Additionally, artificial water supplies such as the TSF may attract this species and appropriate deterrent devices should be used where required.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Terrestrial Vertebrate Fauna

During the fauna survey, a total of 50 terrestrial vertebrate fauna species were recorded within the Study area. These comprise nine mammals (four native), 31 birds and 10 native reptile species.

Based on database search findings and a review of relevant literature, it is suggested that a total of 307 terrestrial vertebrate fauna species have the potential to occur within the Study area. These comprise 43 mammals (32 native and 11 introduced), 168 birds, 87 native reptiles and nine amphibian species.

Fourteen conservation significant fauna species potentially occur within the Study area, comprising:

- Five species listed under the Commonwealth *EPBC Act* and WA *Wildlife Conservation Act*: the Mulgara (*Dasycercus cristicauda* - Vulnerable and Schedule 1), Malleefowl (*Leipoa ocellata* - Vulnerable and Schedule 1), Slender-billed Thornbill (*Acanthiza iredalei iredalei* – Vulnerable), Major Mitchell's Cockatoo (*Cacatua leadbeateri* - Schedule 4) and Peregrine Falcon (*Falco peregrinus* - Schedule 4);

- Four priority species listed under the WA Department of Environment and Conservation (DEC) Priority Species List: the Australian Bustard (*Ardeotis australis* - P4), Bush Stone-curlew (*Burhinus grallarius* - P4), the Grey Falcon (*Falco hypoleucos* - P4) and the Striated Grasswren (*Amytornis striatus striatus* – P4); and

- Five species listed as Migratory under the EPBC Act: the Fork-tailed Swift (*Apus pacificus pacificus*), Rainbow Bee-eater (*Merops ornatus*), Great Egret (*Ardea alba*), Oriental Plover (*Charadrius veredus*) and Common Sandpiper (*Actitis hypoleucos*).

Of these species, the Rainbow Bee-eater was recorded during this survey, and the Mulgara and Bush Stone-curlew were recorded during the previous surveys at Lake Maitland (Outback Ecology 2008).

The Study area contains habitat that is mostly widespread and common throughout the Murchison bioregion, with the following possible exceptions:

- Lake Edge Spinifex;
- Claypan; and
- Kopi Dune.

Of these habitats, only the claypan habitat is likely to be substantially impacted by proposed developments within the Study area. The claypan may be impacted by erosion and sedimentation impacts associated with the construction of the Infrastructure facilities.

6.1.2 Terrestrial Short Range Endemic Invertebrate Fauna

Of the habitats identified as occurring within the Study area, four meet the criteria of potential SRE habitat on the basis of: Sheltered Habitats and Microhabitats or Isolated Habitats. These habitats include: Samphire Flats, Lake Edge Spinifex, Claypan and Kopi Dune habitats. Of these habitats, all have a low potential to support SRE species.

During the Lake Maitland Baseline Terrestrial Fauna Surveys, no known SRE invertebrate species were found (Outback Ecology 2008). However, there were six invertebrate species (four mygalomorph spiders and two scorpions) where identifications were not conclusive due to either a lack of taxonomic knowledge or a lack of knowledge regarding the distribution of the species. These species were: *Conothele* sp nov, *Aname* sp. B, *Kwonkan* sp. nov A and B, *Cethegus* sp. nov, *Urodacus* sp. maitland 1 and *Urodacus* sp. maitland 2.

Of these species, only the scorpion *Urodacus* sp. maitland 1 was found to be restricted to one habitat type (Mulga Woodland/Shrubland Plain) and none of the species were found to be restricted to one of the possible SRE habitats mentioned above. Since none of these species were found to be restricted to potential SRE habitat, it appears unlikely that these area SRE species.

The Priority 2 mygalomorph spider *Kwonkan moriarii* listed under the WA Department of Environment and Conservation (DEC) Priority Species List has been previously recorded 65 km southwest of the Study area in 1962. This species was not recorded during any of the previous surveys at Lake Maitland and no other records of this species exist except the type specimen.

6.2 **Recommendations**

This Level 1 study investigated the potential impacts to fauna from the proposed development of Infrastructure areas Area A or B.

Of the two infrastructure areas, developments within Infrastructure Area A are likely to have a lower impact on native fauna than developments within Infrastructure Area B. This is because the Infrastructure Area A has a large proportion of its total area that is already largely devoid of vegetation as a result of heavy grazing from high numbers of Euros and Red Kangaroos. The Infrastructure Area B also has a substantial area that is largely void of vegetation in the Spinifex Sandplains habitat due to broadscale fires. However, if the Spinifex Sandplain habitat were to be better managed to prevent broadscale files, the habitat has a high likelihood of recovery. The Spinifex Sandplain habitat is also known to support a population of Mulgara, which has a better chance of local recover if impacts from proposed developments could be avoided. These factors make the Infrastructure Area A a preferred choice for developments over the Infrastructure Area B.

6.3 General Management Guidelines

The development of either of the two potential infrastructure areas options at Lake Maitland will require clearing within a number of broad fauna habitats and of some less common habitats. From the information provided, at this early stage it appears that most of the potential impacts to terrestrial vertebrate fauna could be expected to be associated with:

- habitat removal/modification;
- noise;
- light;
- introduced flora; and
- introduced fauna.

The general management guidelines below are suggested to minimise potential impacts to the terrestrial fauna of the Study area:

- Reduce vegetation clearance to a minimum, specifically clearing of significant fauna and SRE habitat;
- Consider the preparation and implementation of a Fire Management Plan, not only to reduce the risk of unplanned fire emanating from the Study area, but also to mitigate against wildfire from off-site ignition sources. This is particularly important in the Spinifex Sandplains habitat which are highly flammable and known to support a local population of Mulgara;
- Minimise unnecessary clearance or disturbance to areas found to support Malleefowl. Any Malleefowl mounds encountered should be marked with flagging tape and coordinates noted for future monitoring;
- Minimise unnecessary clearance or disturbance to areas surrounding *Eucalyptus* species with hollows as these may be utilised by the Major Mitchell's Cockatoo;
- Minimise impacts to surface hydrology by avoiding drainage features wherever possible ;
- Discourage the establishment of any artificial water supplies and assess the likely impact of dewatering and any groundwater drawdown on waterbirds and migratory waders;
- Discourage fauna, particularly water birds, from entering the TSF by utilising chain mesh and small gauge wire fencing, and intermittent audio and light deterrents (WMC ODC-Environment, 2006);
- Beware of traffic hazards caused by fauna crossing roads;
- Reduce artificial light sources where possible and /or direct light sources toward area of interest;
- Implement standard dust suppression methods across the Study area, during the exploration programme to reduce impacts to surrounding vegetation;
- Prevent the establishment of new weed species, and the further spread of existing weed species by maintaining machinery hygiene and restricting access throughout the Study area;
- Develop strategies to reduce the likelihood of increased populations of feral animals, such as appropriate refuse management. For example, ensure food scraps are disposed of appropriately;
- Locate infrastructure in the most degraded areas in Inftrastructure Area A if possible in preference to Infrastrcture Area B.

7. STUDY TEAM

The Lake Maitland Terrestrial fauna assessment was conducted by:

Mr Richard Floyd	B. Sc. Grad. Dip. Nat. Res.	Principal Ecologist
Mr Paul Bolton	B. Sc (Hons)	Biologist (SRE invertebrates)
Miss Mary-Anne Clunies-Ross	B. Sc. Env. Man.	Biologist

The Lake Maitland Terrestrial fauna assessment was conducted under the following Licence issued by DEC:

- Licence to Take Fauna for Scientific Purposes (Regulation 17) – Licence No: SF007100
  - Date of issue: 09/10/2009
  - Date of expiry: 14/10/2009
  - Valid from: 19/10/2009

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Attachment A

Fauna Habitats identified within the Lake Maitland Survey Area and with associated Habitat Assessment Sites

Attachment A - Fauna Habitats identified within the Lake Maitland Study Area with associated Habitat Assessment Sites

Fauna Habitats	Infrastructure Area B Assessment Sites	Infrastructure Area A Assessment Sites	Lake Maitland Surrounds Assessment Sites
Stony Plain			
Mulga Woodland/Shrubland Plain	E3, E4, E8, E10, E11		S2
Drainageline			
Calcrete Plain		W3, W4, H9	
Woodland/Shrubland on Calcrete Flats	E2	W1, W2, W5, W6, W7, W8, W10, H10, W11	S11
Shrubland on Sandplain		W9	S4, S7
Spinifex Sandplain	E5, E6, E7, E9, E13		S1
Mulga Spinifex Sandplain			
Mallee Spinifex Sandplain	E1		
Samphire Flats	E12		S10, S12, S13
Lake Edge Spnifex			S5, S9
Claypan			
Kopi			S3, S6, S8

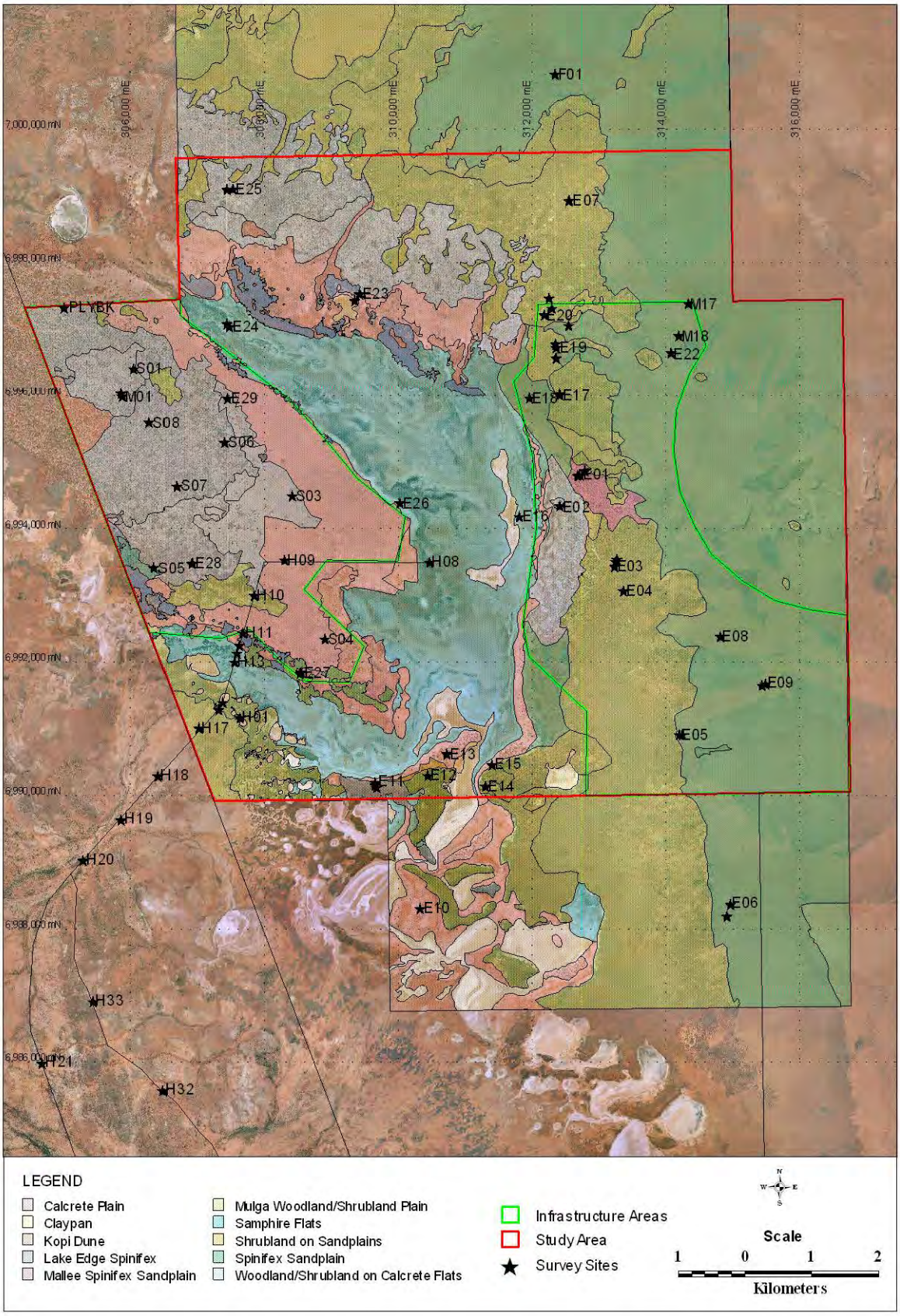

Figure showing the location of habitat assessment sites within and surrounding the Study area

Attachment B

Vertebrate Species Recorded or Potentially Occurring in the Study Area and Surrounds

Attachment B – Vertebrate Species Recorded or Potentially occurring in the Study Area and Surrounds

Legend

*	Introduced Species
#	Unlikely to occur over the Study area
^	Found in Desktop as Potentially Occurring in the Study area
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*: EX Extinct, EN Endangered, VU Vulnerable, CR Critically Endangered ,M Migratory, MA Marine
WC Act	Western Australian *Wildlife Conservation Act 1950*: Schedule 1, S2, S3, S4
Priority Species	Department of Environment and Conservation's Priority Species List: Priority 1, P2, P3, P4, P5

Previous Studies

A Outback Ecology (2009). Current Study.

B Outback Ecology (2008). Lake Maitland Terrestrial Fauna Surveys.

C Outback Ecology (2006). Desktop Vertebrate Fauna assessment and reconnaissance Survey of the Venus Project.

D Halpern Glick Maunsell (1997). Barwidgee Pastoral Lease Mulgara *Dasycercus cristicauda* Survey.

E Ninox (1993). Vertebrate Fauna Assessment of the proposed Bronzewing Gold Project.

F Hall, N. J./ McKenzie, N. L. and Keighery, G. J. (eds). (1994). The Biological survey of the Eastern Goldfields of Western Australia. Part 10. Sandstone - Sir Samuel and Laverton - Leonora Study areas.

Database Searches

G DEC (2009a). Threatened Species Search

H DEC (2009b). NatureMap

I Birds Australia (2009)

J Australian Museum (2009)

K DEWHA (2009a). Environmental Reporting Tool

L DEWHA (2009b). Protected Matters Report

Mammal Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Tachyglossidae																
Tachyglossus aculeatus	Echidna				X	X	X		X	X						
Dasyuridae																
Antechinomys laniger	Kultarr						X		X	X						
Dasycercus cristicauda	Mulgara	VU	S1			X	X	X			X	X			X	X
Ningaui ridei	Wongai Ningaui					X	X			X		X				
Ningaui yvonneae	Southern Ningaui						X									
Psuedantechinus woolleyae	Wooley's Pseudantechinus						X			X						
Sminthopsis crassicaudata	Fat-tailed Dunnart						X			X		X				
Sminthopsis dolichura	Little Long-tailed Dunnart						X					X				
Sminthopsis hirtipes	Hairy-footed Dunnart						X			X		X				
Sminthopsis longicaudata#	Long-tailed Dunnart			P4			X									
Sminthopsis macroura	Stripe-faced Dunnart					X	X			X		X				
Sminthopsis ooldea	Ooldea Dunnart					X	X			X		X				
Macropodidae																
Marcopus fuliginosus	Western Grey Kangaroo				X		X									
Marcopus robustus	Euro				X	X	X		X	X						
Macropus rufus	Red Kangaroo				X	X	X		X	X						
Emballonuridae																
Taphozous georgianus	Common Sheath-tail Bat						X									
Taphozous hilli	Hill's Sheath-tail Bat					X	X									

Mammal Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Molossidae																
Mormopterus planiceps	Little Mastiff Bat					X	X			X						
Tadarida australis	White-striped Freetail Bat					X	X			X		X				
Vespertilionidae																
Chalinolobus gouldii	Gould's Wattled Bat					X	X			X		X				
Chalinolobus morio	Chocolate Wattle Bat						X									
Nyctophilus geoffroyi	Lesser Long-eared Bat					X	X			X		X				
Nyctophilus timoriensis timoriensis	Greater Long-eared Bat						X									
Scotorepens balstoni	Inland Broad-nosed Bat					X	X			X		X				
Scotorepens greyii	Little Broad-nosed Bat						X									
Vespadelus baverstocki	Inland Forest Bat						X									
Vespadelus finlaysoni	Inland Cave Bat					X	X			X		X				
Vespadelus regulus	Southern Forest Bat						X									
Muridae																
*Mus musculus**	House Mouse					X	X	X		X						
Notomys alexis	Spinifex Hopping-mouse					X	X	X		X		X				
Pseudomys hermannsburgensis	Sandy Inland Mouse					X	X	X		X		X				
Pseudomys bolami	Bolam's Mouse						X									
Pseudomys albocinereus	Ash-grey Mouse						X									
Pseudomys desertor	Desert Mouse					X						X				
Felidae																
*Felis catus**	Cat					X	X		X	X		X			X	

Mammal Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Canidae																
*Canis lupus dingo**	Dingo				X	X	X							X		
*Vulpes vulpes**	Fox					X	X		X	X		X			X	
Leporidae																
*Oryctolagus cuniculus**	European Rabbit				X	X	X		X	X		X			X	
Equidae																
*Equus caballus**	Horse						X			X						
*Equus asinus**	Donkey						X									
Camelidae																
*Camelus dromedarius**	Dromedary Camel				X		X			X						
Bovidae																
*Bos taurus**	Cattle				X	X	X			X						
*Capra hircus**	Goat				X		X		X			X			X	
*Ovis aries**	Sheep					X	X		X	X						
TOTAL MAMMAL SPECIES	**43**															

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Casuaridae																
Dromaius novaehollandiae	Emu				X	X	X		X	X			X			
Anatidae																
Cygnus atratus	Black Swan												X			
Tadorna tadornoides	Australian Shelduck									X			X			
Anas gracilis	Grey Teal				X					X			X			
Chenonetta jubata	Wood Duck									X						
Malacorhynchus membranaceus	Pink-eared duck				X					X						
Anas superciliosa	Pacific Black Duck									X			X			
Anhingidae																
Anhinga novaehollandiae	Australasian Darter												X			
Megapodiidae																
Leipoa ocellata	Malleefowl	VU	S1				X				X	X			X	X
Phasianidae																
Coturnix pectoralis	Stubble Quail						X						X			
Ardeidae																
Ardea alba	Great Egret	M													X	X
Ardea novaehollandiae	White-necked Heron									X			X			
Ardea pacifica	White-faced Heron								X	X			X			
Accipitridae																
Elanus axillaris	Black-shouldered Kite					X	X									
Milvus migrans	Black Kite					X	X						X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Haliastur sphenurus	Whistling Kite						X						X			
Lophoictinia isura	Square-tailed Kite						X						X			
Hamirostra melanosternon	Black-breasted Buzzard						X						X			
Circus assimilis	Spotted Harrier						X			X			X			
Circus approximans	Swamp Harrier						X									
Accipiter fasciatus	Brown Goshawk						X		X				X			
Accipiter cirrhocephalus	Collared Sparrowhawk					X	X			X			X			
Aquila audax	Wedge-tailed Eagle				X	X	X		X	X			X			
Hieraaetus morphnoides	Little Eagle					X	X			X			X			
Falconidae																
Falco berigora	Brown Falcon					X	X		X	X			X			
Falco longipennis	Australian Hobby				X	X	X			X			X			
Falco hypoleucos	Grey Falcon			P4			X									
Falco peregrinus	Peregrine Falcon		S4				X						X			
Falco subniger	Black Falcon						X									
Falco cenchroides	Nankeen Kestrel					X	X		X	X			X			
Scolopacidae																
Actitis hypoleucos	Common Sandpiper	M								X						
Rallidae																
Fulicra atra australis	Eurasian Coot									X			X			
Gallinula ventralis	Black-tailed Native Hen						X			X			X			
Otididae																
Ardeotis australis	Australian Bustard			P4			X		X	X	X	X	X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Turnicidae																
Turnix velox	Little Button-quail						X						X			
Burhinidae																
Burhinus grallarius	Bush Stone-curlew			P4		X	X			X	X		X			
Recurvirostridae																
Cladorhynchus leucocephalus	Banded Stilt												X			
Himantopus himantopus	Black-winged Stilt									X			X			
Charadriidae																
Charadrius ruficapillus	Red-capped Plover									X			X			
Charadrius veredus	Oriental Plover	M													X	X
Elseyornis melanops	Black-fronted Dotterel					X	X			X			X			
Vanellus tricolor	Banded Lapwing				X		X			X			X			
Columbidae																
*Columbia livia**	Rock Dove						X									
Phaps chalcoptera	Common Bronzewing				X	X	X		X	X			X			
Ocyphaps lophotes	Crested Pigeon				X	X	X		X	X			X			
Geophaps plumifera	Spinifex Pigeon						X									
Geopelia cuneata	Diamond Dove				X	X	X		X	X			X			
Geopelia striata	Peaceful Dove						X									
*Streptopelia chinensis**	Spotted Turtle-Dove						X									
*Streptopelia senegalensis**	Laughing Turtle-Dove						X									

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Psittacidae																
Calyptorhynchus banksii	Red-tailed Black Cockatoo						X									
Cacatua leadbeateri	Major Mitchell's Cockatoo		S4				X									
Cacatua roseicapilla	Galah				X	X	X		X	X			X			
Cacatua sanguinea	Little Corella					X	X									
Nymphicus hollandicus	Cockatiel					X	X		X	X			X			
Barnardius zonarius	Australian Ringneck				X	X	X		X	X			X			
Psephotus varius	Mulga Parrot					X	X		X	X			X			
Melopsittacus undulatus	Budgerigar					X	X		X	X		X	X			
Neopsephotus bourkii	Bourke's Parrot						X		X	X			X			
Polytelis anthopeplus	Regent Parrot						X									
Polytelis alexandrae	Princess Parrot#	VU		P4			X								X	X
Neophema splendida	Scarlet-chested Parrot#			P4			X									
Pzoporus occidentalis	Night Parrot#	EN	S1				X									
Recurvirostridae																
Recurvirostra novaehollindae	Red-necked Avocet												X			
Cuculidae																
Cuculus pallidus	Pallid Cuckoo						X			X			X			
Chrysococcyx osculans	Black-eared Cuckoo						X						X			
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo						X			X			X			
Strigidae																
Ninox connivens	Barking Owl#			P2			X									
Ninox novaeseelandiae	Southern Boobook Owl						X						X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Tytonidae																
Tyto alba	Barn Owl						X									
Tyto javanica	Eastern Barn Owl												X			
Podargidae																
Podargus strigoides	Tawny Frogmouth					X	X			X			X			
Caprimulgidae																
Eurostopodus argus	Spotted Nightjar					X	X		X				X			
Aegothelidae																
Aegotheles cristatus	Australian Owlet-nightjar					X	X			X			X			
Apodidae																
Apus pacificus	Fork-tailed Swift	M					X								X	X
Halcyonidae																
Todirhamphus pyrrhopygia	Red-backed Kingfisher						X		X	X			X			
Todirhamphus sanctus	Sacred Kingfisher						X						X			
Meropidae																
Merops ornatus	Rainbow Bee-eater	M			X		X						X		X	X
Climacteridae																
Climacteris affinis	White-browed Treecreeper						X		X	X			X			
Climacteris rufa	Rufous Treecreeper						X									
Maluridae																
Amytornis striatus	Striated Grasswren						X			X			X			
Amytornis striatus striatus	Striated Grasswren			P4			X				X	X				
Malurus splendens	Splendid Fairy-wren					X			X				X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Malurus lamberti	Variegated Fairy-wren					X				X			X			
Malurus leucopterus	White-winged Fairy-wren				X	X				X			X	X		
Pardelotidae																
Pardalotus rubricatus	Red-browed Pardalote						X									
Pardalotus striatus	Striated Pardalote						X			X						
Calamanthus campestris	Rufous Fiekdwren						X						X			
Pyrrholaemus brunneus	Redthroat					X	X						X			
Acanthizidae																
Smicrornis brevirostris	Weebill				X	X	X			X			X			
Gerygone fusca	Western Gerygone				X		X						X			
Acanthiza apicalis	Inland Thornbill						X			X			X			
Acanthiza uropygialis	Chestnut-rumped Thornbill				X	X	X		X	X			X			
Acanthiza robustirostris	Slaty-backed Thornbill					X	X		X	X			X			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill						X		X	X		X	X			
Acanthiza iredalei	Slender-billed Thornbill						X									
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	VU					X								X	X
Aphelocephala leucopsis	Southern Whiteface						X		X	X						
Aphelocephala nigricincta	Banded Whiteface						X									
Meliphagidae																
Anthochaera carunculata	Red Wattlebird						X						X			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					X	X		X	X			X			
Manorina flavigula	Yellow-throated Miner				X	X	X		X	X			X			
Lichenostomus virescens	Singing Honeyeater				X	X	X		X	X			X	X		

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Lichenostomus keartlandi	Grey-headed Honeyeater					X	X									
Lichenostomus leucotis	White-eared Honeyeater						X									
Lichenostomus ornatus	Yellow-plumed Honeyeater					X	X			X						
Lichenostomus penicillatus	White-plumed Honeyeater					X	X			X		X	X			
Lichenostomus plumulus	Grey-fronted Honeyeater					X	X						X			
Lichmera indistincta	Brown Honeyeater					X	X			X			X			
Phylidonyris albifrons	White-fronted Honeyeater						X			X			X	X		
Melithreptus brevirostris	Brown-headed Honeyeater						X									
Conopophila whitei	Grey Honeyeater						X									
Certhionyx niger	Black Honeyeater						X			X			X			
Certhionyx variegatus	Pied Honeyeater						X			X			X	X		
Ephthianura tricolor	Crimson Chat					X	X		X	X			X			
Ephthianura albifrons	White-fronted Chat						X						X			
Ephthianura aurifrons	Orange Chat						X									
Petroicidae																
Microeca fascinans	Jacky Winter						X			X			X			
Petroica multicolor	Scarlet Robin						X									
Petroica goodenovii	Red-capped Robin					X	X		X	X			X			
Melanodryas cucullata	Hooded Robin						X		X	X			X			
Drymodes brunneopygia	Southern Scrub-robin						X									
Pomastostomidae																
Pomatostomus temporalis	Grey-crowned Babbler						X						X			
Pomatostomus superciliosus	White-browed Babbler				X	X	X		X	X			X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Cinclosomatidae																
Psophodes occidentalis	Chiming Wedgebill					X	X						X			
Cinclosoma castanotus	Chestnut Quail-thrush					X	X						X			
Cinclosoma cinnamomeum	Cinnamon Quail-thrush						X		X	X						
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush						X						X			
Neosittidae																
Daphoenositta chrysoptera	Varied Sittella				X		X			X			X	X		
Pachycephalidae																
Falcunculus frontatus	Crested Shrike-tit						X									
Pachycephala rufiventris	Rufous Whistler				X	X	X		X	X			X			
Pachycephala inornata	Gilbert's Whistler						X									
Pachycephala pectoralis	Golden Whistler						X									
Colluricincla harmonica	Grey Shrike-thrush				X	X	X		X	X			X			
Oreoica gutturalis	Crested Bellbird					X	X		X	X			X			
Dicruridae																
Grallina cyanoleuca	Magpie-lark				X	X	X		X	X			X			
Rhipidura albiscapa	Grey Fantail						X									
Rhipidura leucophrys	Willie Wagtail				X	X	X		X	X			X			
Campephagidae																
Coracina novaehollandiae	Black-faced Cuckoo-shrike				X	X	X		X	X			X			
Coracina maxima	Ground Cuckoo-Shrike				X		X		X	X			X			
Lalage sueurii	White-winged Triller				X	X	X			X			X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Artamidae																
Artamus personatus	Masked Woodswallow						X		X	X			X			
Artamus cinereus	Black-faced Woodswallow				X	X	X		X	X			X			
Artamus minor	Little Woodswallow						X			X			X			
Artamus leucorynchus	White-breasted Woodswallow						X									
Artamus superciliosus	White-browed Woodswallow						X			X						
Cracticidae																
Cracticus torquatus	Grey Butcherbird					X	X		X	X			X			
Cracticus nigrogularis	Pied Butcherbird				X	X	X		X	X			X			
Cracticus tibicen	Australian Magpie					X	X			X			X			
Strepera versicolor	Grey Currawong						X		X	X						
Corvidae																
Corvus coronoides	Australian Raven				X		X									
Corvus bennetti	Little Crow					X	X			X			X			
Crow Corvus orru	Torresian Crow						X		X				X			
Ptilonorhynchidae																
Chlamydera guttata	Western Bowerbird					X	X						X			
Ptilonorhynchus maculates guttatus	Spotted Bowerbird								X	X						
Alaudidae																
Mirafra javanica	Singing Bushlark						X									
Motacillidae																
Anthus novaeseelandiae	Australian Pipit					X	X			X			X			
Pelecanidae																
Pelecanus conspicillatus	Australian Pelican												X			

Bird Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Threskiornithidae																
Threskiornis spinicollis	Straw-necked Ibis												X			
Phalacrocoracidae																
Phalacrocorax melanoleucos	Little Pied Cormorant								X							
Phalacrocorax sulcirostris	Little Black Cormorant												X			
Passeridae																
Taeniopygia guttata	Zebra Finch				X	X	X		X	X			X			
Policipedidae																
Tachybaptus novaehollandiae	Australasian Grebe												X			
Poliocephalus poliocephalus	Hoary-headed Grebe								X							
Dicaeidae																
Dicaeum hirundinaceum	Mistletoebird						X			X			X			
Hirundinidae																
Cheramoeca leucosternus	White-backed Swallow					X	X			X			X	X		
Hirundo neoxena	Welcome Swallow					X	X		X				X			
Hirundo nigricans	Tree Martin						X			X			X			
Hirundo ariel	Fairy Martin						X						X			
Sylviidae																
Acrocephalus australis	Australian Reed-warbler						X									
Megalurus gramineus	Little Grassbird						X									
Cinclorhamphus cruralis	Brown Songlark						X		X	X			X			
Cinclorhamphus mathewsi	Rufous Songlark						X		X	X			X			
Zosteropidae																
Zosterops lateralis	Silvereye						X									
TOTAL BIRD SPECIES	**168**															

Reptile Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Cheluidae																
Chelodina steindachneri	Steindachner's Turtle					X										
Gekkoninae																
Gehyra punctata	Spotted Dtella					X								X		
Gehyra purpurascens						X	X			X						
Gehyra variegata	Tree Dtella				X		X			X		X		X		
Heteronotia binoei	Bynoe's Gekco					X	X			X		X		X		
Diplodactylinae																
Crenadactylus ocellatus	Clawless Gecko															
Diplodactylus conspicullatus	Fat-tailed Gecko					X	X			X		X				
Diplodactylus granariensis	Western Stone Gecko											X				
Diplodactylus pulcher						X	X			X		X				
Diplodactylus squarrosus							X			X						
Lucasium stenodactylum	Sandplain Gecko				X	X	X									
Nephrurus vertebralis					X	X	X					X				
Nephrurus wheeleri	Banded Knob-tailed Gecko					X	X									
Rhynchoedura ornata	Beaked Gecko					X				X		X				
Strophurus sp	Spiny-tailed Gecko					X										
Strophurus elderi	Jewelled Gecko					X	X			X		X				
Strophurus strophurus	Western Spiny-tailed Gecko						X			X		X				

Reptile Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Strophurus wellingtonae							X			X		X				
Underwoodisaurus milii	Barking Gecko						X			X						
Pygopidaidae																
Delma butleri							X			X		X				
Delma fraseri petersoni							X									
Delma nasuta	Long-nosed Delma					X	X			X		X				
Lialis burtonis	Burton's Legless Lizard					X	X			X						
Pygopus nigriceps	Western Hooded Scaly-foot						X					X				
Agamidae																
Amphibolurus longirostris	Long-nosed Dragon						X									
Caimanops amphiboluroides	Mulga Dragon				X		X			X						
Ctenophorus caudicinctus infans	Ring-tailed Dragon						X			X		X		X		
Ctenophorus caudicinctus mensarum	Ring-tailed Dragon						X					X				
Ctenophorus fordi	Mallee Military Dragon									X						
Ctenophorus isolepis isolepis	Central Military Dragon					X	X		X			X				
Ctenophorus isolepis gularis	Central Military Dragon						X									
Ctenophorus isolepis	Military Dragon									X						
Ctenophorus reticulatus	Western Netted Dragon				X				X	X		X				
Ctenophorus salarium	Claypan Dragon					X	X			X						
Ctenophorus scutulatus	Lozenge-marked dragon					X	X			X		X				

Reptile Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Ctenophorus nuchalis	Central Netted Dragon				X	X	X			X						
Pogona minor minor	Dwarf Bearded Dragon					X	X		X	X						
Moloch horridus	Thorny Devil					X	X			X						
Tympanocryptis cephalus	Pebble Dragon						X									
Scinidae																
Cryptoblepharus carnabyi	"Spiny-palmed Shining Skink"									X						
Cryptoblepharus plagiocephalus						X				X						
Ctenotus atlas						X										
Ctenotus ariadnae							X			X		X				
Ctenotus calurus							X			X		X				
Ctenotus grandis						X	X			X		X				
Ctenotus greeri										X						
Ctenotus helenae						X	X			X		X				
Ctenotus leonhardii						X	X			X		X				
Ctenotus pantherinus ocelifer	Leopard Skink					X	X			X		X				
Ctenotus quattuordecimlineatus							X			X		X				
Ctenotus schomburgkii						X	X			X		X				
Ctenotus severus						X										
Ctenotus uber uber							X					X				
Egernia depressa	Pygmy Spiny-tailed Skink				X	X	X			X		X				

Reptile Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Egernia formosa	Goldfields Crevice Skink						X			X		X				
Egernia inornata	Desert Skink						X					X				
Egernia kintorei#	Giant Desert Skink	VU	S1				X				X				X	X
Egernia striata	Night Skink						X									
Eremiascincus richardsoni	Broad-banded Sand Swimmer					X	X			X		X				
Lerista bipes						X	X			X		X				
Lerista desertorum						X	X			X		X		X		
Lerista muelleri						X	X			X				X		
Menetia greyii	Common Dwarf Skink					X	X			X		X				
Morethia butleri							X			X						
Tiliqua multifasciata	Central Blue-tongue Lizard					X	X			X		X				
Tiliqua occipitalis	Western Blue-tongue Lizard						X			X						
Varanidae																
Varanus brevicauda	Short-tailed Pygmy Monitor						X			X		X				
Varanus caudolineatus	Stripe-tailed Monitor				X		X			X		X				
Varanus eremius	Pygymy Desert Monitor					X	X					X				
Varanus giganteus	Perentie						X									
Varanus gouldii	Gould's Monitor				X	X	X			X						
Varanus panoptes rubidus	Yellow-spotted Monitor					X	X		X	X						
Varanus tristis	Black-headed Monitor						X									

Reptile Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	EPBC Act	WC Act	Priority Species List	Studies Within and Surrounding the Study Area						Database Searches					
					A	B	C^	D	E	F	G	H	I	J	K	L
Typhlopidae																
Ramphotyphlops hamatus							X			X		X				
Ramphotyphlops waitii							X					X				
Boidae																
Antaresia stimsoni	Stimson's Python						X			X						
Aspidites ramsayi#	Woma			P1			X									
Elapidae																
Acanthophis pyrrhus	Desert Death Adder						X									
Brachyurophis semifasciatus	Southern Shovel-nosed Snake						X									
Demansia psammophis	Yellow-faced Whipsnake						X									
Furina ornata	Orange-naped Snake						X			X						
Parasuta gouldii	Gould's Hooded Snake					X										
Parasuta monachus	Monk Snake						X									
Pseudechis australis	Mulga Snake						X			X						
Pseudechis butleri	Yellow-bellied Black Snake						X					X				
Pseudonaja modesta	Ringed Brown Snake						X									
Pseudonaja nuchalis	Gwardar						X			X						
Simoselaps berthodi	Jan's Banded Snake				X		X			X						
Suta fasciata	Rosen's Snake						X					X				
TOTAL REPTILE SPECIES	**87**															

Amphibian Species Recorded or Potentially Occurring in the Study Area and Surrounds

Scientific name	Common name	Studies Within and Surrounding the Study Area						Database Serarches					
		A	B	C^	D	E	F	G	H	I	J	K	L
Hylidae													
Cyclorana maini	Main's Frog			X			X		X				
Cyclorana platycephala	Water Holding Frog			X			X		X				
Myobatrachidae													
Pseudophryne occidentalis	Western Toadlet			X									
Limnodynastidae													
Limnodynastes spenceri				X									
Neobatrachus aquilonius				X									
Neobatrachus centralis				X									
Neobatrachus kunapalari				X			X						
Neobatrachus sutor	Shoemaker Frog			X									
Neobatrachus wilsmorei				X									
TOTAL AMPHIBIAN SPECIES	**9**												

Attachment C

Summary Tables Describing Conservation Status

Status	Code	Description
Categories used in EPBC Act Protected Matters Report		
Endangered	E	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	V	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Migratory	M	Species migrate to, over and within Australia and its external territories.
Schedules of the Western Australian Wildlife Conservation Act 1950		
Schedule 1	S1	Fauna that is rare or likely to become extinct.
Schedule 2	S2	Fauna that is presumed to be extinct.
Schedule 3	S3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds.
Schedule 4	S4	Fauna that is in need of special protection, otherwise than for the reasons mentioned above
Priority Fauna Codes used by the Western Australian DEC		
Priority 1 Taxa with few, poorly known populations on threatened lands.	P1	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2 Taxa with few, poorly known populations on conservation lands.	P2	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3 Taxa with several, poorly known populations, some on conservation lands	P3	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4 Taxa in need of monitoring	P4	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

Status	Code	Description
Priority 5 Taxa in need of monitoring	P5	Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Attachment D

Location of Conservation Significant Species Found in the Lake Maitland Study Area and Surrounds

Location of Conservation Significant Species Found in the Lake Maitland Study Area and Surrounds

Common Name	Scientific Name	Conservation Status			Location (GDA94; Zone 51J)	
		EPBC Act	WC Act	DEC Priority	Easting	Northing
MAMMALS						
Mulgara	*Dasycercus cristicauda*	VU	S1	-	314962	6988370
BIRDS						
Rainbow Bee-eater	*Merops ornatus*	M	-	-	304198	6978959
REPTILES						
No Conservation Significant Reptiles Recorded	-	-	-	-	-	-