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REPORT

Mt Keith Satellite Operations: Short-range Endemic Invertebrate Fauna Impact Assessment

Prepared for BHP Nickel West

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QUALITY STATEMENT

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Executive Summary

BHP Billiton Nickel West (Nickel West) commissioned MWH to undertake a terrestrial short-range endemic (SRE) invertebrate fauna assessment of the proposed Mt Keith Satellite Operations (the Project). The Project is located within the Yakabindie and Mt Keith pastoral leases, approximately 25 km south of the existing Mt Keith Nickel Operation and immediately west of the Wanjarri Nature Reserve in the Northern Goldfields region of Western Australia.

This report documents the results of a terrestrial SRE invertebrate fauna assessment of the Study Area which covers 5,422 hectares. The assessment was informed by a survey of a baseline survey area encompassing 5,675 ha, a survey of Wanjarri Nature Reserve encompassing 52,563 ha to provide regional perspective, a targeted survey of Jones Creek encompassing 1,679 and a desktop study which included both database searches and a literature review.

The specific objectives of this terrestrial SRE invertebrate fauna assessment were to:

- assess the occurrence and likely distribution of SRE invertebrate fauna within the Study Area;
- identify, describe and map potential terrestrial SRE invertebrate fauna habitat and any significant habitat within the Study Area;
- assess survey findings in the regional context by comparisons with available data from other localities within the Murchison bioregion; and
- assess the potential impacts of the Project on terrestrial SRE invertebrate fauna and habitat in the Study Area.

The field survey was conducted in accordance with the Western Australia Environmental Protection Authority's *Guidance Statement No 20. Sampling of Short-range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia*. The invertebrate collection methods used were previously endorsed by the then WA Department of Environment and Conservation (DEC; now Department of Parks and Wildlife). The invertebrate collection methods included wet pitfall trapping, leaf litter processing in Tullgren funnels, soil sieving and targeted searching.

In total the combined surveys comprised 17,600 trapping nights, 149 hours of targeted searching, the collection of 90 soil samples and 90 leaf litter samples. An SRE invertebrate fauna habitat assessment was conducted over the Study Area, which involved characterising habitat according to condition, complexity and suitability for invertebrate taxa prone to short-range endemism.

Drawing on Outback Ecology's previous experience in the Murchison bioregion and subsequent to consultation with invertebrate SRE specialists, the following invertebrate groups prone to short-range endemism were targeted during this assessment: mygalomorph spiders, scorpions, pseudoscorpions, millipedes, slaters and terrestrial snails.

The surveys yielded a total of 1,682 invertebrate specimens from target groups from 49 species. Slaters were the most numerous group to be collected (832 specimens from 8 species), followed by pseudoscorpions (439 specimens from 11 species), scorpions (195 specimens from 9 species), mygalomorph spiders (168 specimens from 15 species), millipedes (38 specimens from two species) and snails (10 specimens from 4 species). Database and literature reviews identified an additional 42 potential SRE species occurring within 50 km of the Project.

Based on current scientific knowledge of species collected within the Study Area, two were considered by experts as Confirmed SRE species, four as Likely SRE species and 23 as Potential SRE species (**ES Table 1**).

ES Table 1: Confirmed and Likely SRE species from the Study Area

SRE Status	Taxa	Group
Confirmed	*Antichiropus 'DIP002'*	Millipede
	Antichiropus 'DIP003'	Millipede
Likely	*Aname 'MYG235'*	Mygalomorph spider
	Synsphyronus `sp. PSE023'	Pseudoscorpion
	Family Armadillidae 'yakabindie b'	Slater
	Pseudodiploexochus 'yakabindie'	Slater

With regards to Project impacts to SRE taxa; one confirmed, one Likely and 14 Potential SRE species have been collected from within disturbance area. However, none of these species have been collected exclusively from within the proposed disturbance area. All species collected within the disturbance area for the Project have also been collected outside the proposed disturbance area.

With respect to habitats, nine broad habitats were identified across the Baseline Survey Area, Targeted Survey Area and Wanjarri Nature Reserve. All of these habitats, excluding Spinifex Sandplain were identified within the Study Area for this assessment. With respect to SRE species, the Creekline and Internal Drainage habitats have a high potential of supporting SRE species. Approximately 4.5 % of Creekline and 14.6 % of Internal Drainage habitat within the Study Area will be directly impacted upon by the Project. From the Baseline and Targeted surveys, it is known that additional Creekline habitat and Internal Drainage habitat occurs outside of the Study Area and will not be directly impacted by the Project. Within the total area mapped for this study, only 1.4 % of Creekline habitat and 1.3 % of Internal Drainage Line habitat will be directly impacted by the Project. Secondary impacts to the Creekline habitat are likely to be minimal, provided that adequate controls of secondary impacts downstream of the Project are implemented and managed appropriately.

Breakaway, Stony Hills and Slopes and Drainage Line habitats were considered to have a medium potential of supporting SRE species. Of these, the Project will have the largest impacts on the stony hills and slope habitat, where 34 % of this habitat in the Study Area will be impacted upon by the Project. No invertebrate habitat was found to be restricted exclusively to the proposed disturbance area. The proposed disturbance area largely comprises habitats with a medium or low potential to support SRE species.

BHP Nickel West

Mt Keith Satellite Operations: Short-range Endemic Invertebrate Fauna Impact Assessment

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1.1 Project Location and Description

BHP Billiton Nickel West (Nickel West) commissioned MWH Australia (MWH) to conduct a terrestrial short-range endemic (SRE) invertebrate fauna assessment (this Assessment) of the proposed Mt Keith Satellite Operations (the Project). The Project is located within the Yakabindie and Mt Keith pastoral leases, approximately 25 km south of the existing Mt Keith Nickel Operation and immediately west of the Wanjarri Nature Reserve in the Murchison region of Western Australia (WA) (**Figure 1-1**).

Broadly, the Project comprises two open cut pits, Six-Mile pit and Goliath pit, and an associated waste rock landform. Nickel West proposes to mine both these pits as satellite to the Mt Keith Processing Hub. The Project will be connected to the existing Mt Keith Operations via a haul road which intersects the Yakabindie and Mt Keith pastoral leases.

Five areas are defined for the purposes of this Assessment (**Figure 1-2**). They include:

- The **Study Area**: The Study Area is defined as a 5,422 hectare (ha) parcel of land which encompasses the Project and will be used for the purposes of this Assessment.
- The **Baseline Survey Area**: The Baseline Survey Area encompasses a 5,675 ha parcel of land that was surveyed during a baseline survey in 2011 (**Section 4.1**). This survey area largely aligns with the Study Area.
- The **Wanjarri Nature Reserve**: The Wanjarri Nature reserve comprises approximately 52,563 ha of land managed by the Department of Parks and Wildlife (DPaW) and lies adjacent to the Baseline Survey Area. The Wanjarri Nature Reserve was surveyed concurrently with the baseline survey to provide regional context. A portion of the nature reserve overlaps the Study Area.
- The **Targeted Survey Area**: The targeted survey area comprises a 1,679 ha parcel of land which encompasses the creek line habitat within the Jones Creek system that was the focus of a targeted millipede survey in 2012 (**Section 4.2**). A portion of the Targeted Survey Area overlaps the Study Area and the Baseline Survey Area.
- The **Disturbance Area**: The disturbance area comprises approximately 1,125 ha and makes up the entire area of disturbance required to develop the Project. Direct clearing associated with these footprints and potential secondary impacts associated with the operation of the Project will be the focus of this Assessment. The vast majority of the disturbance area (1,109 ha) occurs within the Study Area used for this assessment with the remainder (16ha) comprising of proposed access road to the Great Northern Highway which extends outside the Study Area.

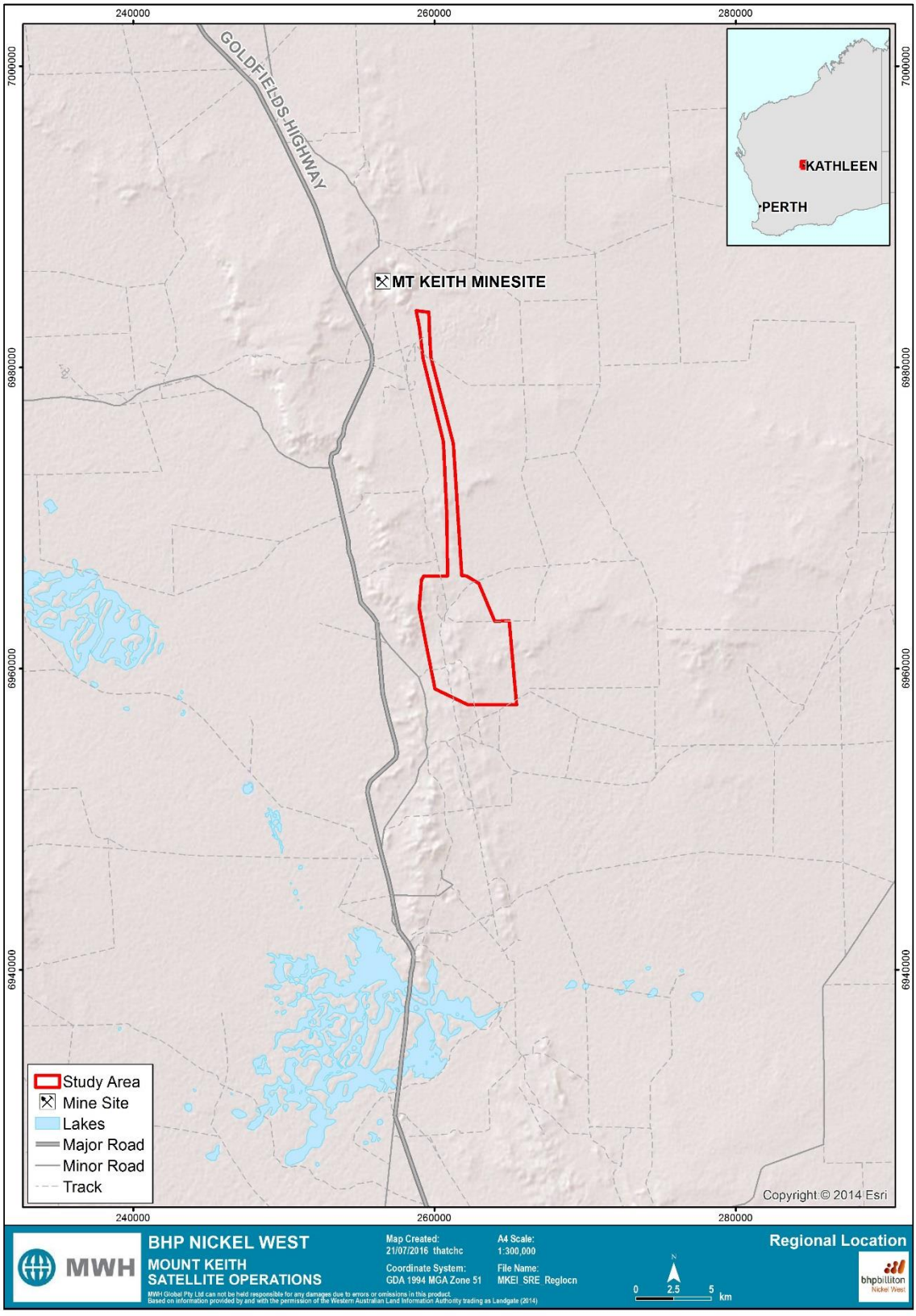

Figure 1-1: Regional location of the Study Area

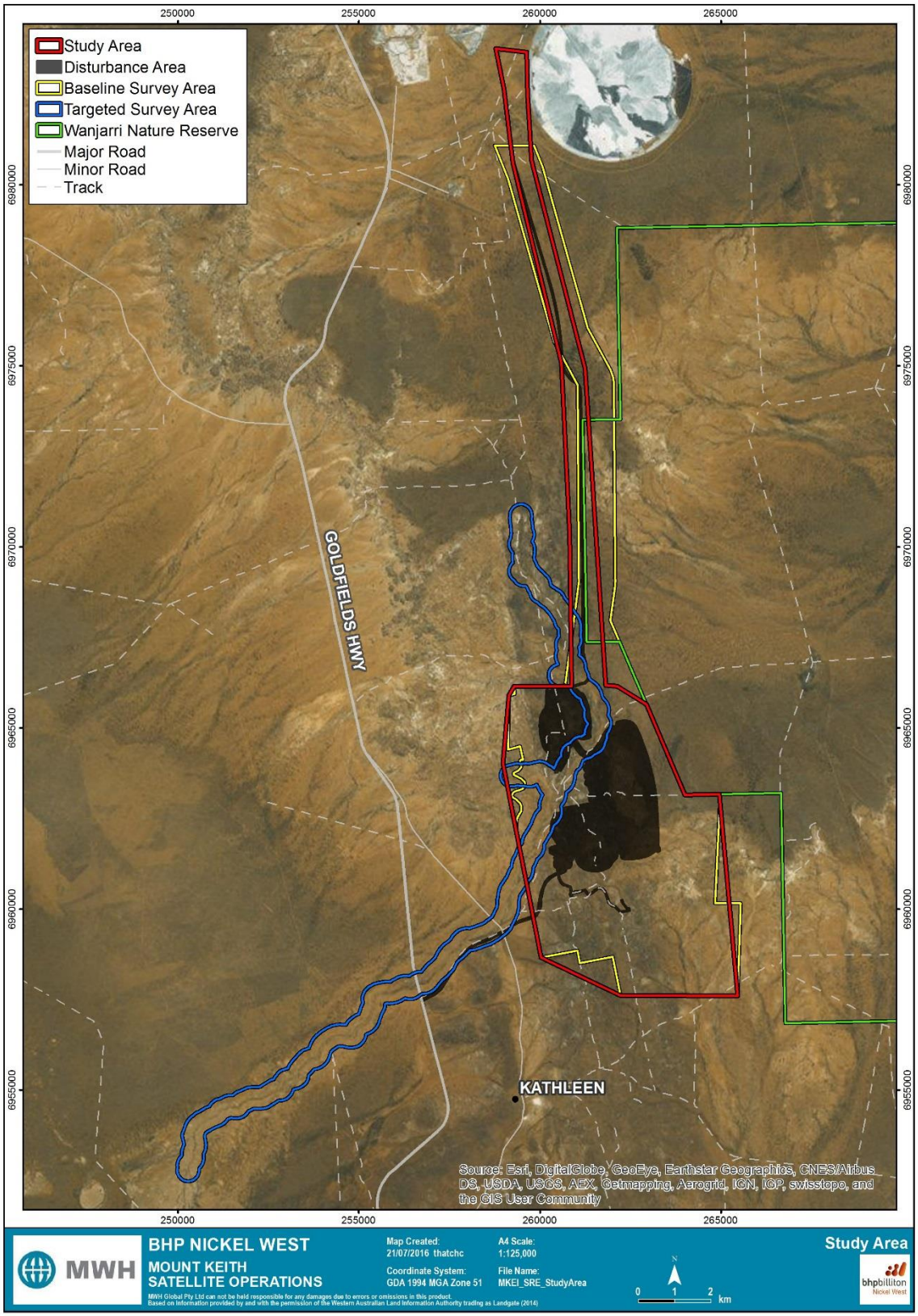

Figure 1-2: The Study Area, Survey Areas and conceptual Project layout

1.2 Assessment Scope and Objectives

The specific objectives of this terrestrial SRE invertebrate fauna assessment were to:

- assess the occurrence and likely distribution of SRE invertebrate fauna within the Study Area;
- identify, describe and map potential terrestrial SRE invertebrate fauna habitat and any significant habitat within the Study Area;
- assess survey findings in the regional context by comparisons with available data from other localities within the Murchison bioregion; and
- assess the potential impacts of the Project on terrestrial SRE invertebrate fauna and SRE habitat in the Study Area.

This assessment comprised a desktop study, an invertebrate fauna field survey that was conducted over two phases between 10 January and 8 April 2011 and a targeted invertebrate fauna survey conducted over two phases between 16 December 2011 and 29 March 2012. For local and regional context, this report also presents a summary of results from previous terrestrial SRE invertebrate fauna surveys that have been conducted in the Study Area and surrounds.

The survey was designed and conducted in accordance with:

- WA Environmental Protection Authority (EPA) Guidance No. 20, Sampling of Short-range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA 2009);
- EPA Guidance No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004); and
- EPA Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002).

The field sampling methodology used during the surveys has been previously endorsed by the then Department of Conservation (now DPaW).

1.3 Short-Range Endemic Invertebrate Taxa

Endemism refers to the restriction of a species to a particular area, at a continental, national or local scale (Allen *et al.* 2002). Harvey (2002) defines a restricted range as a species with a maximum range of 10,000 km². Comprehensive systematic reviews of different faunal groups often reveal the presence of SRE invertebrate species (Harvey 2002). Some better known SRE species have been listed under State or Commonwealth legislation. However, the majority of SRE species have not been listed under legislation, often due to lack of taxonomic knowledge (EPA 2009). SRE invertebrates in general are considered relevant to environmental impact assessment as habitat loss and degradation can decrease their prospects for persistence (EPA 2009).

Invertebrate groups prone to short-range endemism that have potential to occur within the Murchison and are regularly targeted during SRE surveys include: mygalomorph spiders, selenopid spiders, scorpions, pseudoscorpions, millipedes, slaters and terrestrial snails. Additional invertebrate groups have potential to include SRE species (see Harvey 2002) however these groups are generally considered beyond the requirements of fauna surveys for EIA.

Taxonomists (i.e. Western Australian Museum [WAM] and Phoenix Environmental) have developed criteria for explaining the degree of certainty surrounding the SRE status of a specimen where specific knowledge gaps exist, such as:

- unknown geographic distribution of a species due to patchy/limited sampling;
- limited taxonomic resolution due to limited knowledge of a particular group or a lack of specialist skills; and
- specimens are of an inappropriate life stage or sex to allow for accurate identification to species level.

These categories will be used to provide context to specimens collected during surveys (**Table 1-1**).

Table 1-1: Categories for status with respect to short-range endemism

Status	Criteria
Pseudoscorpions and Millipedes (WAM)	
Confirmed	• A known distribution of < 10 000 km2. • The taxonomy is well known. • The group is well represented in collections and / or via comprehensive sampling.
Potential	• Patchy sampling has resulted in incomplete knowledge of the geographic distribution of the group. • Incomplete taxonomic knowledge. • The group is not well represented in collections. • This category is most applicable to situations where there are gaps.
Widespread	• A known distribution of > 10 000 km^2. • The taxonomy is well known. • The group is well represented in collections and / or via comprehensive sampling.
Unknown	• Specimens belonging to known SRE groups, that cannot be accurately identified to species level due to an inappropriate sex or life stage.
Mygalomorph Spiders, Scorpions and Isopods (Phoenix Environmental)	
Confirmed	• Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published). • Group well represented in collections, in particular from the region in question. • High levels of endemism in documented species i.e. *Antichiropus* millipedes (Paradoxosomatidae) and scorpions in the genus *Aops* (Urodacidae). • Inference is often possible from immature specimens.
Likely	• Taxonomically poorly resolved group. • Unusual morphology for the group (i.e. some form of troglomorphism). • Often singleton in survey and few, if any, regional records. • Opiliones in the genus *Dampetrus*.

Status	Criteria
Potential	• Taxonomically poorly resolved group. • Often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records. • Congeners often widespread. • Specimens belonging to known SRE groups, that cannot be accurately identified to species level due to an inappropriate sex or life stage.
Widespread	• Taxonomically well resolved (but often not published) and demonstrated wide distribution (i.e. > 10,000 km2).

2 Existing Environment

2.1 Biogeographic Region

The Study Area is located within the Murchison bioregion (**Figure 2-1**), as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (Thackway and Cresswell 1995). Landscapes of the Murchison bioregion typically comprise low hills and mesas separated by flat colluvium and alluvial plains. The vegetation is dominated by low Mulga woodlands (*Acacia aneura* complex) on plains reduced to scrub on hills, with tree steppe of *Eucalyptus* sp., *Triodia* sp. on sandplains, saltbush shrubland on calcareous soils and saline areas with samphire (Beard 1990, Thackway and Cresswell 1995). The bioregion is rich and diverse in both its flora and fauna although most species are wide-ranging and usually occur in adjoining regions.

Within the Murchison Bioregion, the Study Area is located within the Eastern Murchison subregion, characterised by its internal drainage and extensive areas of elevated red desert sandplains with minimal dune development, salt lake systems associated with the occluded palaeodrainage system as well as broad plains of red-brown soils, breakaways and red sandplains (Cowan *et al.* 2001). Vegetation is dominated by Mulga Shrublands, often rich in ephemerals, hummock grasslands, saltbush shrublands and *Tecticornia* spp. shrublands (Cowan *et al.* 2001).

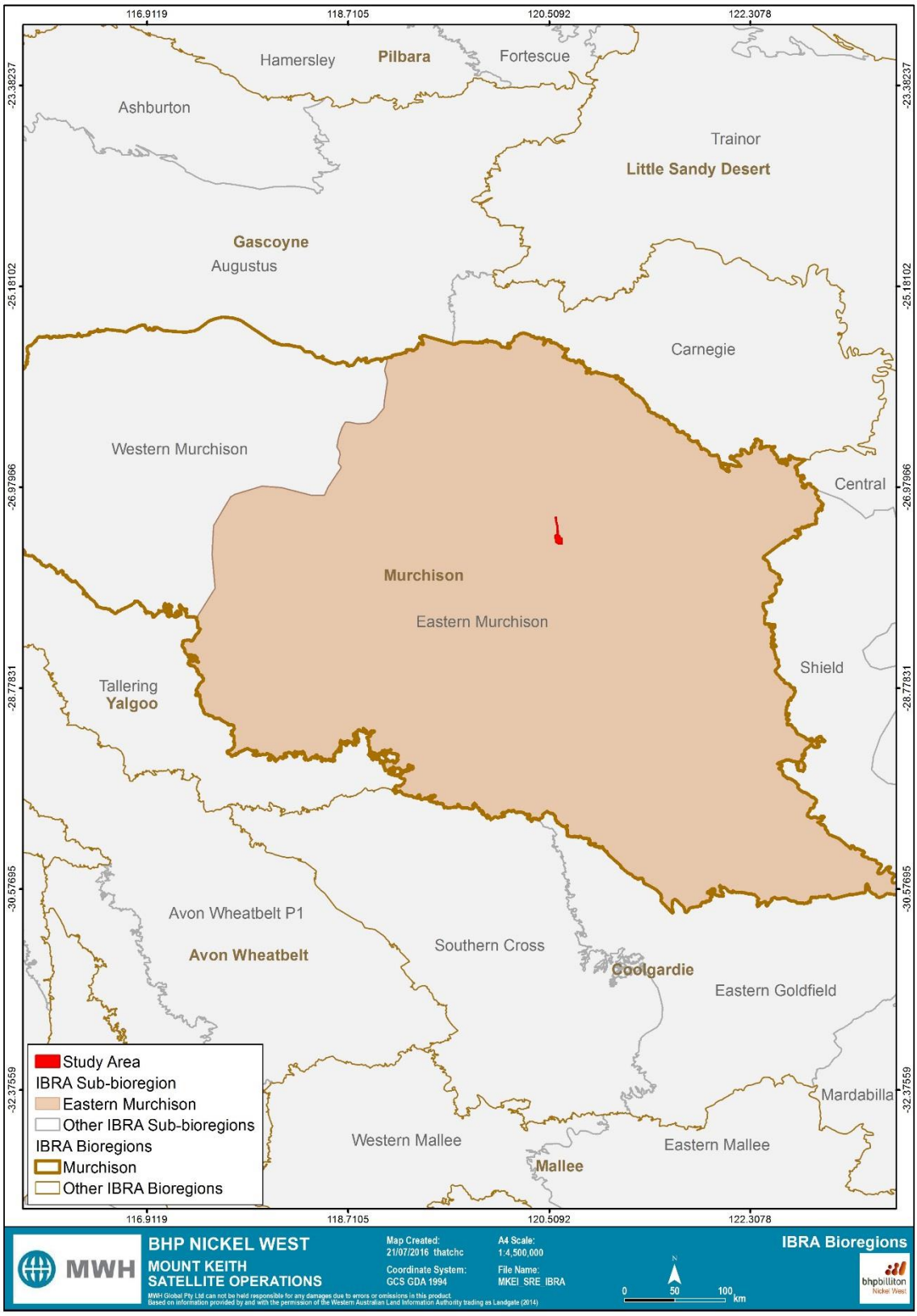

Figure 2-1: Location of the Study Area with respect to IBRA sub-bioregions

2.2 Land Systems

A regional survey was undertaken in the Murchison bioregion by the Department of Agriculture (now the Department of Agriculture and Food) and the Department of Land Administration (now Landgate) to develop a comprehensive description of the biophysical resources and assess the vegetation composition and soil condition within the region (Pringle *et al.* 1994). This information was used to classify and map the land systems of the region according to similarities in landform, soil, vegetation, geology and geomorphology. An assessment of land systems provides an indication of the occurrence and distribution of fauna habitats present within and surrounding the Study Area. The Study Area comprises fourteen land systems, with the majority of the Study Area falling within the Bevon and Sherwood land systems (**Table 2-1**; **Table 2-1**).

Table 2-1: Land systems occurring within the Study Area

Land system	Brief description	Proportion of Study Area		Area in the Eastern Murchison subregion (ha)
		Ha	%	
Bevon	Irregular low ironstone hills with stony lower slopes supporting Mulga shrublands.	1785.86	32.94	224,793
Sherwood	Breakaways, kaolinised footslopes and extensive gently sloping plains on granite supporting Mulga shrublands and minor halophytic shrublands.	1089.39	20.09	1,109,448
Bullimore	Extensive sand plains supporting Spinifex hummock grasslands.	542.02	10.00	3,560,476
Windarra	Gently undulating stony plains and low rises with quartz mantles on granite, supporting acacia-eremophila shrublands.	465.75	8.59	227,973
Jundee	Hardpan plains with ironstone gravel mantles and occasional sandy banks supporting Mulga shrublands.	341.95	6.31	507,116
Tiger	Gravelly hardpan plains and sandy banks with Mulga shrublands and wanderrie grasses.	335.25	6.18	111,277
Violet	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.	235.86	4.35	441,473
Nubev	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting Mulga and halophytic shrublands.	201.95	3.72	149,770
Monk	Hardpan plains with occasional sandy banks supporting Mulga tall shrublands and wanderrie grasses.	155.27	2.86	996,800
Sunrise	Stony plains supporting Mulga shrublands.	69.22	1.28	35,850
Ararak	Broad plains with mantles of ironstone gravel supporting Mulga shrublands with wanderrie grasses.	64.09	1.18	149,889

Land system	Brief description	Proportion of Study Area		Area in the Eastern Murchison subregion (ha)
		Ha	%	
Wyarri	Granite domes, hills and tor fields with gritty-surfaced fringing plains supporting Mulga and granite wattle shrublands.	62.72	1.16	88,609
Yanganoo	Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting Mulga shrublands and wanderrie grasses on banks.	61.97	1.14	1,441
Wilson	Large creeks with extensive distributary fans, supporting Mulga and halophytic shrublands.	10.76	0.20	151,478

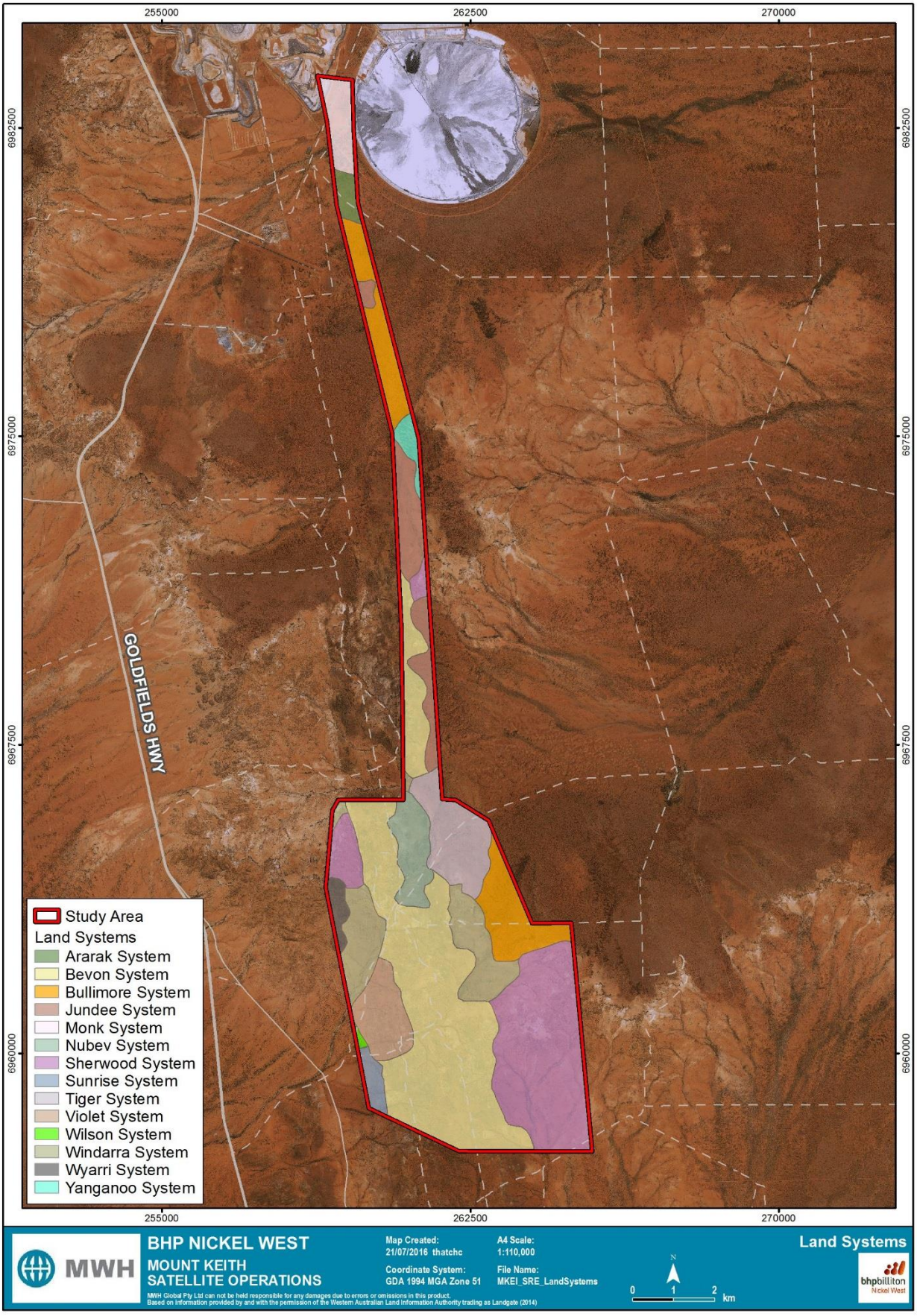

Figure 2-2: Land systems occurring within the Study Area

2.3 Land Use

Grazing of native pastures accounts for the vast majority of land use within the Eastern Murchison subregion (~85%), followed by Unallocated Crown Land (UCL) and Crown reserves which compose approximately 12% combined (Cowan *et al.* 2001). Mining activity within the region is considerable, dominated by nickel and gold mining, most of which are leases upon pastoral lands including the nearby Mt Keith Minesite. Only a small fraction of the subregion is protected within the conservation reserve system (<2%) and the subregion is not considered comprehensive or representative of ecosystems present (Cowan *et al.* 2001). Most conservation reserves are protected as Nature Reserves with only one National Park within the region, Goongarrie National Park, located 275 km south-east of the Study Area.

The Study Area is located on the Mt Keith and Yakabindie pastoral leases and borders the western edge of the Wanjarri Nature Reserve (**Figure 2-3**). The Wanjarri Nature Reserve encompasses approximately 53,000 ha, which comprises of mostly undulating sand plains, however, sand dunes, breakaways and low granite hills are also present. The Wanjarri Nature Reserve has a diverse vertebrate fauna, particularly birds, with 122 species recorded from the reserve (CALM 1996). The characteristics of the Wanjarri Nature Reserve that are of conservation value include:

- it being an arid land and desert landscape that supports a variety of habitats;
- the presence of Spinifex grasslands which characterise what most people perceive to be the deserts of the Australian inland;
- it representing a useful case study on the recovery of rangeland plant communities after grazing is discontinued; and
- the utilisation of particular habitats by threatened wildlife.

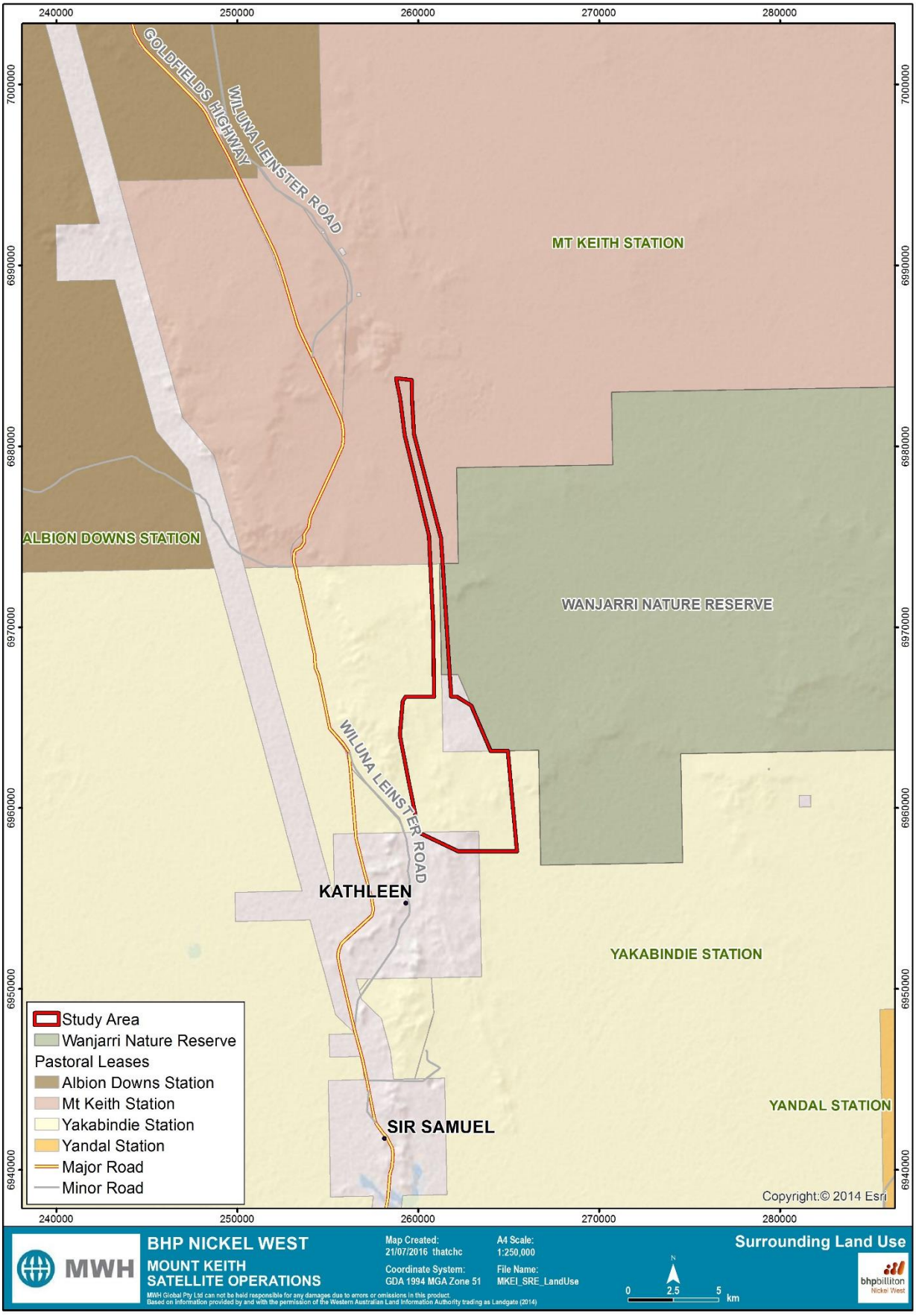

Figure 2-3: Land use within the Study Area and surrounds

2.4 Hydrology

The most prominent hydrology feature within the Study Area is Jones Creek. Jones Creek is a lateral tributary system, incised into the Barr-Smith Range, where the majority of runoff is received from the upper catchment, which covers an area of 64.1 km^2. During large flood events water is rapidly shed from this part of the catchment into the creek, aided by the rocky nature of the terrain and sparse vegetative cover. The terminus for the creek is a large floodplain area to the south-west of the Study Area, containing a number of claypans (Berry in prep). Beyond this, drainage becomes increasingly diffuse, before reaching Lake Miranda, located within the Carey Palaeodrainage system (Wetland Research and Management 2005).

Anecdotal evidence suggests that on average, Jones Creek flows once or twice a year, in response to moderate or high intensity rainfall of 25 mm or more (Berry in prep). The morphology of the channel leads to high energy flows, with a velocity of up to 1.7 m per second. In the terminal claypans (outside of the Study Area), depths of over two metres have been recorded following intensive rainfall. During large floods, the creek and associated claypans become connected, providing a mechanism for chemical and biological exchange (Berry in prep, Wetland Research and Management 2005).

Jones Creek is a freshwater system that, after flow events, rapidly dries to form a series of disconnected pools. Downstream of the Study Area, water is retained in the claypans for longer periods, supporting a predominantly freshwater ecosystem for several months or more (Berry in prep). The pools that form within Jones Creek, along with the claypans, provide an important refuge for aquatic biota within an arid landscape (Wetland Research and Management 2005).

2.5 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 millimetres (mm) (Pringle *et al.* 1994). Rainfall over the Study Area is unreliable, with zero rainfall potentially recordable in any month (Pringle *et al.* 1994). Summer rainfall is typical of the region, however, most years experience a dry period that lasts from four to six months, typically commencing around October (Pringle *et al.* 1994).

The Yeelirrie meteorological station (station 012090) is the closest Bureau of Meteorology (BOM) weather station to the Study Area and is located approximately 60 km to the west (**Figure 1-1**). Meteorological data collected from the Yeelirrie meteorological station indicates that rainfall mainly occurs in the first half of the year (BoM 2016). The annual average rainfall recorded at the Yeelirrie meteorological station is approximately 239 mm with an average of 32 rain days recorded per annum (BoM 2016) (**Figure 2-4**). Peak temperatures are recorded from November to March. Mean daily maximum temperatures range from 37.9 °C in January to 19.3°C in July. Mean daily minimum temperatures range from 22.3 ºC in January to 3.5 ºC in June (BoM 2016).

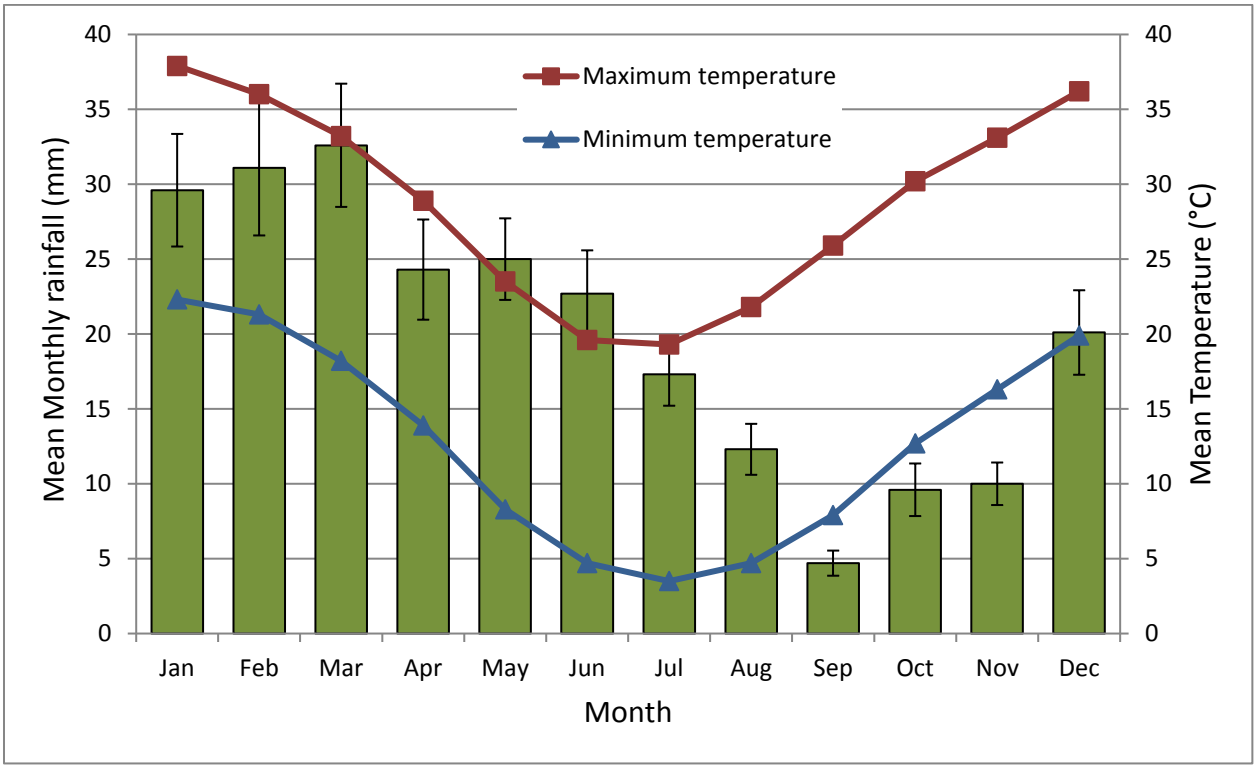

Figure 2-4: Mean rainfall and temperature data recorded from the Yeelirrie meteorological station (BoM 2016)

3 Desktop Study

3.1 Database Searches

A search of relevant databases and a literature review was undertaken prior to the field surveys in order to:

- determine the SRE taxa that have been previously collected in the region;
- facilitate the identification of SRE habitat within the Study Area; and
- assist with the assessment of the conservation significance of the invertebrate species collected.

Five database searches were conducted around a central coordinate (51J 261433 mE, 6965254 mS), with varying buffers as deemed appropriate (**Table 3-1**).

Table 3-1: Database searches

Custodian	Database	Reference	Buffer (km)
DPaW	Threatened and Priority Fauna	(DPaW 2016b)	100
DPaW	NatureMap	(DPaW 2016a)	40
Department of Environment (DoE)	Protected Matters	(DoE 2016)	50
WAM	Arachnids and Myriapod Database	(WAM 2016a)	100
WAM	Mollusc Database	(WAM 2016b)	100

The results of the database searches and literature review are presented in **Section 5.2**.

3.2 Literature Review

The literature review considered five previous SRE surveys of relevance to the Study Area (**Table 3-2**). Surveys considered were those that were publically available, recently conducted and in close proximity to the Study Area. As all specimens from SRE surveys are required to be lodged with the WAM, the majority of the records from the literature review were already captured in the WAM database searches.

Table 3-2: Key findings of SRE studies conducted within the vicinity of the Study Area

Reference	Study details	Proximity to Study Area	Survey Methods	Broad habitats	SRE fauna
(Outback Ecology 2012a)	Location: Yakabindie: Lake Way South Borefield Study Type: Level 1 Terrestrial Short-range Endemic Invertebrate Fauna Assessment Survey Date: April 2011	Adjacent to and north of the Study Area	• targeted searching • habitat mapping	8 broad fauna habitats including: • Spinifex Sandplain • Mulga over spinifex on sand plain • Salt lake mosaic • Sparse mulga woodland • Kopi dune • Sand dune • Drainage Line • Stony Hill and Slope	Potential SRE species: • *Aganippe* sp. • *Anidiops* sp. • *Cethegus* sp.
(Outback Ecology 2012b)	Location: Yakabindie: South East Borefield Study Type: Level 1 Terrestrial Short-range Endemic Invertebrate Fauna Assessment Survey Date: June 2012	Adjacent to and south of the Study Area	• targeted searching • habitat mapping	8 broad fauna habitats including: • Sparse Mulga Woodland • Playa • Drainage Line • Mulga over Wanderrie grass • Mulga over Spinifex on sandplain • Stony Plain • Calcrete plain • Acacia shrubland • Annual shrubland	n/a
Outback Ecology (2011)	Location: Lake Way Study Type: Wiluna Uranium Project: Terrestrial Fauna Assessment Survey Date: Autumn 2010	75 km north	• dry pitfall trapping • leaf litter collection • Tullgren funnels, • soil sieving, • ultraviolet (UV) spotlighting and	12 broad fauna habitats including: • open Mulga woodland over spinifex • Eucalypt woodland • mallee/Mulga complex over spinifex	Putative SRE • *Aname* MYG176 • *Aname* MYG177* • *Aname* MYG173* • *Kwonkan* MYG175* • *Urodacus* 'yeelirrie'

Reference	Study details	Proximity to Study Area	Survey Methods	Broad habitats	SRE fauna
			• targeted searching		
(Outback Ecology 2012a)	Location: Lake Way Study Type: Wiluna Uranium Project: Targeted Terrestrial Fauna Survey and Habitat Assessment Survey Date: March 2011	75 km north	• targeted searching • habitat mapping	12 broad fauna habitats including: • Mallee/Mulga Complex over Spinifex, • Melaleuca Stands • Eucalypt Woodland	Potential SRE • *Cethegus* sp. • *Aname* sp. • *Anidiops* sp. • *Urodacus* 'laverton 4' • *Urodacus* 'gibson 5'
(ecologia Environment 2011)	Location: Yeelirrie Study Type: SRE Invertebrate Fauna Baseline Survey Survey Date: • Searches: July 2009 • Wet pitfall trapping: Oct 2009 – Jan 2010 • Targeted survey: March 2010.	50 km west-northwest	• wet pitfall trapping, • leaf litter collection, • soil sieving and • targeted searching.	8 broad habitats including: • calcrete/calcrete outwash • chenopod shrubland • Breakaways • hardpan Mulga • shrubland of spinifex sandplain	Three Confirmed SRE: • *Idiosoma* sp., • *Pseudolaureola* sp. • Platyarthridae/Barthytropidae 13 potential SRE: • *Aganippe* sp., • *Aname* 'MYG170', • *Aname* 'MYG212', • Barychelidae, • Cheridiidae, • *Cubaris* sp. 1, • *Cubaris* sp. 2*, • Geophilida, • *Kwonkan* 'MYG171', • *Kwonkan* 'MYG172', • *Kwonkan* 'MYG210', • *Kwonkan* 'MYG211'; and • *Urodacus* 'yeelirrie'

* no longer considered to be a SRE species

4 Methods

Two surveys were conducted over the Study Area:

- the Baseline Survey (consisting of the Baseline Survey Area and Wanjarri Nature Reserve); and
- a Targeted Survey for a millipede for a millipede (*Antichiropus* 'DIP003') that had been collected during the Baseline Survey.

Methods for each survey are presented in **Section 4.1** and **Section 4.2**, respectively. Coverage of these surveys with respect to the Study Area is presented in **Figure 1-2**. Some areas of the Study Area extend outside of areas surveyed during the Baseline and Targeted Survey (**Figure 1-2**). For these additional areas, habitat mapping was extrapolated based on aerial imagery with reference to mapping from both the Baseline Survey and the Targeted survey.

4.1 Baseline Survey

4.1.1 Survey Timing

The baseline survey was conducted over two phases between 10 January and 8 April 2011. Two trapping phases were conducted during the survey period due to a considerable rainfall event in February, which caused widespread flooding throughout the Study Area (**Section 4.1.2**). The flooding raised concerns that the wet pitfall traps deployed in phase 1 were compromised due to inundation by water and the dilution of the preserving agent. In an attempt to counter any losses caused by flooding, the phase 2 survey traps were deployed upon collection of the phase 1 traps. Upon examination, almost all specimens collected from the phase 1 traps were well preserved and suitable for identification.

The two survey phases were conducted as follows:

- Phase 1: phase 1 wet pitfall traps were deployed from 10 to 21 January 2011 and collected between 2 and 11 March 2011. Targeted searches and systematic trapping were conducted at each survey site. Habitat mapping was also completed; and
- Phase 2: phase 1 wet pitfall traps replaced with phase 2 wet pitfall traps from 2 to 11 March 2011. The phase 2 wet pitfall traps were collected between 4 and 8 April 2011.

4.1.2 Weather Conditions

The records from three Bureau of Meteorology (BOM) weather stations have been considered for the Study Area: Yakabindie Homestead, Yeelirrie and Leinster. The Yakabindie Homestead weather station is located approximately 10 km south west of the Study Area, with the Yeelirrie and Leinster weather stations located approximately 60 km west and 60 km south of the Study Area, respectively. Consideration of data collected from these three weather stations is useful in providing regional context given the localised nature of rainfall in the Murchison.

During the phase 1 survey, the daily maximum temperatures recorded from the Leinster weather station ranged between 21.0 ºC and 44.4 ºC, with minimum between 14.6 ºC and 29 ºC (BoM 2016). A mean maximum temperature of 33.6 ºC and mean minimum of 21.2 ºC over the survey period were recorded at the Leinster, which is similar to the long-term average (BoM 2016). In the six weeks prior to the phase 1 survey, 105.4 mm of rain was recorded at Leinster, 83.2 mm from Yeelirrie and 103.0 mm from Yakabindie (**Figure 4-1**). During the Phase 1 survey period 64.2 mm of rain was recorded from Leinster, 185.7 mm from Yeelirrie and 204.5 mm from Yakabindie (**Figure 4-2**). The rainfall recorded prior to and during the phase 1 survey was substantially above the long-term average for the period which ranges from 30-33 mm per month from January to March (**Figure 2-4**)(BoM 2016).

During phase 2, the daily maximum temperatures recorded from the Leinster weather station during the survey period ranged between 21.7 ºC and 35.2 ºC, with minimum between 11.8 ºC and 21.7 ºC (BoM 2016). A mean maximum temperature of 29.7 ºC and mean minimum of 16.9 ºC over the survey period were recorded at the Leinster which is similar to the long-term average (BoM 2016). During the survey period, 1.6 mm of rainfall was recorded from Leinster, 13.8 mm from Yeelirrie and 9.8 mm from Yakabindie (**Figure 4-3**). The rainfall recorded during the phase 2 survey was below the long-term average for the period (BoM 2016).

Both the phase 1 and phase 2 surveys were conducted between November and April which is the optimum period for invertebrate surveys in the northern Goldfields (EPA 2009).

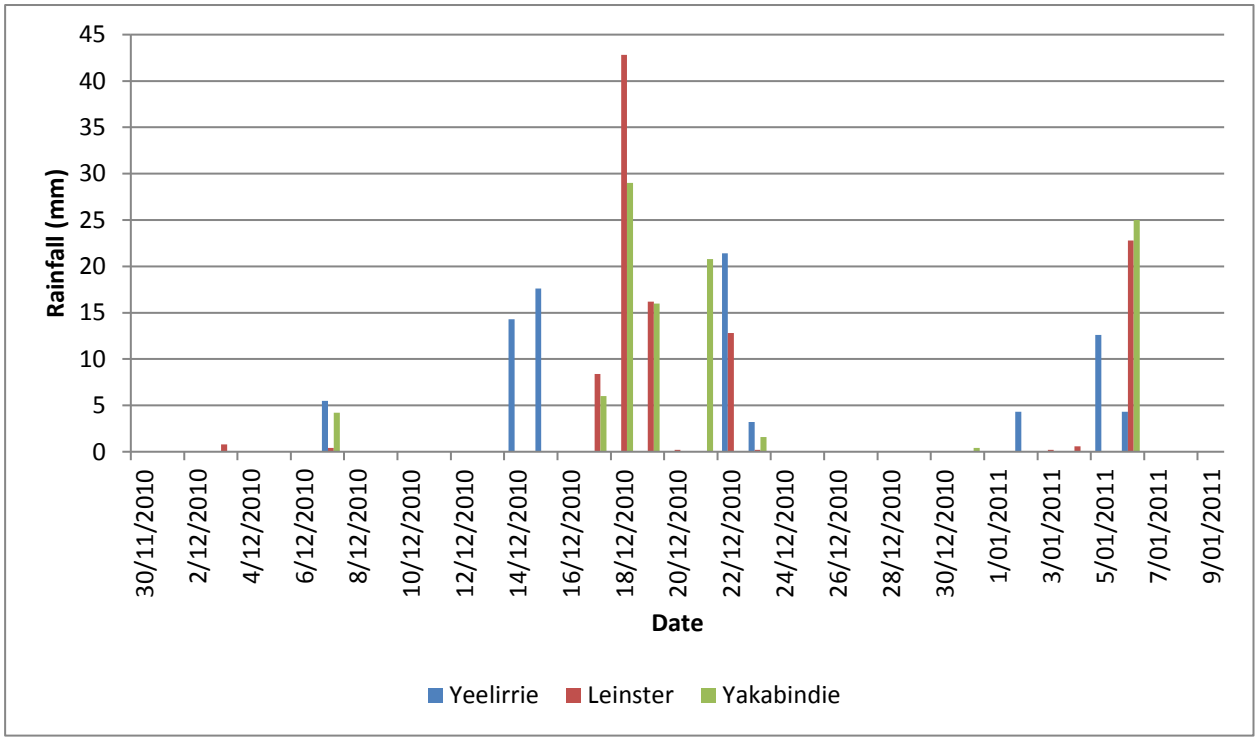

Figure 4-1: Rainfall recorded six weeks prior to the phase 1 survey

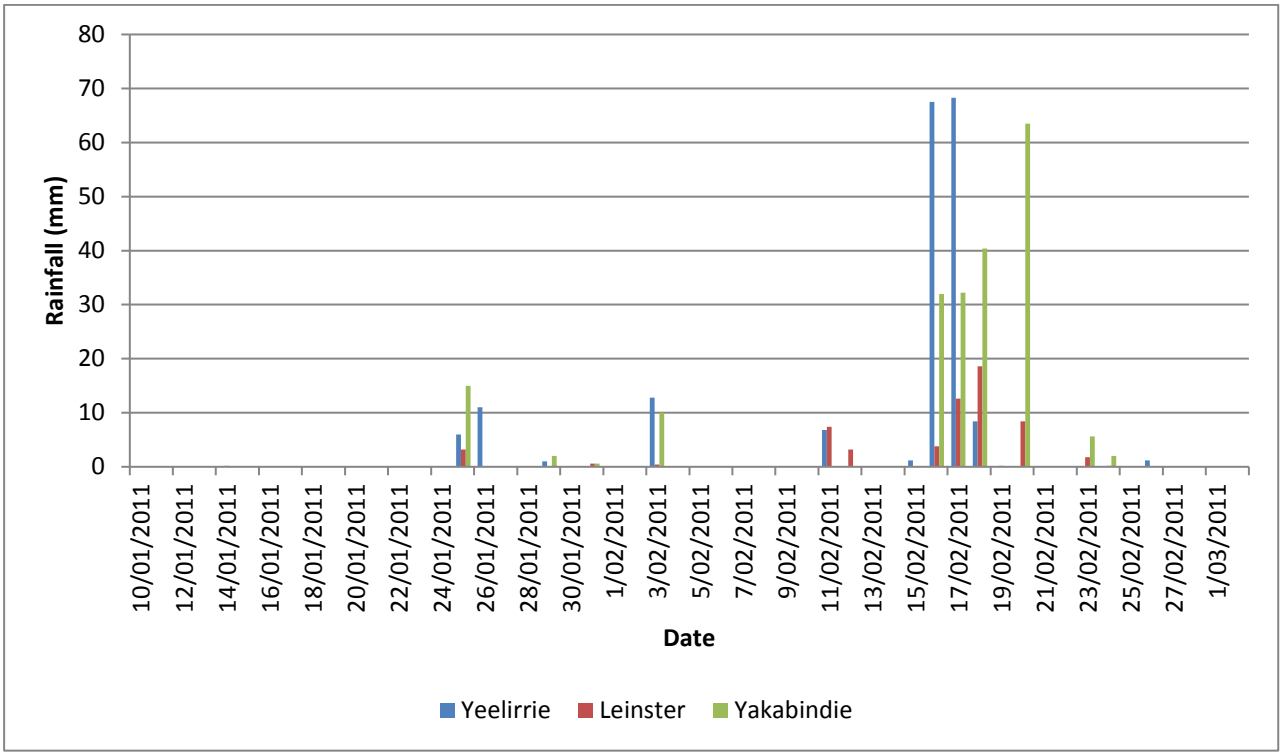

Figure 4-2: Rainfall recorded during the phase 1 survey

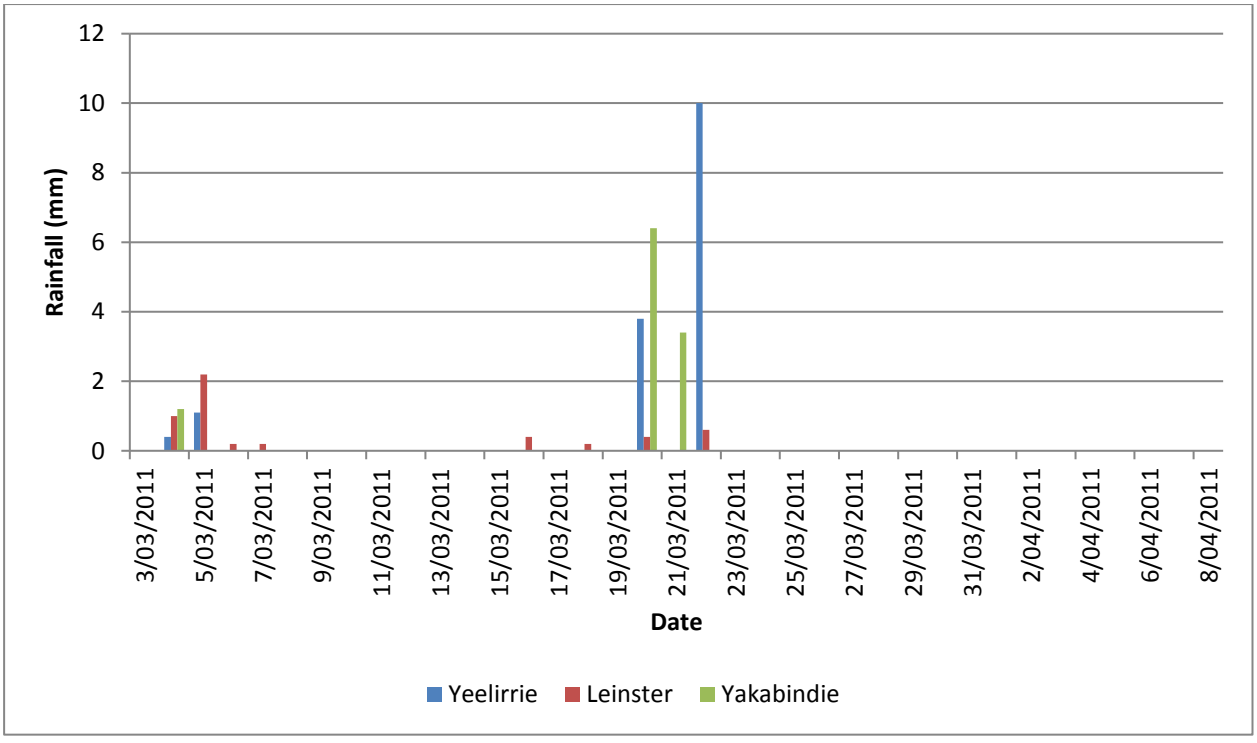

Figure 4-3: Rainfall recorded during the phase 2 survey

4.1.3 Survey Sites

Prior to the survey, a set of prospective survey sites were selected via a desktop analysis of aerial imagery. These sites were ground-truthed in the field and the optimal sites selected based on representation of the habitats present within the Study Area and vehicle accessibility at the time of survey.

A total of 30 systematic survey sites were sampled during the phase 1 survey (**Figure 4-4**; **Table 4-1**). Invertebrate collection methods employed at systematic survey sites comprised wet pitfall trapping, targeted searching, and soil and litter collection (**Section 4.1.5**). An additional eleven sites were target searched (Target 10 to Target 20) to gain improved geographical coverage during the phase 1 survey (**Figure 4-4**; **Table 4-2**). Phase 2 wet pitfall traps were redeployed at the same phase 1 systematic survey sites. Other invertebrate collection methods were not employed during the phase 2 survey. Where possible, survey sites were established in representative habitats both inside and outside of the proposed disturbance area (**Table 4-1**, **Table 4-2**). A site description for each of the survey sites is presented in **Appendix A**.

Table 4-1: Systematic survey sites sampled during phase 1 and phase 2 of the baseline survey

Site	Habitat	Inside disturbance area	Coordinates (GDA 94 MGA 51J)	
			Easting	Northing
Site 1	Drainage Line	No	260069	6963956
Site 2	Creekline	No	260911	6964243
Site 3	Stony Hill and Slope	Yes	260465	6964501
Site 4	Sparse Mulga Woodland	No	259961	6963678
Site 5	Stony Hill and Slope	Yes	261750	6962100
Site 6	Stony Hill and Slope	Yes	261501	6961523
Site 7	Stony Plain	No	263364	6960976
Site 8	Drainage Line	No	263236	6961464
Site 9	Stony Plain	Yes	262859	6962179
Site 10	Sparse Mulga Woodland	No	262053	6965091
Site 11	Stony Plain	Yes	262420	6963264
Site 12	Internal drainage	Yes	262584	6963485
Site 13	Stony Hill and Slope	Yes	261769	6963257
Site 14	Mulga over Spinifex Sandplain	No	263744	6962817
Site 15	Internal drainage	No	263462	6964221
Site 16	Stony Hill and Slope	No	260949	6959255
Site 17	Stony Hill and Slope	No	262683	6958525
Site 18	Stony Plain	No	264919	6958082
Site 19	Creekline	No	261585	6965583
Site 20	Drainage Line	No	261934	6960653
Site 21	Stony Hill and Slope	No	262236	6959963
Site 22	Drainage Line	No	260165	6961711
Site 23	Stony Plain	No	265955	6975664
Site 24	Internal drainage	No	262649	6978125
Site 25	Internal drainage	No	270876	6978638

Site	Habitat	Inside disturbance area	Coordinates (GDA 94 MGA 51J)	
			Easting	Northing
Site 26	Drainage Line	No	269627	6975479
Site 27	Mulga over Spinifex Sandplain	No	271770	6958826
Site 28	Mulga over Spinifex Sandplain	No	270827	6971413
Site 29	Sparse Mulga Woodland	No	265827	6972471
Site 30	Sparse Mulga Woodland	No	271730	6962668

Table 4-2: Targeted search sites sampled during phase 1 of the baseline survey

Site	Habitat	Inside disturbance area	Coordinates (GDA 94; MGA Zone 51J)	
			Easting	Northing
Target 10	Breakaway	Yes	261561	6961828
Target 11	Mulga over Spinifex over sand plain	No	259467	6980247
Target 12	Mulga over Spinifex over sand plain	No	261536	6973507
Target 13	Breakaway	No	261406	6971259
Target 14	Creekline	No	260535	6963476
Target 15	Creekline	No	259807	6961681
Target 16	Mulga over Spinifex over sand plain	No	266652	6964356
Target 17	Mulga over Spinifex over sand plain	No	266879	6964974
Target 18	Mulga over Spinifex over sand plain	No	269797	6963651
Target 19	Mulga over Spinifex over sand plain	No	271740	6967092
Target 20	Mulga over Spinifex over sand plain	No	271012	6979232

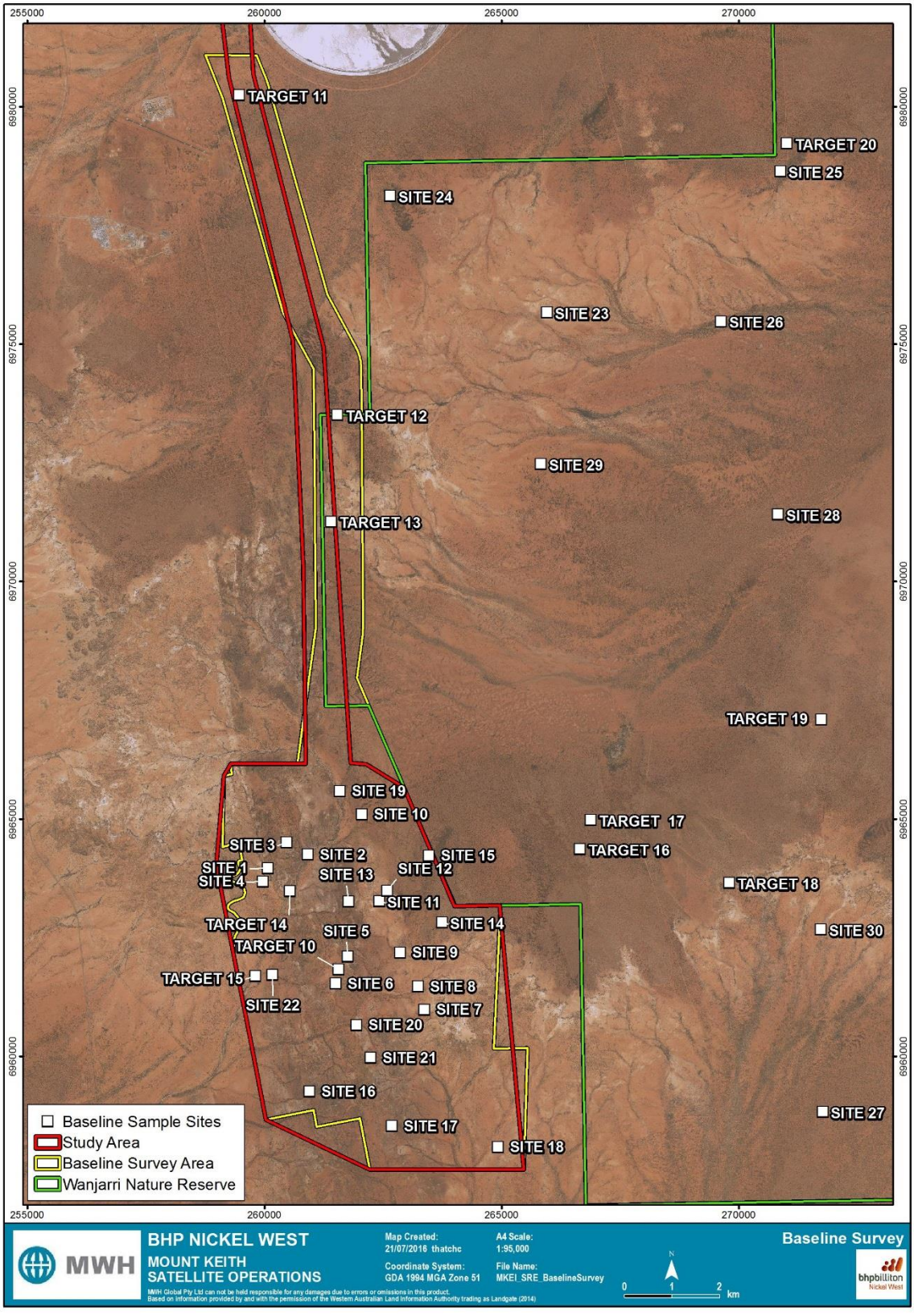

Figure 4-4: Location of systematic and targeted survey sites sampled during the Baseline Survey (phase 1 and phase 2)

4.1.4 SRE habitat assessment

Habitat assessments form an important part of the environmental impact assessment process as it relates to SRE invertebrate fauna. A habitat's potential for supporting SRE fauna can be used to identify habitats of conservation value and may also be used to identify the availability of suitable habitat for SRE species, outside of a disturbance area.

Potential terrestrial SRE habitats within the Baseline Survey Area and neighbouring Wanjarri Nature Reserve were identified and assessed in terms of complexity, quality, connectivity and extensiveness within the landscape. A SRE habitat assessment was conducted for each potential SRE habitat unit identified within the survey areas. This assessment entailed:

- establishment of habitat assessment reference points of suitable replication within representative habitat inside and outside of the disturbance area (where possible) to characterise the extent of SRE habitat in the area; and
- a standardised habitat assessment field sheet was completed for each site. The assessment was made in an area of approximately 50 m x 50 m. Landscape position, outcropping, soil type, broad vegetation type, litter cover, existing disturbance, extensiveness and physical connectivity within the landscape were recorded.

There are no prescriptive guidelines for identifying potential SRE habitats, though the most prospective habitats tend to be those that are sheltered, isolated or both (EPA 2009, Harvey 2002). Information resulting from the habitat assessments of the Baseline Survey Area has been incorporated into the descriptions of each broad habitat identified in the Study Area and is presented in **Section 5.1**.

4.1.5 Collection techniques

The techniques used for collecting SRE taxa during the Baseline survey are summarised in **Table 4-3** and described below. These methods are aligned with those specified by the EPA (2009) and endorsed by invertebrate SRE specialists of the WAM and DPaW (then Department of Conservation [DEC]).

Table 4-3: Summary of SRE sampling methods and effort for phase 1 and phase 2 survey of the Baseline Survey

Sampling technique	Target group	Sampling effort per site		Total effort
		Phase 1 survey	Phase 2 survey	
Wet pitfall trapping	All groups	5 traps open for a total of 60 nights (30 sites)	5 traps open for a total of 27 nights (30 sites)	13,050 trapping nights
Targeted searching	All groups	3 person hours (41 sites)	N/A	123 person hours
Litter collection	All groups	3 samples (30 sites)	N/A	90 samples
Soil sieving	Terrestrial snails	3 samples (30 sites)	N/A	90 samples

Wet pitfall trapping

The DPaW have suggested that wet pitfall trapping for terrestrial SRE invertebrate fauna is likely to be a more effective sampling method than dry pitfall trapping (Brad Durrant pers. comm. March 2010). Wet pitfall trapping involves a longer trapping period, with traps normally left open for up to six weeks. This increases the probability of trapping species that are active only briefly or sporadically, such as species which become active during periods of rainfall. Wet pitfall traps were left open for 60 nights during phase 1 and 27 nights during the phase 2 components of the Baseline Survey. Trapping effort totalled 13,050 trap nights over both phases; 9,000 trap nights in phase 1 and 4,050 trap nights in phase 2.

A wet pitfall trap comprises a plastic container that slots into a buried cylindrical PVC pipe (100 mm x 250 mm). Care was taken to ensure that the top of the container was flush with the top of the PVC pipe and the ground surface. The container was filled with approximately 500 millilitres (ml) of a preserving agent (100% propylene glycol) and a cover was suspended approximately 20 mm above the trap to reduce vertebrate by-catch and to limit rain entering the trap. To increase the effectiveness of the pitfall trap, two drift fences (flywire mesh) measuring approximately 75 centimetres (cm) in length and 15 cm in height were set on each side of the trap. The base of the fence was buried into the ground. Traps were placed at 5 to 10 metre (m) intervals where possible.

Upon the completion of the field survey, wet pitfall traps were removed, all holes back-filled and containers collected and sent back to the MWH (then Outback Ecology) laboratory. The contents of wet pitfall traps were examined using a dissecting microscope in the laboratory. Specimens from target taxa were removed and placed into vials containing 100% ethanol.

Vertebrates are sometimes collected in wet pitfall traps. All vertebrates were identified by Outback Ecology vertebrate fauna specialists. The records of invertebrates and vertebrates identified from both phases of the survey were forwarded to the DPaW (then DEC) as stipulated by the Fauna licenses under which these surveys were executed (Regulation 4 and Regulation 17).

Targeted searching

Each site was searched for SRE invertebrates for three person hours. Microhabitats searched included: leaf litter, beneath logs, bark and rocks, crevices, at the bases of shrubs and trees and beneath Spinifex hummocks. Burrows suspected to be those of mygalomorphs or scorpions were excavated and the occupants, if any, were collected. All specimens were placed into 100 % ethanol upon collection. A total of 123 person hours were spent targeted searching.

Leaf litter collection and Tullgren funnels

Three samples of leaf litter were collected from each site, with a total of 90 samples taken over both surveys. The samples were collected by scraping back the top layer of litter to reveal the decomposition layer above the soil. Leaf litter samples were sealed in plastic bags and kept cool during fieldwork and

subsequent transportation to the MWH (then Outback Ecology) laboratory. Tullgren funnels were used to extract invertebrates from the leaf litter samples. Tullgren funnels use light and heat generated above the sample to encourage the downward movement of invertebrates. Eventually the invertebrates exit the funnel and fall into a container of 100 % ethanol. Leaf litter samples were left in the Tullgren funnels for at least 48 hours. After this time, the collection containers beneath the Tullgren funnels were examined for invertebrates using a binocular microscope. The leaf litter remaining in the funnels was searched for invertebrates using two times magnification.

Soil sieving

At each survey site, three soil samples, each approximately 2 L in volume, were collected and sieved. Areas targeted included potential terrestrial snail habitats, such as, under bushes and trees, at the base of Breakaways, under leaf litter and under rock ledge. Sieved soil (0.1-1.0 cm fraction) was collected and placed into sealed bags. The samples were transported and sorted under magnification at the MWH (then Outback Ecology) laboratory. A total of 90 soil samples were collected and processed over both phases of the Baseline Survey.

4.1.6 Specimen Processing and Identification

Specimens belonging to taxa prone to short-range endemism were delivered to WAM for registration and delivery to taxonomists. The taxonomists whom identified invertebrate specimens are shown in **Table 4-4**.

Table 4-4: Specialist invertebrate taxonomists engaged to identify specimens collected from the surveys

Invertebrate group	Taxonomists	Organisation
Mygalomorph spiders	Dr Volker Framenau	Phoenix Environmental Sciences
Pseudoscorpions and millipedes	Dr Mark Harvey Dr Mieke Burger Dr Catherine Car	Western Australian Museum
Scorpions	Dr Erich Volschenk	Scorpion ID
Snails	Dr Shirley Slack-Smith Mr Corey Whisson	Western Australian Museum
Slaters	Dr Simon Judd	Independent consultant
Genetic analysis	Dr Yvette Hitchen Dr Terrie Finston	University of Western Australia

4.1.7 SRE Baseline Survey Team and Licencing

The SRE Baseline Survey was conducted by experienced MWH invertebrate zoologists (**Table 4-5**).

Table 4-5: SRE Baseline Survey Team

Personnel	Qualifications	Role
Mr. Paul Bolton	B. Sc. (Marine Biology/Zoology) (Hons.)	Senior Environmental Scientist
Dr. Adrian Rakimov	B.Sc. (Zoology) (Hons.), Ph.D.	Senior Invertebrate Zoologist
Dr. Peter Langlands	B.Sc. (Zoology) (Hons), Ph.D.	Invertebrate Zoologist
Mr Matt Quinn	B.Sc (Marine Sci./Environ.Sci.)	Environmental Scientist
Mr. Brad Scanlon		Field Technician

The Baseline Survey was executed under the Licence to Take Fauna for Scientific Purposes (Regulation 17):

Licence No: SF008850
Date of issue: 10/01/2011
Valid from: 10/01/2011
Date of expiry: 09/01/2012

The Baseline Survey was also executed under the Licence to Take Fauna from the Wanjarri Nature Reserve for Scientific Purposes (Regulation 4):

Licence No: CE003099
Date of issue: 10/01/2011
Valid from: 10/01/2011
Date of expiry: 09/01/2012

4.2 Targeted Survey

The targeted survey was primarily conducted to better understand the distribution of a millipede species (*Antichiropus* 'DIP003') that had been collected during the Baseline Survey. The survey focused on the more mesic areas of creek line habitat within the Jones Creek system as this was considered the most favourable habitat for this taxa.

4.2.1 Survey Timing

The Targeted Survey was conducted over two phases between 16 December 2011 – 29 March 2012. This survey timing replicated the February 2011 (phase 1 and phase 2) survey timing when the millipede *Antichiropus* 'DIP003' was originally collected after a substantial rainfall event. These Targeted Survey phases are described as phase 3 and phase 4 to distinguish them from phase 1 and phase 2 conducted during the Baseline Survey. The two survey phases were conducted as follows:

- phase 3 survey: wet pitfall traps were deployed from 16 – 21 December 2011 and collected between 30 – 31 January 2012. Targeted searches and systematic trapping were conducted at each survey site. Habitat mapping was also completed; and
- phase 4 survey: phase 3 wet pitfall traps replaced with phase 4 wet pitfall traps on 1 February 2012. The phase 4 wet pitfall traps were collected on the 29 March 2012.

4.2.2 Weather Conditions

The records from the Yakabindie Homestead and Leinster Bureau of Meteorology weather stations were considered when assessing the weather conditions over the Targeted Survey period. Temperature and Rainfall data were sourced from the Leinster weather station, whereas only rainfall data was available from the Yakabindie Homestead weather station.

During phase 3, the daily maximum temperatures recorded from the Leinster weather station ranged between 20.5 ºC and 41.3 ºC, with minimum temperatures between 15.7 ºC and 27 ºC (BoM 2016). A mean maximum temperature of 34.2 ºC and mean minimum of 21.5 ºC were recorded at Leinster over the survey period, which is similar to the long-term average temperature for the period (BoM 2016). During phase 4, the daily maximum temperatures recorded from the Leinster weather station ranged between 19.4 ºC and 42.5 ºC, with minimum temperatures between 10.9 ºC and 27.6 ºC (BoM 2016). A mean maximum temperature of 35.6 ºC and mean minimum of 21.8 ºC over the survey period were recorded at the Leinster weather station which is similar to the long-term average for the period (BoM 2016). The phase 2, phase 3 and phase 4 survey periods experienced significantly less rainfall than that recorded during the phase 1 survey period.

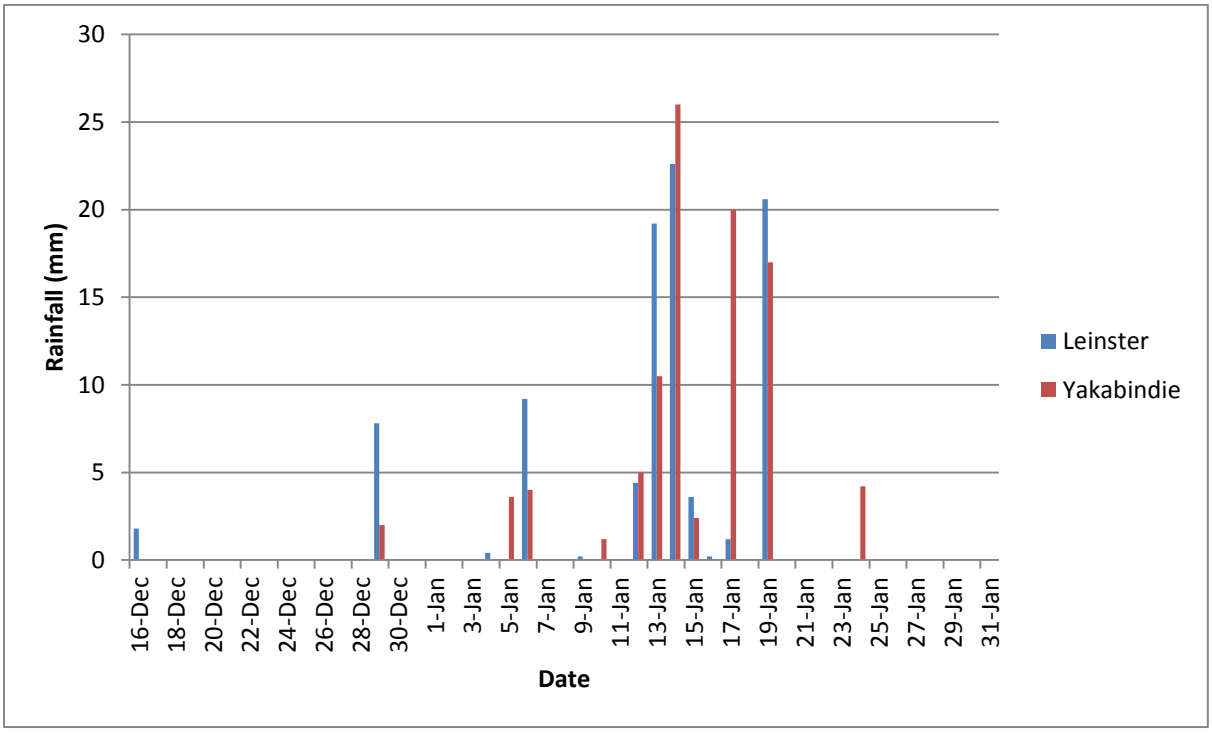

Figure 4-5: Rainfall recorded during the phase 3 survey

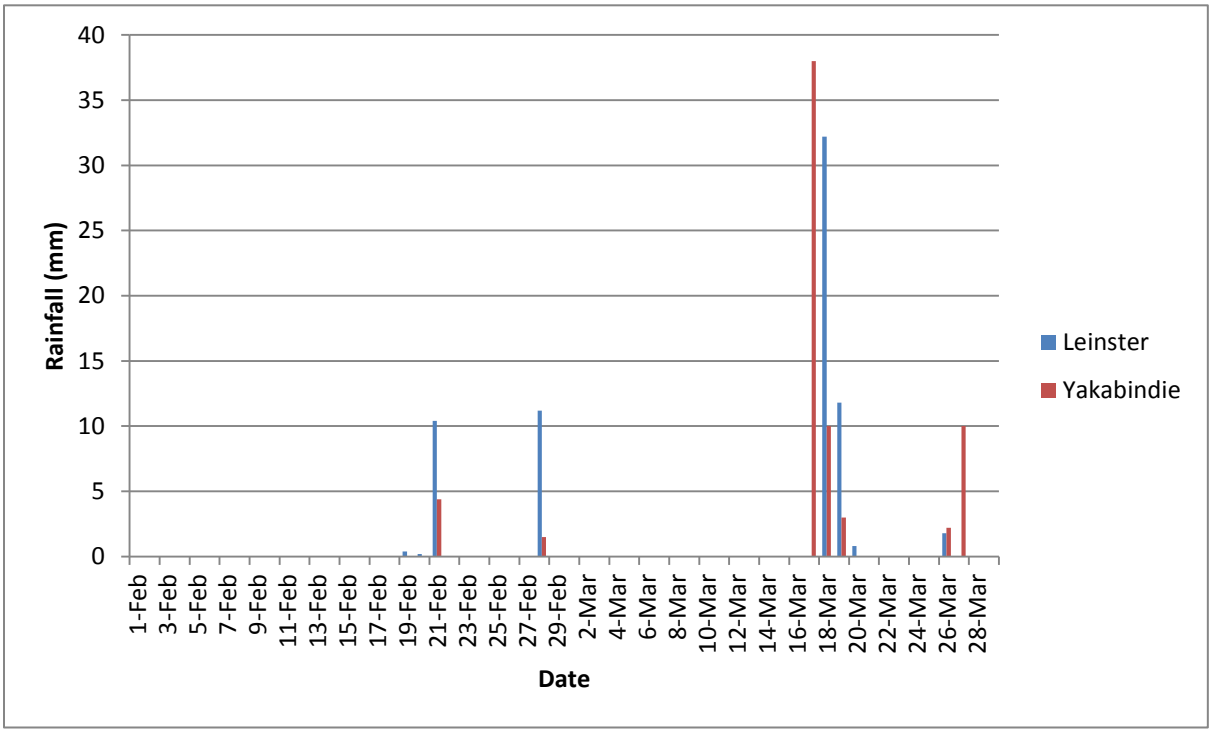

Figure 4-6: Rainfall recorded during the phase 4 survey

4.2.3 Survey Sites

A total of ten systematic survey sites were sampled during the Targeted Survey (**Table 4-6**, **Figure 4-7**). These sites were established in creek line habitat occurring within the Jones Creek system. Additionally, two sites in creek line habitat were target searched where it was not possible to use pitfall traps due to

heritage restrictions on ground disturbance (**Table 4-6**, **Figure 4-7**). To test whether the conditions during the survey were suitable for the activity of *Antichiropus* 'DIP003'; Site 1 and Site 2 from the Baseline Survey (where *Antichiropus* 'DIP003' had been collected during phase 1) were re-established during the Targeted Survey. That way, if no specimens were collected at the new sites, it could be determined whether it was due to the absence of the species in these areas, or due to the lack of activity during the survey period. Invertebrate collection methods employed at systematic survey sites consisted of wet pitfall trapping and targeted searching (**Section 4.2.4**).

Table 4-6: Systematic and targeted survey site locations for the Targeted Survey

Site	Relation to proposed disturbance area	Coordinates (GDA 94 MGA 51J)	
		Easting	Northing
Site T1	Inside	261618	6965487
Site T2	Inside	257494	6958718
Site T3	Downstream	260196	6963614
Site T4	Downstream	258877	6959571
Site T5	Upstream	256695	6957971
Site T6	Upstream	259520	6970442
Site T7	Upstream	259486	6970034
Site T8	Upstream	259496	6969291
Site T9	Upstream	259952	6968635
Site T10	Downstream	259920	6969011
Target T1	Upstream	261042	6966463
Target T2	Upstream	260843	6967739
Target T3	Downstream	253941	6956169

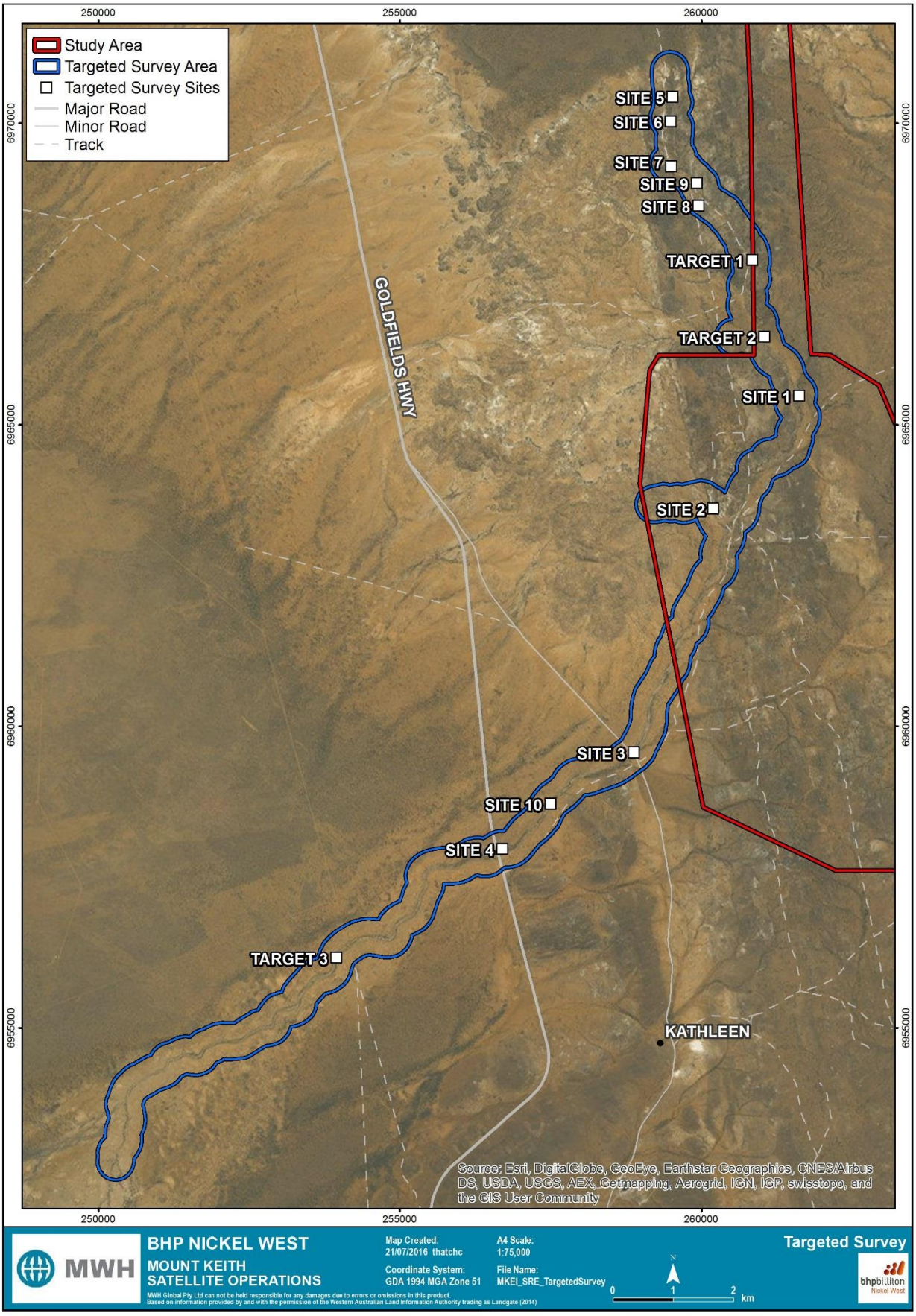

Figure 4-7: Survey sites for the Targeted Survey

4.2.4 Collection Techniques

Wet pitfall trapping and targeted searching were used for collecting SRE invertebrate fauna during this survey (**Table 4-7**). These methods are aligned with those used during phase 1 and phase 2 of the Baseline Survey.

Table 4-7: Summary of SRE sampling methods and effort for Phase 3 and Phase 4 surveys

Sampling technique	Target group	Sampling effort per site		Total effort
		Phase 3 survey	Phase 4 survey	
Wet pitfall trapping	All groups	5 traps open for a total of 47 nights (10 sites)	5 traps open for a total of 44 nights (10 sites)	4,550 trapping nights
Targeted searching	All groups	2 person hours (13 sites)	N/A	26 person hours

Wet Pitfall Trapping

During phase 1 and phase 2 of the Baseline survey, all 36 specimens of the millipede *Antichiropus* 'DIP003' collected from wet pitfall traps, hence, this technique was employed again for phase 3 and phase 4 of the Targeted Survey. Wet pitfall traps were left open for 47 nights during phase 3 and 44 nights during phase 4 of the Targeted Survey. Trapping effort totalled 4,550 trap nights over both phases; 2,350 trap nights in phase 3 and 2,200 trap nights in phase 4. All other aspects of the wet pitfall trapping followed those for methods for wet pitfall trapping outlined under **Section 4.1.5**.

Targeted Searching

Each site was searched for millipede taxa for two person hours. Microhabitats that were searched included: leaf litter, beneath logs, bark and rocks, crevices, at the bases of shrubs and trees and beneath Spinifex hummocks. Additionally, three sheets of cardboard (30 cm x 20 cm) were placed at each of the systematic trapping sites and weighted down with soil and rocks. Searching for millipedes was conducted beneath these sheets when collecting the pitfall traps. All specimens were placed into 100 % ethanol upon collection. A total of 26 person hours were spent targeted searching.

4.2.5 SRE habitat assessment

Habitat assessments were completed using the same habitat assessment form as was used during the Baseline Survey (**Section 4.1.4**). The specimens of *Antichiropus* 'DIP003' collected during phase 1 and phase 2 of the Baseline Survey occurred in association with creek line habitat within the Jones Creek system. Therefore, the extent of creek line habitat occurring within the Jones Creek system was quantified as part of this Targeted Survey. Creekline habitat within the Jones Creek system was identified and assessed in terms of complexity, quality, connectivity and extensiveness within the landscape.

4.2.6 Specimen Processing and Identification

Millipede specimens were delivered to the WA Museum for registration and delivery to taxonomists. The taxonomists whom identified invertebrate specimens are shown in **Table 4-4**.

Table 4-8: Specialist invertebrate taxonomists engaged to identify specimens collected from the surveys

Invertebrate group	Taxonomists	Organisation
millipedes	Dr Mark Harvey Dr. Catherine Car	Western Australian Museum

4.2.7 SRE Targeted Survey Team and Licensing

The SRE Targeted Survey was conducted experienced MWH invertebrate zoologists (**Table 4-9**).

Table 4-9: SRE Targeted Survey Team

Personnel	Qualifications	Role
Mr Matt Quinn	B.Sc (Marine Sci./Environ.Sci.)	Environmental Scientist
Mr Arnold Slabber	B.Sc (Aquatic Science) (Hons.)	Environmental Scientist

The surveys were executed under the Licence to Take Fauna for Scientific Purposes (Regulation 17):

Licence No: SF008382

Valid from: 15/12/2011

Date of expiry: 14/12/2012

5 Results and Discussion

The results of the Baseline Survey, the Targeted Survey and the Desktop Study are summarised within this section and discussed with respect to the Study Area. The occurrence of habitats within the Study Area was informed by the findings of the Baseline Survey and Targeted Survey (**Section 5.1**). The occurrence of SRE species within the Study Area was informed by the findings of the Baseline Survey, the Targeted Survey and the Desktop Study (**Section 5.2**).

5.1 Terrestrial SRE Invertebrate Fauna Habitats

The Baseline survey and Targeted survey identified a total of eight broad habitats occurring within the Study Area. One additional habitat type 'Spinifex Sandplain' was recorded in the neighbouring Wanjarri Nature Reserve. Areas of each habitat within the survey areas and within the Study Area are presented in **Table 5-1**, **Figure 5-1** and **Figure 5-2**. The areas of habitats from the survey areas are presented here to provide regional context to the Study Area, however, the habitats within the Study Area will be the focus of the Impact Assessment. Each of these habitats were broadly categorised as having a high, medium or low potential to support SRE species on the basis of forming sheltered microhabitats or by forming habitat isolates (**Section 4.1.4**). Habitat descriptions are provided in **Sections 5.1.1 - 5.1.9**.

As outlined in **Section 4**, some areas of the Study Area used for this assessment extend outside of areas surveyed during the Baseline and Targeted Survey (**Figure 1-2**). For these additional areas, habitat mapping was extrapolated based on aerial imagery with reference to mapping from the Baseline Survey and the Targeted survey.

Table 5-1: Assessment of habitats within the Baseline Survey Area, Wanjarri Nature Reserve and the Targeted Survey and their potential to support SRE taxa

Fauna Habitat	Potential to support SRE species	Area (ha) of habitat				Habitat Description
		Baseline Survey Area	Wanjarri Nature Reserve*	Targeted Survey Area*	Study Area	
Internal drainage	High	17.8	166.8	-	17.1	These areas of low elevation tend to form isolated, sheltered environments with elevated soil water content.
Creekline	High	77.2	-	251.2	76.7	Sheltered creek line with banked sides and unique riparian vegetation subject to ephemeral flows.
Breakaway	Medium	86.8	335.9	-	66.7	Breakaways provide sheltered areas that do not receive direct sunlight for much of the day. These habitats are isolated from other sheltered areas within the landscape.
Mulga over Spinifex Sandplain	Low	784.7	8,147.1	13.2	417.2	Leaf litter from Mulga trees provides an important habitat for species located within the Spinifex Sandplain habitat. However the habitat is relatively well represented in the surrounding landscape.
Stony Hill and Slope	Medium	1,818.7	18.3	431.3	1,928.7	Hill and slope were exposed for much of the day and provided limited sheltered areas for relictual species. However, the system of hill and slope in the Study Area is isolated from similar systems in the region.
Drainage Line	Medium	448.5	2,958.1	70.8	496.2	In general, drainage lines provide more shelter than surrounding habitats.
Sparse Mulga Woodland	Low	1,092.1	4,868.1	906.3	1034.7	Sparse Mulga Woodlands provide little shelter when compared to other habitats in the landscape.
Stony Plain	Low	1,349.0	13,481.0	-	1,292.8	Stony Plains were exposed for much of the day and provided limited sheltered areas for relictual species. Additionally, they form a habitat that is extensive and contiguous in the landscape.
Spinifex Sandplain	Low	-	22,586.9	5.8	-	The Spinifex Sandplain was exposed for much of the day and provided limited sheltered areas for relictual species. Additionally, they form a habitat that is extensive and contiguous within the Wanjarri Nature Reserve. This habitat does not occur within the Study Area.
Disturbance	Low	-	-	-	91.8	Areas cleared for mining. Largely present in the northern portion of the Study Area
Totals		**5,675**	**52,563**	**1,679**	**5,422**	

* Areas overlap the Study Area and Baseline Survey Area

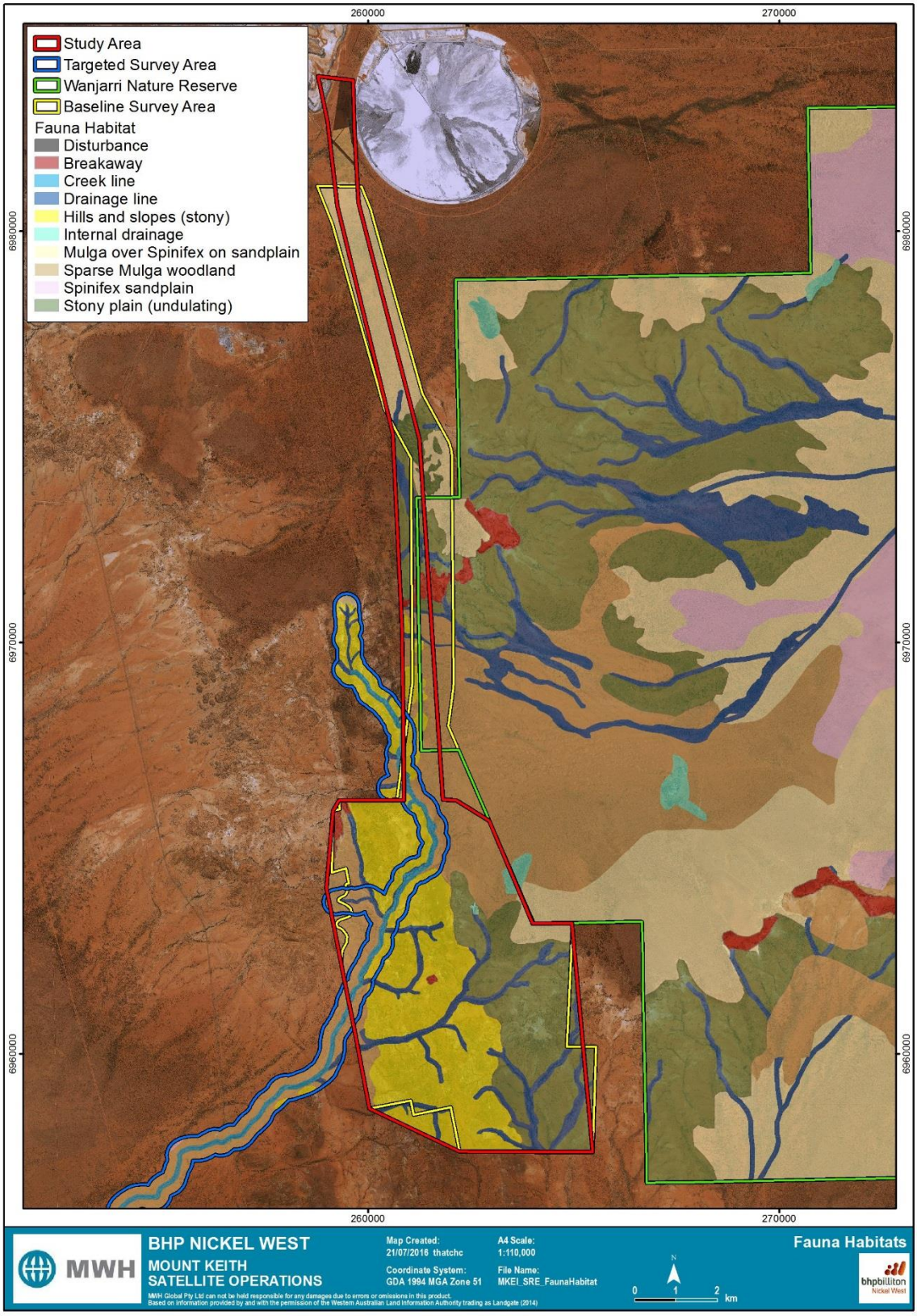

Figure 5-1: Habitat types within the Study Area

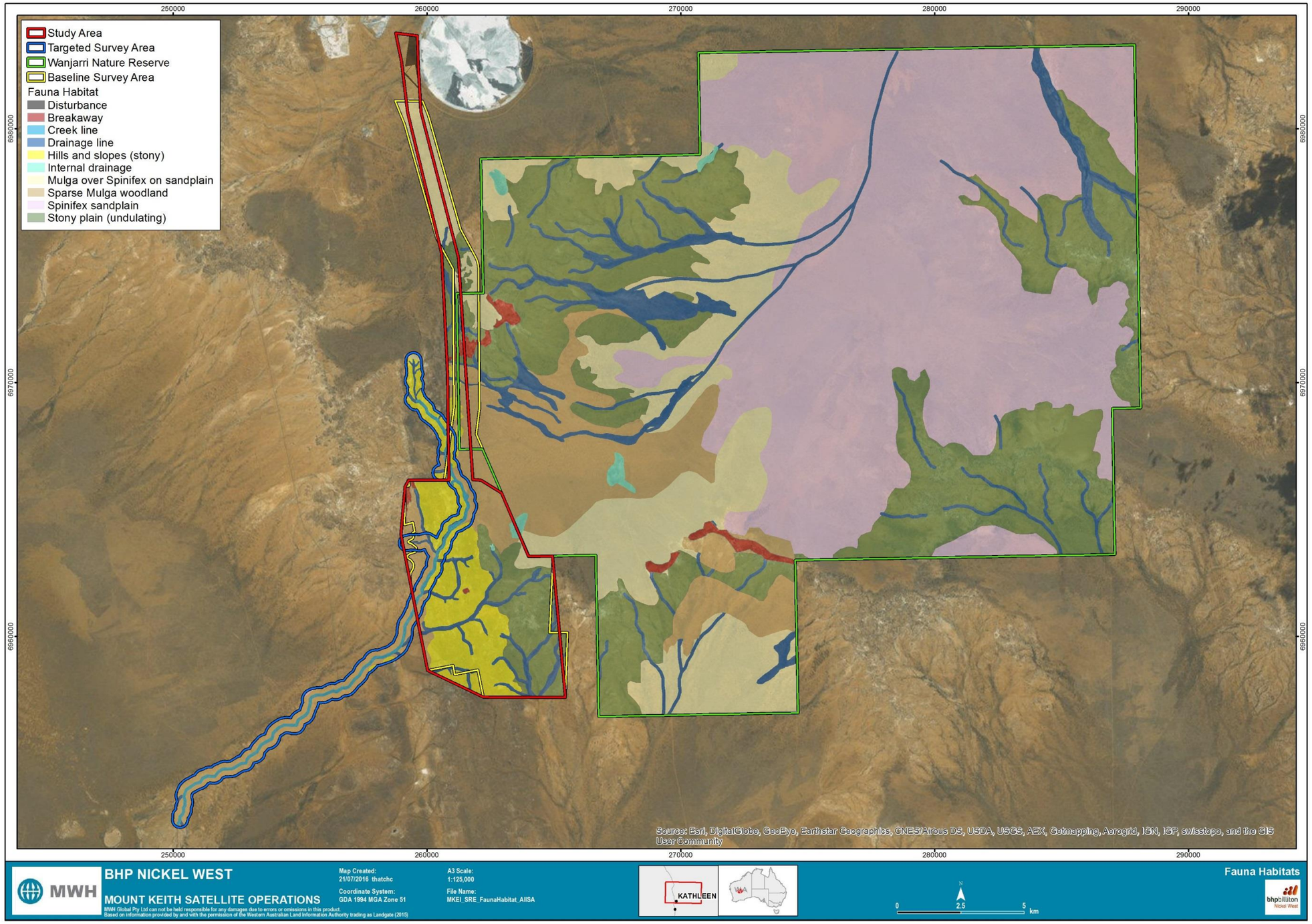

Figure 5-2: Habitats within the vicinity of the Study Area

5.1.1 Creekline

Creekline habitat has a high potential for supporting SRE species as this habitat has isolated, sheltered microhabitats with unique riparian vegetation. The habitat is characterised by alluvium with banked sides and riparian vegetation. The habitat is well connected throughout its extent, yet isolated from similar habitat in the surrounding landscape. The Creekline habitat is associated with areas of low topography and local overland flows.

Creekline habitat within the Study Area exits as part of the Jones Creek system which flows south west through the central portion of the Study Area (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat does not occur in the Wanjarri Nature Reserve, however it does occur both upstream and downstream of the Study Area. Upstream of the Study Area, the Jones Creek system flows from its headwaters in the Bar Smith range north of the Study Area. Downstream of the Study Area, Jones Creek flows in a south west direction for approximately 20 km to where it fans out and flows underground at a point approximately 6 km north west of the Yakabindie homestead. The water from Jones Creek then re-emerges approximately 7.5 km to the south of this point where it feeds into Lake Miranda.

Creekline habitat was assessed at two systemic survey sites and two targeted survey sites during the Baseline Survey (**Table 4-1, Table 4-2**, **Figure 4-4**) and at ten systematic and 3 targeted search sites during the Targeted Survey (**Table 4-6**, **Figure 4-7**).

Vegetation primarily comprised low woodlands of *Acacia aneura* with sparse *Eucalyptus camaldulensis* on the fringing banks, with an understorey of various *Acacia* species. Leaf litter accumulations were plentiful. The substrate consisted of alluvium and duplex soils, relictual, sandy red loams and gravels over clay, with naturally low nutrient and moisture content (Western Botanical 2011).

5.1.2 Internal Drainage

Internal drainage habitat has a high potential for supporting SRE species as this habitat forms isolated, sheltered environments that tend to have elevated soil moisture content. Connectivity is poor as this habitat forms in drainage basin landforms which are generally surrounded by areas of increased elevation. Vegetation in these habitats is typically denser when compared to habitats in the surrounding area. This vegetation provides increased levels of shelter and leaf litter accumulation which creates important invertebrate microhabitats.

Internal drainage habitat occurs in occurs in a small portion in the east of the Study Area. This habitat is also known to occur in the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at four systematic survey sites during the Baseline Survey (**Table 4-1**, **Figure 4-4**). Vegetation primarily comprised dense *Acacia aneura* with an understorey of *Eremophila* and *Triodia* species. The substrate consisted of sandy loam soils.

5.1.3 Breakaway

Breakaway habitat has a medium potential of supporting SRE species as this habitat forms isolate environments that provide sheltered areas that do not receive direct sunlight for much of the day. These areas may also serve as fire refuges. The habitat is characterised by quartz or lateritic Breakaways and associated scree slopes.

Breakaway habitat occurs in both the Study Area and the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at two targeted survey sites during the Baseline Survey (**Table 4-2**, **Figure 4-4**).

Vegetation was limited in this habitat, comprising sparse low woodlands of *Acacia aneura* with an understorey of various *Atriplex* and *Triodia* species. The substrate consisted of an eroded quartes sand and sandy loam soils.

5.1.4 Stony Hills and Slopes

Stony Hill and Slope habitat has a medium potential to support SRE species as this habitat is isolated from similar habitat in the surrounding landscape. The habitat is relatively well connected north to south through the Study Area. Disturbance was evident within this habitat, specifically the construction of recent exploration infrastructure such as roads and drill pads as well as the felling of large Mulga trees from historic mining activities. This habitat was exposed for much of the day and provided limited sheltered areas for relictual species. Stony Hills and Slopes tend to occur in association with the Bevon land system which is relatively uncommon in the Eastern Murchison sub-bioregion (**Table 2-1**).

Stony Hill and Slope habitat occurs within the Study Area, however, does not occur in the Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at seven systemic survey sites during the Baseline Survey (**Table 4-1**, **Figure 4-4**).

Vegetation typically comprised low open woodland of *Acacia aneura*, *Acacia quadrimarginea* and *Acacia pruinocarpa* with an understorey of *Eremophila*, *Prostanthera* and *Dodonaea* species. The substrate consisted of red sand and sandy loam soils with a surface layer that had a high coverage of loose lateritic material.

5.1.5 Mulga over Spinifex on Sandplain

Mulga over Spinifex Sandplain habitat has a low potential to support SRE species as the habitat is well connected and relatively well represented throughout the landscape. The deep sands provide a suitable substrate for burrowing invertebrate species. Additionally, leaf litter from Mulga trees provides an important habitat for species located within this habitat. Mulga over Spinifex Sandplain habitat tends to occur in association with the Bullimore land system which is relatively common in the Eastern Murchison sub-bioregion (**Table 2-1**).

Mulga over Spinifex Sandplain occurs in both the Study Area and the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at three systematic survey sites and seven targeted survey sites during the Baseline Survey (**Table 4-1, Table 4-2**, **Figure 4-4**).

Vegetation comprised of open low woodland of *Acacia aneura* and *Acacia quadrimarginea* with an understorey of hummock grassland dominated by *Triodia basedowii*. The substrate consisted of red sand and sandy loam soils.

5.1.6 Drainage Line

Drainage line habitat has a medium potential to support SRE species as it creates sheltered areas on a suitable substrate for burrowing species. The habitat is well connected throughout its extent, yet isolated from similar habitat in the surrounding landscape. Drainage Line habitats are associated with areas of low topography and local overland flows.

Drainage Line habitat occurs in both the Study Area and the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at five systematic survey sites during the Baseline Survey (**Table 4-1, Figure 4-4**).

Vegetation tended to comprise of low open woodland of *Acacia aneura* with a sparse understorey of various *Atriplex* and *Triodia* species. The substrate consisted of alluvium over red clay and sandy loam soils.

5.1.7 Sparse Mulga Woodland

Sparse Mulga Woodland habitat has a low potential to support SRE species as it creates limited sheltered areas for relictual species. The habitat is well connected throughout the surrounding landscape.

Sparse Mulga Woodlands habitat occurs in both the Study Area and the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at four systemic survey sites during the Baseline Survey (**Table 4-1, Figure 4-4**).

Vegetation comprised of low very open woodland of *Acacia aneura* with a sparse understorey of *Scaevola spinescens*, *Rhagodia drummondii* and *Eremophila exilifolia*. The substrate consisted of red sands and sandy loams with a surface layer of loose lateritic material.

5.1.8 Stony Plain

Stony Plain habitat has a low potential to support SRE species as it creates limited sheltered areas for relictual species. The habitat is well connected throughout the surrounding landscape.

Stony Plain habitat occurs in both the Study Area and the neighbouring Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). This habitat was assessed at five systematic survey sites during the Baseline Survey (**Table 4-1, Figure 4-4**).

Vegetation comprised of low open woodland of *Acacia aneura* and *Acacia tetragonophylla* with a very scattered shrub layer consisting of *Eremophila platycalyx*, *Rhagodia drummondii*, *Senna artemisioides* and *Sida ectogama*. The substrate primarily consisted of red sandy loams with a surface layer of loose lateritic material.

5.1.9 Spinifex Sandplain

Spinifex Sandplain habitat has a low potential to support SRE species as it creates limited sheltered areas for relictual species. The habitat is well connected throughout the surrounding landscape and appears to occur in association with the Bullimore land system which is relatively common in the Eastern Murchison sub-bioregion (**Table 2-1**).

Spinifex Sandplain habitat does not occur within the Study Area, however it comprises almost half of the Wanjarri Nature Reserve (**Table 5-1**, **Figure 5-1**, **Figure 5-2**). Vegetation generally comprised of low very open woodland of *Acacia aneura* with a closed grassland understorey dominated by *Triodia* sp. The substrate primarily consisted of red sand and clay soils.

5.2 Terrestrial SRE Invertebrate Fauna

Results from the Baseline Survey, Targeted Survey, Desktop Study and habitat mapping, combined with regional knowledge and ecological data, were used to inform the occurrence of SRE species within the Study Area. Detailed taxonomic reports completed in 2011 and 2012 have been reviewed by relevant taxonomists in April 2016 to ensure that all species listings are current i.e. that all specimens identified as SRE species were still considered to be SRE species and that all specimens identified as widespread species are still considered to belong to widespread species.

Key changes since the taxonomic reports were completed are summarised below:

- Arachnids (mygalomorphs) (**Appendix B** & **Appendix C**): No changes to taxonomy or SRE status (Tim Moulds WAM *pers comm*., 18/5/16).
- Scorpions (**Appendix D**): *Lychas annulatus* was previously considered a widespread species, but is now considered to be a Potential SRE (Data deficient see **Section 1.3**) following evidence from analysis of DNA sequences. No other changes (Erich Volschenk *pers comm*., 24/3/16).
- Pseudoscorpions and Millipedes (**Appendix E** & **Appendix F**): All pseudoscorpions of the Family Olpiidae are now considered Potential SRE (Data deficient see **Section 1.3**). No other changes (Tim Moulds WAM *pers comm*., 18/5/16)..
- Slaters (**Appendix G**): Substantial taxonomic revision of the families has occurred since the original taxonomic report. A new taxonomic report has been issued (Simon Judd *pers comm*., 17/6/16).
- Molluscs (**Appendix H**): No changes. All molluscs collected are still not considered to represent SRE species (Corey Whisson *pers comm*., 29/3/16).

5.2.1 SRE Species Recorded from the Baseline Survey Area, Wanjarri Nature Reserve and the Targeted Survey Area.

The survey of the Baseline Survey Area and Wanjarri Nature Reserve yielded a total of 1,680 invertebrate specimens from 48 species or morphospecies. Hereafter, the term 'species' will be used to refer to both species and morphospecies. A further 38 specimens from two species were recorded during the Targeted Survey. A summary of the number of specimens and species sampled from each of the targeted invertebrate taxa during the surveys are presented in **Table 5-2**. Slaters were the most numerous group to be collected, followed by pseudoscorpions, scorpions, mygalomorph spiders, millipedes and snails.

Table 5-2: Summary of invertebrates from SRE taxa collected from the Baseline Survey Area, Wanjarri Nature Reserve and the Targeted Survey Area.

Target group	Baseline Survey		Targeted Survey		Total	
	Number of specimens	Number of species	Number of specimens	Number of species	Number of specimens	Number of species
Mygalomorph spiders	168	15	-	-	168	15
Scorpions	195	9	-	-	195	9
Slaters	832	8	-	-	832	8
Snails	10	4	-	-	10	4
Pseudoscorpions	439	11	-	-	439	11
Millipedes	36	1	2	2	38	2
TOTAL	**1,680**	**48**	**38**	**2**	**1682**	**49**

Of all the invertebrates collected during the surveys, based on current known species distributions, two were considered by experts as Confirmed SRE species (two millipedes), four as Likely SRE species (one mygalomorph spider, one pseudoscorpion and two slaters) and 23 as Potential SRE species (**Table 5-3**, **Figure 5-3**). All of these species had specimens collected within the Study Area.

Of the potential SRE species, 10 were identified to species or morphospecies, while 13 could not be identified to this level due to being of an inappropriate age or sex for identification (assigned the suffix 'sp.' or 'indet'). As a conservative measure, these are included as potential SREs in **Table 5-3**. It is difficult to draw conclusions on the distributions of the unidentified specimens included in **Table 5-3** without undertaking comparative molecular analysis with reference collections. Additionally, it should be noted that unidentified specimens may also represent identified taxa included in **Table 5-3**.

Table 5-3: SRE species collected from the Study Area

Group	Taxa	SRE status
Mygalomorph spiders	*Aname* 'MYG235'	Likely SRE
	Idiosoma sp.	Potential SRE
	Cethegus sp.	Potential SRE
	Conothele sp.	Potential SRE
	Aganippe sp.	Potential SRE
	Anidiops sp.	Potential SRE
	Yilgarnia sp.	Potential SRE
Scorpions	*Urodacus* cf 'gibson 5'	Potential SRE
	Lychas annulatus	Potential SRE
Pseudoscorpions	*Synsphyronus* `sp. PSE023`	Likely SRE
	`Genus 7/4` sp.	Potential SRE
	Austrohorus sp.	Potential SRE
	Beierolpium `sp. 8/2`	Potential SRE
	Beierolpium `sp. 8/3`	Potential SRE
	Beierolpium `sp. 8/4 small`	Potential SRE
	Indolpium sp.	Potential SRE
	Linnaeolpium sp.	Potential SRE
Slaters	*Budddelundia* 96	Potential SRE
	Budddelundia 45	Potential SRE
	Cubaris yeelirrie1	Potential SRE
	Cubaris yeelirrie2	Potential SRE
	Pseudodiploexochus yakabindie	Likely SRE
	Armadillidae yakabindie a	Potential SRE
	Armadillidae yakabindie b	Likely SRE
	Armadillidae sp. indet.	Potential SRE
	Philosciidae sp. indet.	Potential SRE
	Trichorhina sp. indet.	Potential SRE
Millipedes	*Antichiropus* 'DIP003' (formerly *Antichiropus* 'sp. yakabindie')	Confirmed SRE
	Antichiropus 'DIP002'	Confirmed SRE

* *Yellow highlight:* Species not identified to species or morphospecies

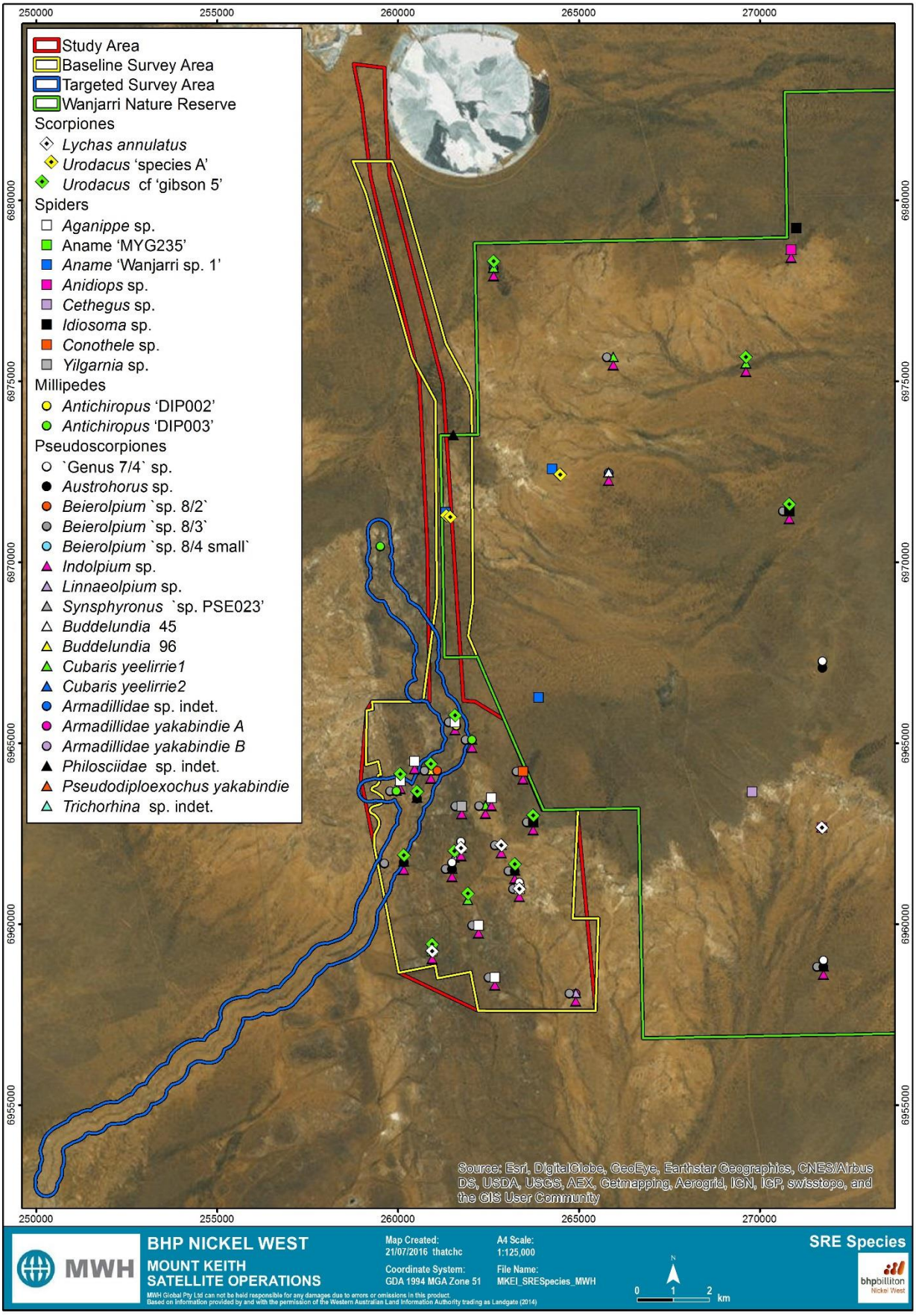

Figure 5-3: SRE species collected from the Study Area

5.2.2 SRE Species recorded during the desktop study from the wider region

The desktop study identified 42 potential SRE taxa occurring within 50 km of the Study Area. Of these, two were recorded within the Study Area (Biota 2006, WAM 2016a):

- *Aname* 'Wanjarri sp. 1' (mygalomorph spider) and;
- *Urodacus* 'species A' (scorpion).

Both of these species have also been recorded at a number of locations outside the Study Area in the adjoining Wanjarri Nature Reserve. These species are considered further in **Section 5.2.3.**

Additionally, four potential SRE species were recorded in close proximity (within 10 km) to the Study Area (**Figure 5-4**). These records include the mygalomorph spider *Kwonkan moriartii* which is listed as Priority 2 under the DPaW's Priority Species List. The potential SRE species recorded within 10 km of the Study Area included:

- *Aname* `Wanjarri sp.2`
- *Kwonkan moriartii*
- *Urodacus* `SCO009, Biota 2`
- *Urodacus* `species B (Biota)`

Database returns where specimens were not identified to species or morphospecies have been removed from the search results. This was because without a species or morphospecies, it is not possible to make an informative comparison with other specimens from the database or with specimens collected in this study.

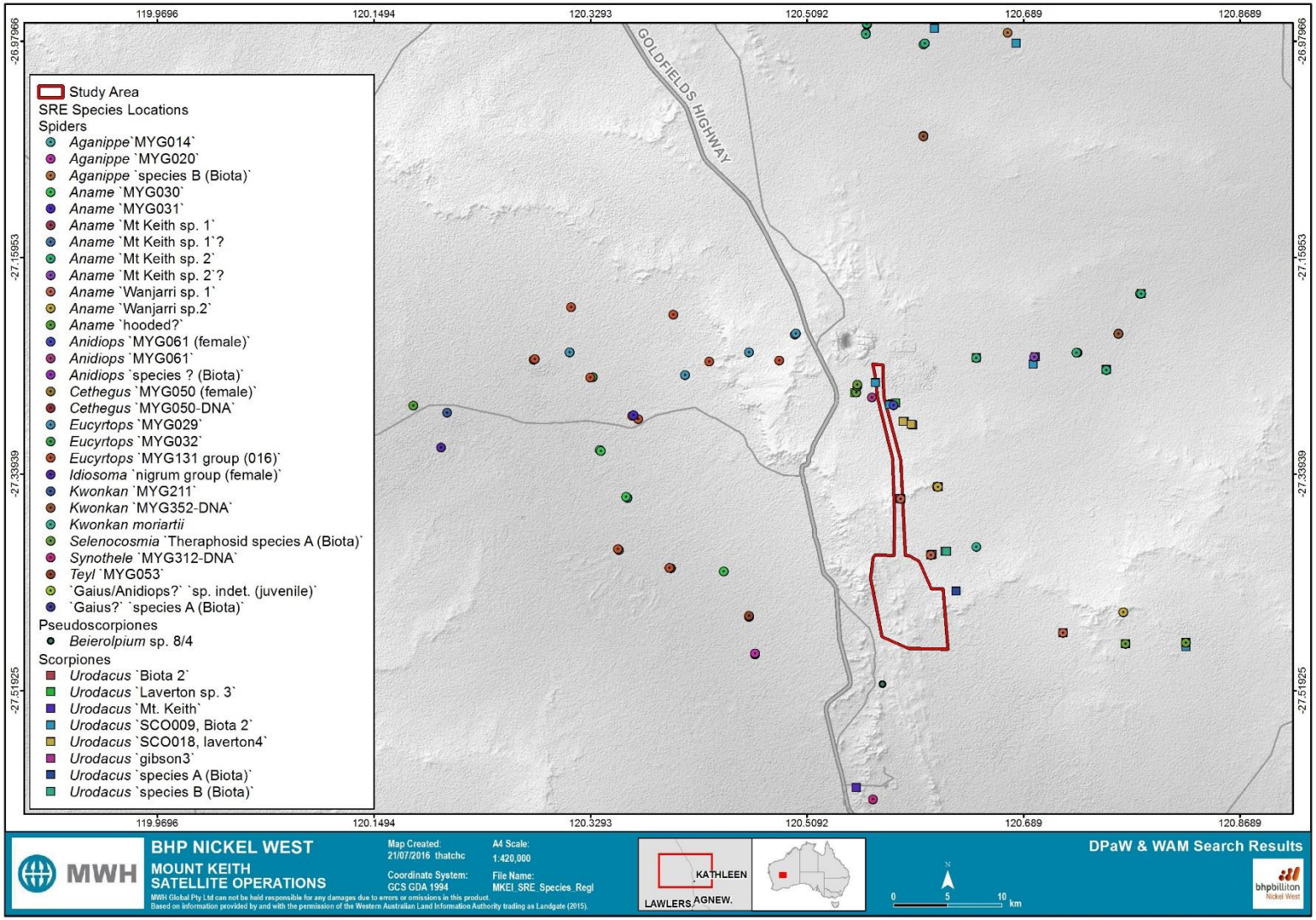

Figure 5-4: SRE species identified from the desktop study

5.2.3 SRE Species and habitat associations

In total, based on this study and previous studies, there are two Confirmed, four Likely and 25 Potential SRE species (23 from this study and two from the desktop study) that have been collected within the Study Area (**Table 5-4**). The two confirmed SRE species are the millipedes, *Antichiropus* 'DIP002' and 'DIP003'. The four Likely SRE species include the spider *Aname* 'MYG235', the pseudoscorpion *Synsphyronus* `sp. PSE023' and the slaters Armadillidae 'yakabindie b' and *Pseudodiploexochus* 'yakabindie'.

Millipede: *Antichiropus* 'DIP002'

Antichiropus 'DIP002' is a confirmed SRE species that is only represented by a single specimen collected during phase 3 (targeted survey). No other collection records of this species have been made since the surveys. The genus *Antichiropus* consists almost entirely of species with restricted distributions, where only two out of the approximately 160 species have widespread distributions (Car and Harvey 2014, Harvey 2002). Each species is distinguished by shape of the male gonopods. This method has been used in millipede taxonomy for 150 years and has been shown to be a good indicator of valid biological species (**Appendix E**). The single specimen was collected from within the Creekline habitat inside the Study Area (**Table 5-4**, **Figure 5-5**).

Millipede: *Antichiropus* 'DIP003'

Antichiropus 'DIP003' (formally known as 'sp. nov. Yakabindie') is a confirmed SRE species that has only been collected during the Baseline and Targeted surveys. *Antichiropus* 'DIP003' was collected from a total of six locations inside the Study Area (**Table 5-4**, **Appendix E**, **Appendix F**).

Of the 37 individuals collected during the baseline and targeted surveys, 35 specimens were collected during phase 1 of the baseline survey. Only a single specimen was collected during phase 2 survey of the baseline survey and a single specimen collected during phase 4 during the targeted survey. No specimens of *Antichiropus* 'DIP003' were collected during phase 3 survey. Rainfall during the phase 1 baseline survey was above average compared to previous years and was substantially higher than rainfall during the other survey periods (**Figure 4-2**). This suggests that the activity of this species is associated with significant rainfall events. Significant rainfall events typically occur between January and March each year (**Section 2.5**).

Of the six locations where this species has been recorded, two sites (21 specimens) were within the Creekline habitat, two sites (10 specimens) were within the Stony Hill and Slope habitat and two sites (6 specimens) were within the Sparse Mulga Woodland habitat (**Table 5-4**, **Figure 5-5**). However, it should be noted that all of these sites were in close proximity to Jones Creek and had drainage features that connected with the Creekline habitat. All but one of these six sites occur inside of the Study Area.

Mygalomorph spider: *Aname* 'MYG235'

The mygalomorph spider *Aname* 'MYG235' is a likely SRE species and is only know from the single record within the Study Area. No other collection records of this species have been made since the surveys.

This species was collected within the Stony Hills and Slopes habitat (**Table 5-4**, **Figure 5-5**). This habitat does not occur in the Wanjarri Nature Reserve, however, it does occur to the north and south of the Study Area (**Figure 5-5**).

Pseudoscorpion: *Synsphyronus* `sp. PSE023'

The pseudoscorpion *Synsphyronus* `sp. PSE023' is a likely SRE species known from a single record within the Study Area. No other collection records of this species have been made since the surveys. This species was collected in the Internal Drainage habitat which forms habitat isolates within the Study Area and the adjoining Wanjarri Nature Reserve (**Table 5-4**, **Figure 5-5**). Connectivity between these habitat isolates is poor and therefore this species may have a fragmented distribution. *Synsphyronus* `sp. PSE023' was not recorded at the three other Internal Drainage sites surveyed during the baseline survey.

Slater: Family Armadillidae 'yakabindie b'

This species from the family Armadillidae is considered a likely SRE species and is only known from a single specimen collected during the baseline survey inside the Study Area. The species has morphologically similar characteristics to a species collected in the jarrah forest and one from the Goldfields. The single specimen of this species was collected within the Stony Hills and Slopes habitat. This habitat does not occur in the Wanjarri Nature Reserve, however, it does occur to the north and south of the Study Area (**Figure 5-5**).

Slater: *Pseudodiploexochus* 'yakabindie'

The slater *Pseudodiploexochus* sp. nov. is considered a likely SRE species and is only known to occur within the Study Area and Wanjarri Nature Reserve (**Figure 5-5**). Species from the genus *Pseudodiploexochus* are usually associated with high rainfall areas in the south-west of Western Australia where almost all are SRE species (**Appendix G**). Specimens of *Pseudodiploexochus* sp. nov. were collected from the Creekline, Drainage Line, Stony Hill and Slope, Sparse Mulga Woodland, Stony Plain and Mulga Over Spinifex on Sand Plain habitats (**Table 5-4**). Although this species has only been recorded from a limited distribution, it appears to inhabit a variety of habitats.

Potential SRE Species

For Potential SRE species, there exists some uncertainty over whether the species has a restricted range. In these situations, habitat is a useful indicator to whether a Potential SRE species is likely to have a restricted range or not, as species are likely to have distributions that align with the habitats within which they were collected.

Of the 25 Potential SRE species that have been collected from the Study Area (23 from these surveys and 2 from the desktop study), only two were collected exclusively from habitats that were considered to have medium to high potential to support SRE species (**Table 5-4**; **Figure 5-5**). The remaining Potential SRE species are unlikely to represent true SRE species as they were collected from habitats that were widespread, well connected, and lacked microhabitats (**Table 5-1**). This suggests that the potential SRE

status of these species may not represent restricted distributions but rather a lack of taxonomic resolution and/or regional records (**Table 1-1**). It should be noted that where specimens are grouped under 'sp' or 'indet', there exists the possibility that they comprise more than one species.

The two Potential SRE species collected exclusively from habitats with a high or medium potential to support SRE taxa were (**Table 5-4**; **Figure 5-5**):

- *Conothele* sp. (spider), and
- *Beierolpium* `sp. 8/2` (pseudoscorpion)

Mygalomorph spider: *Conothele* sp.

Mygalomorph spider specimens from the genus *Conothele* were collected at four locations during the baseline survey, all from within habitats with high or medium potential to support SRE species. It should be noted that because these specimens were females and juveniles, they could not be identified to species or morphospecies (**Appendix B**). Consequently, it is not known whether these specimens all represent the same species or comprise of more than one species. These specimens are considered to represent a potential SRE species given that the genus was found to be regionally diverse during the DEC Carnarvon Basin regional survey (**Appendix B**). Three of these species were recorded from the Internal Drainage habitat which forms habitat isolates within the Study Area and the adjoining Wanjarri Nature Reserve (**Table 5-4**; **Figure 5-5**). A single specimen was recorded from the Stony Hills and Slopes habitat which does not occur in the Wanjarri Nature Reserve, however, it does occur to the north and south of the Study Area (**Figure 5-5**).

Pseudoscorpion: *Beierolpium* `sp. 8/2`

The pseudoscorpion *Beierolpium* `sp. 8/2` is a potential SRE species and the single specimen was collected from the Creekline habitat which has a high potential to support SRE species. All of the Family Olpiidae have recently been considered to have potential to represent SRE species based on a lack of taxonomic information. This includes a number of genera that were collected during the baseline survey including *Austrohorus*, *Beierolpium*, *Indolpium, Linnaeolpium* and Genus '9/4'. Of these, three species from the genus *Beierolpium* were collected during the survey. All of these specimens from the family Olpiidae were collected from widespread and unrestricted habitats in the landscape with the exception of *Beierolpium* `sp. 8/2`. As *Beierolpium* `sp. 8/2` is a potential SRE species, it is possible that is restricted to the Creekline habitat. The Creekline habitat is restricted to Jones Creek which occurs in the central portion of the Study Area and extends both upstream and downstream of the Study Area.

Table 5-4: SRE species, collection location, number of specimens and habitat

Green indicates species collected from habitats with low potential to support SRE species. Orange indicates species collected from habitats with high or medium potential to support SRE species.

Taxonomic group			Spider								Scorpion			Pseudoscorpion								Slater										Millipede	
SRE Status			Likely	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Likely	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Potential	Likely	Potential	Likely	Potential	Potential	Confirmed	Confirmed
Habitat	Likelihood of supporting SRE Taxa	Site	*Aname* 'MYG235'	*Idiosoma* sp.	*Cethegus* sp.	*Conothele* sp.	*Aganippe* sp.	*Anidiops* sp.	*Yilgarnia* sp.	*Aname* 'Wanjarri sp.	*Urodacus* cf 'gibson 5'	*Lychas annulatus*	*Urodacus 'species A'*	Synsphyronus `sp. PSE023'	`Genus 7/4` sp.	Austrohorus sp.	Beierolpium `sp. 8/2`	Beierolpium `sp. 8/3`	Beierolpium `sp. 8/4 small`	Indolpium sp.	Linnaeolpium sp.	Buddelundia 96	Buddelundia 45	Armadillidae sp. indet.	Armadillidae yakabindie a	Philosciidae sp. indet.	Armadillidae yakabindie b	Cubaris yeelirrie2	Pseudodiploe xochus	Trichorhina sp. indet.	Cubaris yeelirrie1	Antichiropus 'DIP003'	Antichiropus 'DIP002'
Breakaway	Medium	Target 10									1					1					1												
		Target 13																															
		*								1			3																				
		*											1																				
Internal drainage	High	Site 12				2	1													6		30		1							5		
		Site 15				1								1		1		1		1	1		5							1			
		Site 24									2									15				58							5		
		Site 25						1								1				4				24	3						7		
Stony Hill and Slope	Medium	Site 3				1	1									1				3		4		7							27	9	
		Site 5										1			8					20						3			6		1		
		Site 6													1	1		7		44									2		3		
		Site 13							1							3		2		9											23	1	
		Site 16	1								4	3			3	2				3							1						
		Site 17					2									3		7		4									1		12		
		Site 21					1											6		5	1			1							3		
Drainage Line	Medium	Site 1					1		1		3									1		13			5			10					
		Site 8									2				1			6		4						2			1		13		
		Site 20									8																				5		
		Site 22									7				1	1				3				4	3						17		
		Site 26									7					2				3											3		
Mulga over spinifex on sand plain	Low	Site 14		3							5					1		9		1			13					1				
		Site 27													1	5		8		6								8	4	2			
		Site 28		3							2				1	3		5		9				3					7	3			
		Target 11																															
		Target 12																								1							
		Target 16																															
		Target 17																															
		Target 18			1																												
		Target 19													1	1																	
		Target 20		1					1																								
Stony Plain	Low	Site 7					1					1			4			2		14	1					5			3		42		
		Site 9										1						3		36		5				1					30		
		Site 11																1		11						17			6		41		
		Site 18																2		5	1				3				2		21		
		Site 23														2		3		16											56		
		*								1																							
		*											3																				
Sparse Mulga Woodland	Low	Site 4																1											3	1	8	2	
		Site 10																2	1	11		1			2						7	4	
		Site 29														1				3			2	3					1		13		
		Site 30						1				2				1													1		41		
		*								1																							
Creekline	High	Site 2									3					1	1	1		1		11				1					4		
		Site 19					1				2							2		2		2							1		4	20	
		Target 14									1				1							23											
		Target 15																1															
		Site T1																															1
		Site T5																														1	

* Collected by Biota (2006)

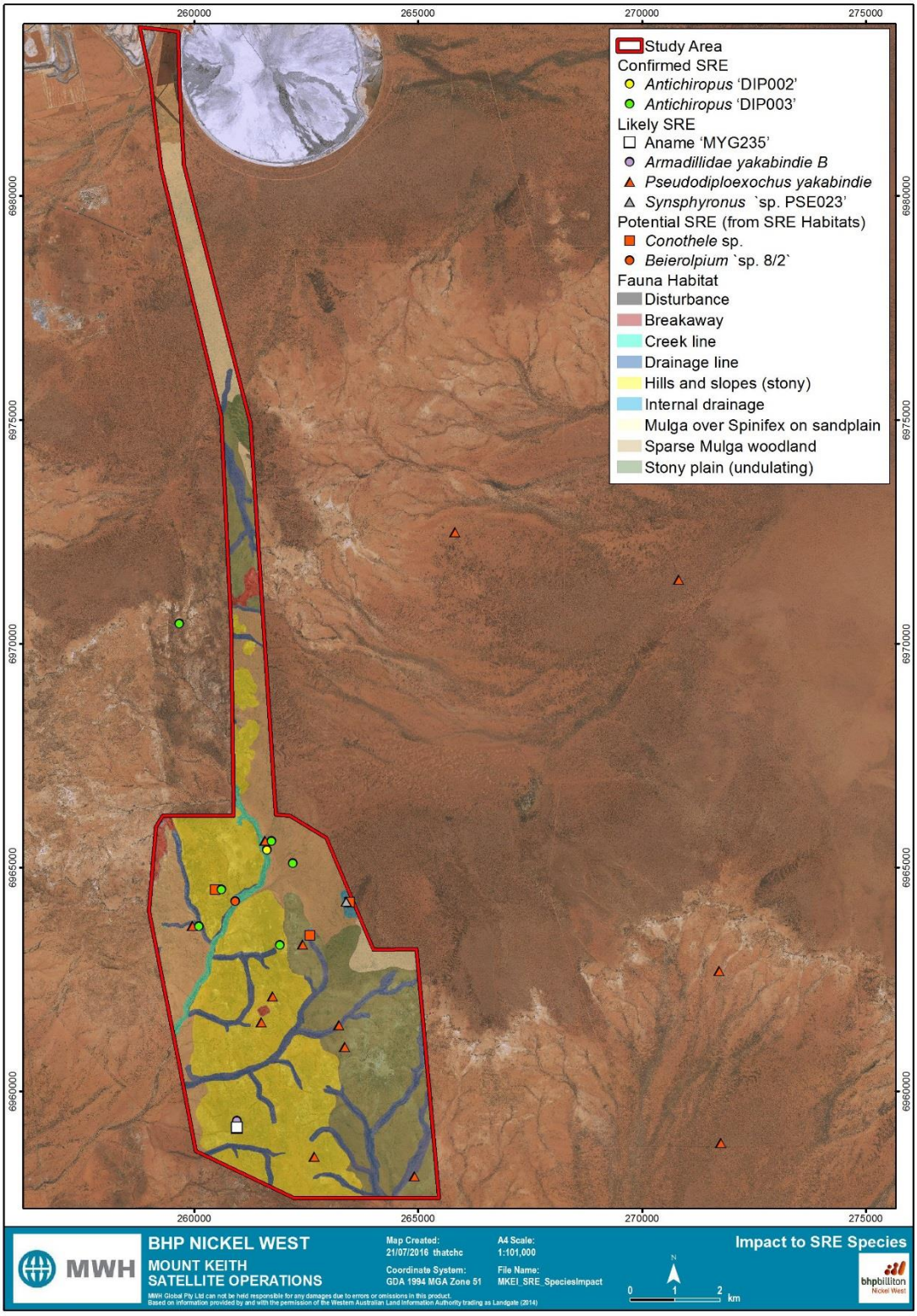

Figure 5-5: Collection locations of confirmed SRE species, likely SRE species and Potential SRE species collected from SRE habitats with respect to the Study Area

5.3 Survey 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 a fauna survey. These are assessed in **Table 5-5**. 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 during different seasons. Nevertheless, all potential limitations and constraints identified by the EPA (2004) were considered and satisfied.

Table 5-5: Summary of potential survey limitations and constraints

Aspect	Limitation / Constraint?	Current survey
Competency/experience of consultants	no	All members of the survey team have several years of experience undertaking SRE invertebrate fauna surveys of this kind in WA (**Section 4.1.7** and **Section 4.2.7**). Invertebrate specimens were identified by recognised taxonomic experts (**Section 4.1.6** and **Section 4.2.6**).
Scope	no	Terrestrial SRE invertebrate fauna were assessed using established and standardised sampling techniques which have been endorsed by the DEC (now DPaW).
Proportion of fauna identified, recorded and/or collected	partial	The surveys (phase 1 & phase 2) of the Baseline survey area yielded a total of 1,680 invertebrate specimens from SRE groups which were identified to 48 species. Slaters were the most numerous group to be collected (832 specimens from 8 species), followed by pseudoscorpions (439 specimens from 11 species), scorpions (195 specimens from 9 species), mygalomorph spiders (168 specimens from 15 species), millipedes (36 specimens from one species) and snails (10 specimens from 4 species). Additionally, a subsequent targeted survey (phase 3 and phase 4) was conducted the following season. This resulted in the collection of two specimens of two species of millipede. One of these species was not collected during the baseline (phase 1 and phase 2) surveys. All specimens collected from groups prone to short-range endemism were submitted to the WAM or relevant taxonomists for identification. All specimens were identified down to the lowest taxonomic level possible. However, identifications could not always be made to the species level if the taxonomy of the group was not well resolved or if the life stage or sex required for identification were not collected. Database and literature reviews identified a total of 42 potential SRE species with potential to occur within the Study Area based on the proximity of records. Of these species, two had been recorded within the Study Area for this assessment. The survey was designed to maximise the collection of specimens belonging to target groups, however, it is recognised that surveys across years and seasons may be necessary to collect the majority of species in an area. The duration of the surveys (particularly the long term deployment of pitfall traps) provided a reasonable opportunity to cover the distinct climatic conditions that often influence SRE activity.

Aspect	Limitation / Constraint?	Current survey
Sources of information (e.g. previously available data as distinct from new data)	no	Previously available data relevant to this survey was obtained via database searches (**Section3.1**) and by undertaking a literature review (**Section 3.2**). New collection records resulting from this survey are presented in **Section 5.2.**
Proportion of task achieved, and further work which might be needed	no	Representative sites from all habitats in the Study Area were sampled using a range of collection methods. Specimens belonging to target SRE groups were collected from inside and outside of disturbance areas. All specimens from target groups were identified by relevant taxonomic experts. Habitats considered to have potential for supporting SRE species were considered as part of the impact assessment.
Timing, weather, season, cycle	no	All phases of survey work were conducted within the optimum survey period for the northern Goldfields (i.e. November to April) as recommended by the EPA (2009). A substantial rainfall event during the phase 1 survey resulted in ideal conditions for the activity of SRE species. These conditions resulted in the capture of a number of specimens of species that were not recorded during the subsequent phases of survey work (**Section 4.1.2** and **Section 4.2.2**).
Disturbances	no	Parts of the Study Area were disturbed by clearing and drilling activities associated with resource exploration however this did not hamper sampling coverage or adequacy. Evidence of fire was observed in the Study Area but was typical of the wider region. The baseline survey included the Wanjarri Nature reserve where recent disturbance was limited.
Intensity	no	During phase 1, all collection methods (wet pitfall traps, targeted searching, soil and litter collection) were employed at 30 sites and a further 11 sites were target searched during the phase 1 survey. Wet pitfall traps were deployed at 30 sites in the phase 2 survey. In total, both phases of the baseline survey resulted in trapping comprised 13,050 trapping nights, 123 hours of targeted searching, the collection of 90 soil samples and 90 leaf litter samples. During phase 3 of the targeted survey, wet pitfall trapping and targeted searching were employed at 10 sites and a further 3 sites were targeted searched. Wet pitfall traps were at the same 10 sites during the phase 4 survey. In total both phases of the targeted survey resulted in trapping comprising 4,550 trapping nights and 26 hours of targeted searching.
Completeness	partial	All habitats within the Study Area were adequately surveyed. However, some areas of habitat in the Study Area that potentially support SRE species (such as outcrop and creek line habitats) could not be sampled due to heritage listing. Additional areas of similar habitats were surveyed within the Wanjarri Nature Reserve to provide regional context.
Resources	no	Resources were adequate to complete the survey. Survey participants were competent in the collection of invertebrates and identification of the habitats encountered during the survey.
Remoteness and access problems	partial	Access was very good and adequate survey coverage was achieved throughout the Study Area and the adjacent Wanjarri Nature Reserve.
Availability of contextual information	no	Contextual information on the occurrence of SREs in the region was available and sourced through the WAM Database and through a literature review of regional SRE invertebrate fauna surveys. Additional information was also considered which included DEC's Threatened and Priority Fauna Database and DECs NatureMap database.

6 Impact Assessment

This section presents an assessment of the potential impacts of the Project on terrestrial SRE invertebrate fauna habitat and SRE species identified during the Baseline Survey, Targeted Survey and from the desktop study. The primary objectives of this section are to describe the relevant threatening processes associated with the Project (**Section 6.1**), and to examine the likely impact of these threatening processes on SRE invertebrate fauna habitat (**Section 6.2**) and SREs present in the Study Area (**Section 6.3**).

6.1 Threatening Processes

Threatening processes specifically associated with the Project can be categorised as either direct or indirect impacts. Direct impacts primarily occur through land clearing, whereas indirect impacts include inappropriate fire regimes, introduced flora and changes to surface hydrology (EPA 2009), increased noise, vibration, artificial light, and impacts of dust. The threatening processes that are potentially associated with the development of the Project are discussed below.

6.1.1 Land Clearing

Land clearing is likely to be the largest potential impact on SRE invertebrate fauna and habitat with approximately 1,115 ha being cleared to develop the Project within the Study Area (**Table 6-1**, **Figure 6-1**). Additional clearing may also be required during the life of the Project for the construction of infrastructure, additional access tracks, installation of pit crest and abandonment bunds and drainage control structures.

Land clearing will directly remove potential SRE invertebrate fauna habitat resulting in habitat contraction and potentially habitat fragmentation. By definition short-range endemic invertebrate fauna species typically have poor powers of dispersal (Harvey 2002) and are therefore unable to emigrate from land as it is being cleared. Land clearing will result in the loss of SRE species populations that occur within disturbance areas. Additionally, land clearing can result in habitat fragmentation and increase degradation through edge effects. Clearing of habitats with the potential to support SRE species (**Section 5.1**) should be limited where practicable.

6.1.2 Fire

The development and operation of the Project may alter the fire regime of the Study Area. Short-range endemic invertebrate habitats such as outcrops are often fire refuges (EPA 2009) which may not be burnt with the frequency of the surrounding landscape. Breakaway habitat has the potential to provide fire refuge within the Study Area (**Figure 5-1**). Increasing fire frequency in fire refuges is likely to be detrimental to SRE species which have evolved in the absence of fire. The impact of inappropriate fire regimes may be reduced through the implementation of an appropriate fire management plan.

6.1.3 Introduced Flora

The Project may result in the introduction of environmental weeds from mobile mining equipment. The invasion of weeds may have a negative impact on SRE species as it can fundamentally alter the composition and structure of vegetation communities on which SREs rely (Cowie and Werner 1993, Gordon 1998). Invasion by non-native species typically results in a decline in native plant species richness (Grice 2006). It is, therefore, important to implement management strategies to reduce the occurrence and spread of weeds during mining operations.

6.1.2 Changes to Surface Hydrology

The Project may result in changes to surface hydrology in the Study Area which may affect SRE habitat. The main drainage feature within the Study Area is Jones Creek which aligns with the Creekline habitat (**Figure 5-1**). Jones Creek is a highly ephemeral first-order stream which is incised into the Barr-Smith Range (MWH 2016). Within the creek, water flows from the north, through the Study Area and then to the southwest with the terminus for the creek as a floodplain containing a number of claypans (MWH 2016).

Impacts to Jones Creek are likely to comprise of direct disturbance in the form of two causeways that will be constructed across the creek to facilitate the transport of waste to the waste landform and to transport ore to Mt Keith for processing. Additional disturbance may be secondary in nature, where sediment may be carried into the creek from the nearby waste landform and from areas that have been cleared for the Project (**Figure 6-1**). Higher sediment loads in surface water runoff may result in sedimentation downstream.

Appropriate management of surface hydrology will be required by the Project to minimise impacts to the Creekline habitat that occurs along Jones Creek. This habitat has a high potential to support SRE species and is known to support the two confirmed SRE species recorded during this study.

6.1.5 Noise and Vibration

Noise and vibration from the Project will be associated with blasting, crushing and screening, haul trucks, road trains, diesel power generation and general machinery necessary for mine operation. Information on the potential effects of noise and vibration on SRE species is limited. A trial that tests the effect of exploration drilling on the SRE Shield-backed trapdoor spider has been conducted at Jack Hills in the Murchison by Crosslands Resources (DMP 2010). In the trial, spiders were observed in their burrows while vibration simulating drilling was produced. Preliminary results suggest that the effects of vibration on spiders may be limited, however, the intrusion of the burrows by endoscopic camera may also have influenced spider behaviour. Raven (2008), suggests that vibrations created by blasting and heavy earthmoving equipment may actually attract spiders and other arachnids, which subsequently places these individuals at risk of direct contact with mining activities. Without further research, it is not possible to predict and quantify the noise and vibration impacts on SRE species.

6.1.3 Light

The Project will result in an increase in the exposure of SRE invertebrate fauna to artificial light. Most SRE invertebrate fauna in the eastern Murchison are active during the hours of darkness and it is possible that artificial light will influence feeding and breeding behaviour. To reduce possible impacts of artificial light on SRE fauna, lighting should be designed to illuminate designated operations areas rather than the surrounding landscape.

6.1.4 Dust

The Project will potentially result in an increase in dust pollution resulting from blasting, the movement of light and heavy vehicles and the general use of equipment on site. Dust pollution may lead to the degradation of surrounding vegetation. High levels of dust pollution may reduce plant growth resulting in the degradation of the overall ecosystem and increased risk of disease in plants. Adequate dust suppression measures should be implemented to reduce the effects of dust on potential SRE habitats and SRE species.

6.2 Impact to SRE Habitat within the Study Area

Habitat loss is listed as a key threatening process under the EPBC Act, however, it is recognised that this is a necessary and typical outcome of the development of the Project. The removal of SRE habitat within the proposed disturbance area will result in the loss of SRE populations that reside in these habitats.

Nine broad habitats were identified across the Baseline Survey Area, Targeted Survey Area and Wanjarri Nature Reserve. All of these habitats, excluding Spinifex Sandplain were identified within the Study Area for this assessment. The area of each habitat in the Study Area that will be directly impacted upon by the Project is quantified in **Table 6-1** and shown in **Figure 6-1**.

The development of the Project will result in the loss of a total of 1,115 ha of habitat comprising 3.5 ha of creek line, 2.5 ha of Internal Drainage, 6.4 ha of Breakaway, 69.2 ha of Drainage Line and 18.1 ha of Mulga over Spinifex on Sandplain, 656.5 ha of Stony Hill and Slope, 147.5 ha Sparse Mulga Woodland and 211.3 ha of Stony Plain habitat present in the Study Area (**Table 6-1**; **Figure 6-1**). No SRE habitats were found to be restricted exclusively to the proposed disturbance area.

Creekline and Internal Drainage habitats are considered to have a high potential for supporting SRE species (**Table 5-1**, **Figure 5-1**). Approximately 14.6 % of Internal Drainage and 4.5 % of Creekline habitat occurring within the Study Area will be removed as a result of the Project (**Table 6-1**, **Figure 6-1**). Both the Internal Drainage and Creekline habitats are known to occur outside of the Study Area. Secondary impacts to the Creekline habitat are likely to be minimal, provided that adequate controls of secondary impacts downstream of the Project are implemented and managed appropriately.

Breakaway, Drainage Line and Stony Hill and Slope habitats are considered to have a medium potential for supporting SRE species (**Table 5-1**, **Figure 5-1**). Approximately 9.7 % of Breakaway and 13.9 % of

Drainage Line habitat will be removed as a result of the Project (**Table 6-1**, **Figure 6-1**). Breakaway and Drainage Line habitats tend to form isolates within the Study Area and their removal will reduce habitat availability at a localised level.

Mulga over Spinifex on Sandplain, Sparse Mulga Woodland and Stony Plain habitats are considered to have a low potential of supporting SRE taxa (**Table 5-1**, **Figure 5-1**). Approximately 4.3 % of Mulga over Spinifex on Sandplain, 14.3 % of Sparse Mulga Woodland and 16.3 % of Stony Plain habitat will be removed by the Project (**Table 6-1**, **Figure 6-1**). The removal of these habitats is unlikely to affect the biological diversity of SRE species within the Study Area.

Table 6-1: The extent of habitats within the proposed disturbance area with respect to the Study Area and the total area mapped for this study

Habitat	Area of habitat in disturbance area (ha)	Area of habitat in Study Area (ha)	Proportion of each habitat in Study Area (%)	Proportion of each habitat in the total areas mapped (%)
Internal Drainage	2.5	17.07	14.6	1.3
Creekline	3.5	76.68	4.5	1.4
Breakaway	6.4	66.73	9.7	1.7
Mulga over Spinifex on Sandplain	18.1	417.4	4.3	0.2
Stony Hill and Slope	656.5	1928.67	34.0	30.4
Drainage Line	69.2	496.21	13.9	2.0
Sparse Mulga Woodland	147.5	1034.69	14.3	2.2
Stony Plain	211.3	1292.83	16.3	1.4
Spinifex Sandplain	-	0	-	0.0
Disturbance	-	91.82	-	0.0
Total	**1,115**	**5,422**	**-**	**-**

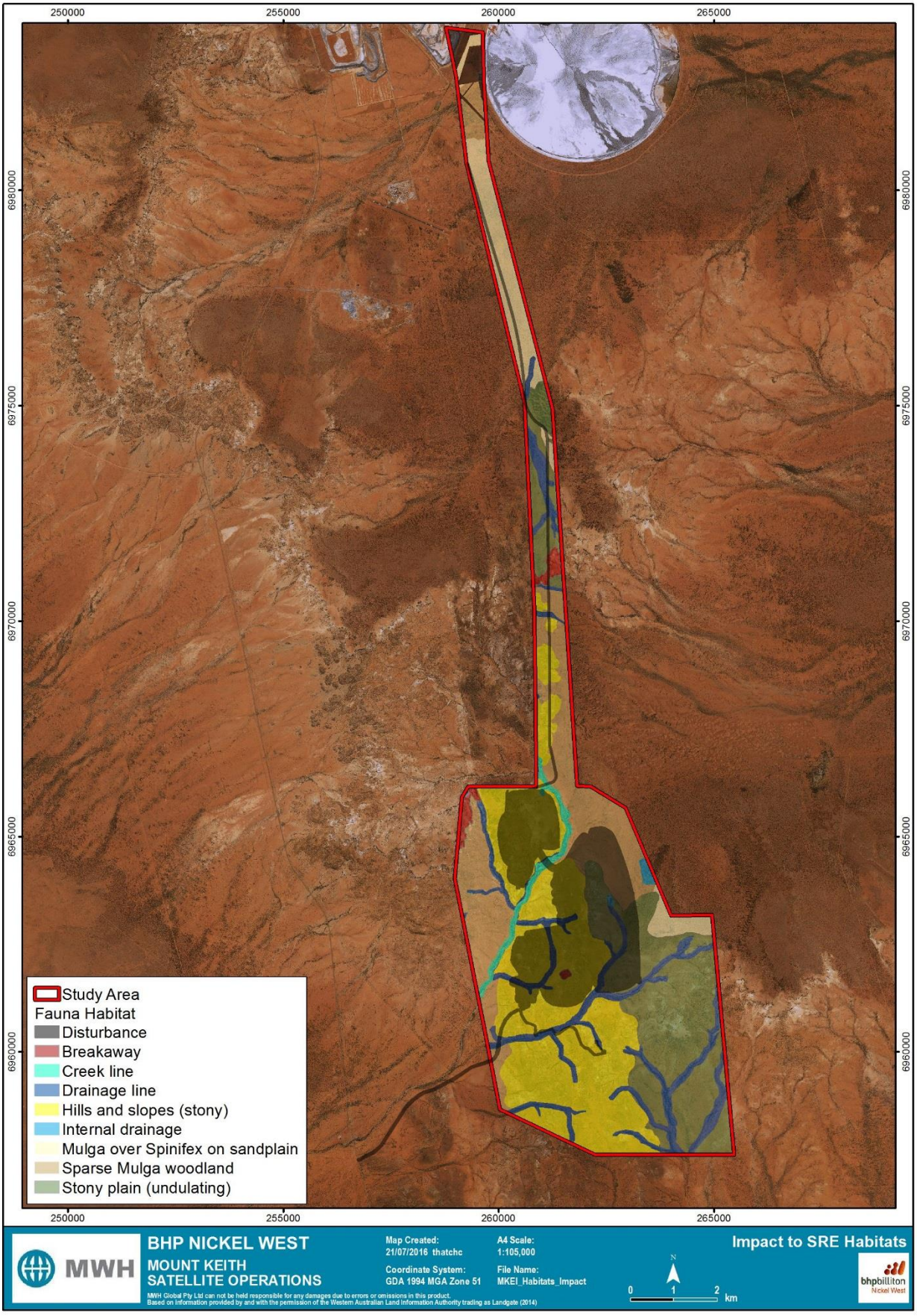

Figure 6-1: SRE habitat in relation to the proposed disturbance area

6.3 Impact to SRE species within the Study Area

The Baseline survey, Targeted survey and desktop study have identified two confirmed SRE species, four Likely SRE species and 25 Potential SRE species from within the Study Area. Of these species, one confirmed, one Likely and 14 Potential SRE species have been collected from within disturbance footprints (**Table 6-2**). However, none of these species have been collected exclusively from within the disturbance area. All species collected within the disturbance area for the Project have also been collected outside the disturbance area.

For brevity, only the Confirmed, Likely and Potential SRE species recorded within the disturbance area are discussed in the following sections (**Sections 6.3.1 – 6.3.3**). Those species only recorded outside the disturbance area are not discussed in this section. Impacts to these species only recorded outside the disturbance area are considered to be minimal as they are not known to occur within the area to be impacted by the Project and are known to have distributions that extend outside the disturbance area.

Table 6-2: SRE species in relation to the proposed disturbance area and habitat

Group	Taxa	SRE status	Recorded within disturbance area?	Recorded outside disturbance area?
Mygalomorph spiders	*Aname* 'MYG235'	Likely	No	Yes
	Idiosoma sp.	Potential	No	Yes
	Cethegus sp.	Potential	No	Yes
	Conothele sp.	Potential	Yes	Yes
	Aganippe sp.	Potential	Yes	Yes
	Anidiops sp.	Potential	No	Yes
	Yilgarnia sp.	Potential	Yes	Yes
	Aname 'Wanjarri sp. 1'*	Potential	No	Yes
Scorpions	*Urodacus* cf 'gibson 5'	Potential	Yes	Yes
	Lychas annulatus	Potential	Yes	Yes
	Urodacus 'species A'*	Potential	No	Yes
Pseudoscorpions	*Synsphyronus* `sp. PSE023`	Likely	No	Yes
	`Genus 7/4` sp.	Potential	Yes	Yes
	Austrohorus sp.	Potential	Yes	Yes
	Beierolpium `sp. 8/2`	Potential	No	Yes
	Beierolpium `sp. 8/3`	Potential	Yes	Yes
	Beierolpium `sp. 8/4 small`	Potential	No	Yes
	Indolpium sp.	Potential	Yes	Yes
	Linnaeolpium sp.	Potential	Yes	Yes
Slaters	*Budddelundia* 96	Potential	Yes	Yes
	Budddelundia 45	Potential	No	Yes
	Cubaris yeelirrie1	Potential	Yes	Yes
	Cubaris yeelirrie2	Potential	No	Yes
	Pseudodiploexochus yakabindie	Likely	Yes	Yes
	Armadillidae yakabindie a	Potential	No	Yes
	Armadillidae yakabindie b	Likely	No	Yes
	Armadillidae sp. indet.	Potential	Yes	Yes
	Philosciidae sp. indet.	Potential	Yes	Yes
	Trichorhina sp. indet.	Potential	No	Yes
Millipedes	*Antichiropus* 'DIP003'	Confirmed	Yes	Yes
	Antichiropus 'DIP002'	Confirmed	No	Yes

* *Species identified from the desktop study*

* *Yellow highlight:* Species not identified to species or morphospecies

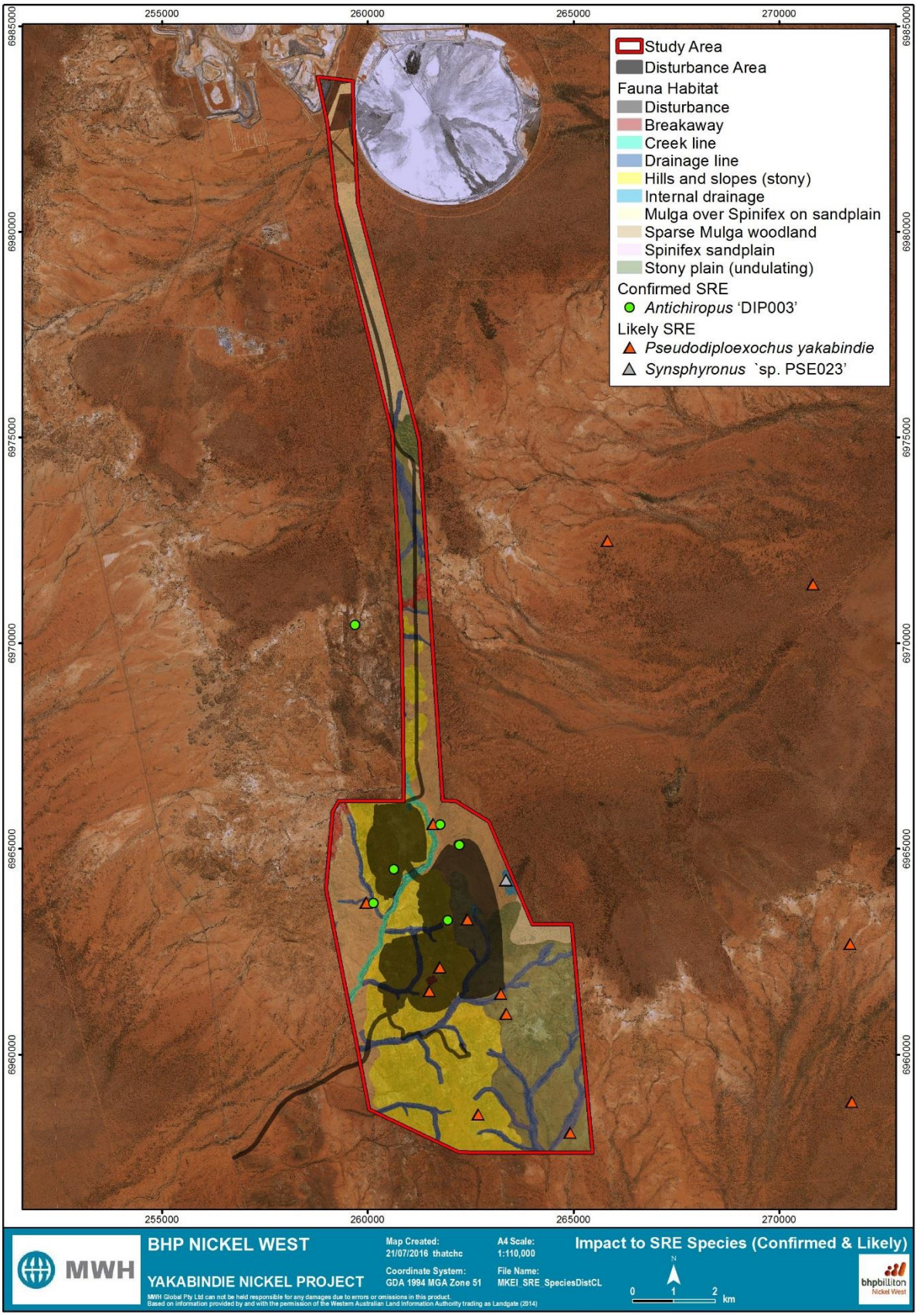

Figure 6-2: Confirmed and Likely SRE species that occur within the proposed disturbance area

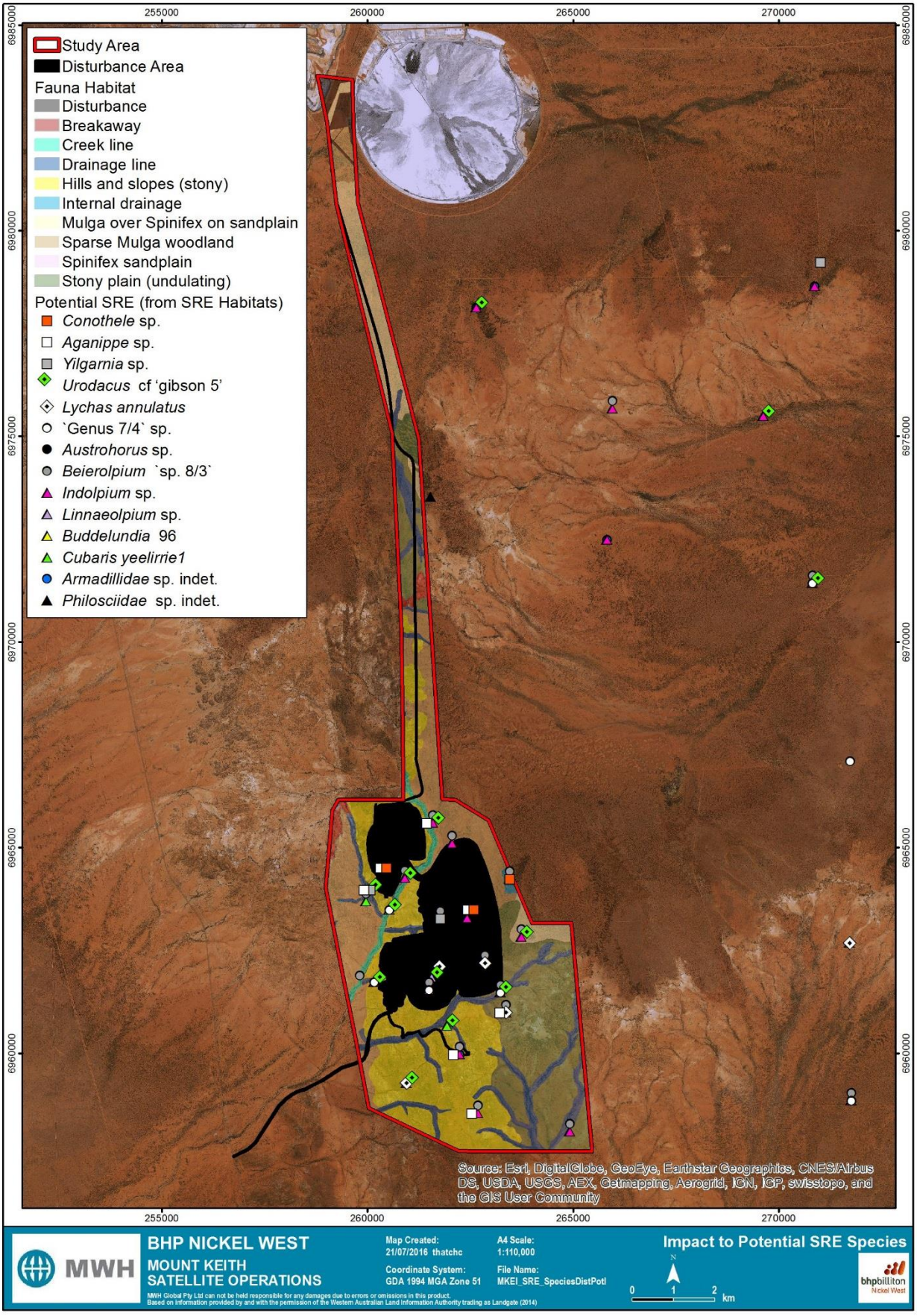

Figure 6-3: Potential SRE species that occur within the proposed disturbance area

6.3.1 Confirmed SRE species

***Antichiropus* 'DIP003'**

A total of 37 specimens of the millipede *Antichiropus* 'DIP003' were collected across six sites and three habitats (**Table 5-4**). The majority of these specimens (21) were collected from the Creekline habitat with all other collection sites occurring in close proximity to the Creekline habitat associated with Jones Creek. Consequently, Jones Creek and its associated drainage features appear to be an important habitat for this confirmed SRE species. Two of the six known locations for this *Antichiropus* 'DIP003' occur within the proposed disturbance area. However, since the Project largely avoids the Creekline habitat (**Figure 6-2**), and provided that secondary impacts to the creekline habitat are managed appropriately, it appears that impacts from the Project are unlikely to affect the long term persistence of this species.

6.3.2 Likely SRE species

***Pseudodiploexochus* 'yakabindie'**

A total of 38 specimens of the slater *Pseudodiploexochus* 'yakabindie' were collected across 13 sites and six habitats (**Table 5-4**). Given that only three of the 13 collection locations for this species occurs within the proposed disturbance area (**Figure 6-2**), it appears unlikely that the Project will affect the long term persistence of this species.

6.3.3 Potential SRE species

***Conothele* sp.**

A total of four specimens of the mygalomorph spider *Conothele* sp. were collected across three sites and two habitats (**Table 5-4**). Both of these habitats, Internal Drainage and Stony Hills and Slopes, have high and medium potential to support SRE species, respectively (**Section 5.1**). As specimens of this species were only collected from SRE habitats, this potential SRE has a higher likelihood of being restricted in its distribution than other potential SRE species collected in this study. Specimens of this species were collected at two sites within and one site outside the proposed disturbance area (**Figure 6-3**). Given that the species is known to occur outside the proposed disturbance area and given that both habitats are well distributed outside the proposed disturbance area (**Section 5.1**), it appears unlikely that the Project will affect the long term persistence of this species.

***Aganippe* sp.**

A total of 8 specimens of the mygalomorph spider *Aganippe* sp. were collected across seven sites and five habitats (**Table 5-4**). Six of these seven sites were within habitats likely to support SRE species suggesting that the species may be restricted in its distribution (**Section 5.1**). However, given that only two of the seven sites fall within the proposed disturbance area (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of this species.

***Yilgarnia* sp.**

A total of three specimens of the mygalomorph spider *Yilgarnia* sp. were collected from three locations across three habitats (**Table 5-4**). Only one of these three locations falls within the proposed disturbance

area for the Project (**Figure 6-3**), and consequently, it appears unlikely that the Project will affect the long term persistence of this species.

***Urodacus* cf 'gibson 5'**

A total of 47 specimens of the scorpion *Urodacus* cf 'gibson 5' were collected from 13 locations from locations six habitats (**Table 5-4**). Given that only one of the 13 locations occurs within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

Lychas annulatus

A total of eight specimens of the scorpion *Lychas annulatus* were collected from five locations across three habitats (**Table 5-4**). Given that only two of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

`Genus 7/4` sp.

A total of 22 specimens of the pseudoscorpion `Genus 7/4` sp. (family Olpiidae) were collected across ten sites and five habitats (**Table 5-4**). Given that only two of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

***Austrohorus* sp.**

A total of 31 specimens of the pseudoscorpion *Austrohorus* sp. were collected across 18 sites and eight habitats (**Table 5-4**). This species appears to be associated with a diverse range of habitats. Given that only four of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

***Beierolpium* `sp. 8/3`**

A total of 69 specimens of the pseudoscorpion *Beierolpium* `sp. 8/3` were collected across 19 sites and seven habitats (**Table 5-4**). This species appears to be associated with a diverse range of habitats. Given that only four of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

***Indolpium* sp.**

A total of 240 specimens of the pseudoscorpion *Indolpium* sp. were collected from 27 sites across seven habitats (**Table 5-4**). Given that only seven of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

***Linnaeolpium* sp.**

A total of five specimens for the pseudoscorpion *Linnaeolpium* sp. were collected across five sites and four habitats (**Table 5-4**). Given that only one of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

***Budddelundia* 96**

A total of 89 specimens of the slater *Budddelundia* 96 were collected from eight sites across six habitats (**Table 5-4**). The majority of these specimens occurring in sheltered habitats with a high or medium potential to support SRE species: Internal Drainage (30), Drainage Line (13), Creekline (36). However, given that only three of these sites occur within the proposed disturbance area for the Project (**Figure 6-3**), and that these sheltered habitats will not be substantially impacted by the Project, it appears unlikely that the Project will affect the long term persistence of the species.

***Cubaris* yeelirrie1**

A total of 391 specimens of the slater *Cubaris* yeelirrie1 were collected across 24 sites and six habitats (**Table 5-4**). Given that only seven of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

Armadillidae sp. indet.

A total of 101 specimens of Armadillidae sp. indet. were collected across eight sites and five habitats (**Table 5-4**). These specimens likely belong to Armadillidae yakabindie a (**Appendix G**). Given that only two of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), it appears unlikely that the Project will affect the long term persistence of the species.

Philosciidae sp. indet.

A total of 30 specimens of Philosciidae sp. indet. were collected across seven sites and five habitats (**Table 5-4**). Given that three of these locations occur within the proposed disturbance area for the Project (**Figure 6-3**), and that the species occurs across a variety of habitats, it appears unlikely that the Project will affect the long term persistence of the species.

7 Conclusion

The survey of the Baseline Study Area, Wanjarri Nature Reserve and the Targeted Survey Area yielded a total of 1,682 invertebrate specimens from target groups that were identified to 49 species. Slaters were the most numerous group to be collected (832 specimens from 8 species), followed by pseudoscorpions (439 specimens from 11 species), scorpions (195 specimens from 9 species), mygalomorph spiders (168 specimens from 15 species), millipedes (38 specimens from two species) and snails (10 specimens from 4 species). Database and literature reviews identified an additional 42 potential SRE species occurring within 50 km of the Project.

Based on current scientific knowledge of species collected within the Study Area, two were considered by experts as Confirmed SRE species, four as Likely SRE species and 23 as Potential SRE species.

The two confirmed SRE species were:

- *Antichiropus* 'DIP002' (millipede)
- *Antichiropus* 'DIP003' (millipede)

The four likely SRE species were:

- *Aname* 'MYG235' (spider)
- *Synsphyronus* `sp. PSE023' (pseudoscorpion)
- Family Armadillidae 'yakabindie b' (slater)
- *Pseudodiploexochus* 'yakabindie' (slater)

For Potential SRE species, habitat can be a useful indicator to whether a species is likely to have a restricted range or be widely distributed, as species are likely to have distributions that align with the habitats within which they were collected. Of the 25 potential SRE species collected from the Study Area, only two were collected exclusively from habitats with a high or medium potential to support SRE taxa were:

- *Conothele* sp. (spider), and
- *Beierolpium* `sp. 8/2` (pseudoscorpion)

With regards to Project impacts to SRE taxa; one confirmed, one Likely and 14 Potential SRE species have been collected from within disturbance area. However, none of these species have been collected exclusively from within the disturbance footprints. All species collected within the disturbance area for the Project have also been collected outside the disturbance area.

With respect to habitats, nine broad habitats were identified across the Baseline Survey Area, Targeted Survey Area and Wanjarri Nature Reserve. All of these habitats, excluding Spinifex Sandplain were identified within the Study Area for this assessment. With respect to SRE species, the Creekline and Internal Drainage habitats have a high potential of supporting SRE species. Approximately 4.5 % of

Creekline and 14.6 % of Internal Drainage habitat within the Study Area will be directly impacted upon by the Project. From the Baseline and Targeted surveys, it is known that additional Creekline habitat and Internal Drainage habitat occurs outside of the Study Area and will not be directly impacted by the Project. Within the total area mapped for this study, only 1.4 % of Creekline habitat and 1.3 % of Internal Drainage Line habitat will be directly impacted by the Project. Secondary impacts to the Creekline habitat are likely to be minimal, provided that adequate controls of secondary impacts downstream of the Project are implemented and managed appropriately.

Breakaway, Stony Hills and Slopes and Drainage Line habitats were considered to have a medium potential of supporting SRE species. Of these, the Project will have the largest impacts on the stony hills and slope habitat, where 34 % of this habitat in the Study Area will be impacted upon by the Project. No invertebrate habitat was found to be restricted exclusively to the proposed disturbance area. The proposed disturbance area largely comprises habitats with a medium or low potential to support SRE species.

8 References

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Appendix A Site descriptions

Site 1 **Habitat type:** Drainage line **Landform:** Drainage line **Vegetation:** Low open forest of Eucalyptus sp. over a low open forest of *Acacia aneura, Acacia quadrimarginea* and *Eremophila galeata* over sparse chenopod shrubland **Leaf litter:** 50% **Substrate:** Sandy clay loam **Disturbance:** Nil	
Site 2 **Habitat type:** Creek line **Landform:** Creek line **Vegetation:** Shrub mallee of Eucalyptus socialis over a open shrubland of *Acacia aneura, Acacia quadrimarginea* over chenopod comprising various Atriplex and *Maireana* species. **Leaf litter:** 50% **Substrate:** Silt loam **Disturbance:** Nil	
Site 3 **Habitat type:** Hills and slopes (stony) **Landform:** Slope **Vegetation**: Low open woodland of *Acacia aneura, Acacia quadrimarginea* over a low open shrubland of *Senna artemisioides*, *Corymbia* sp. *and Ptilotus obovatus* **Leaf litter:** <10% **Substrate:** Clay Loam **Disturbance:** Drilling activity	

Site 4 **Habitat type:** Sparse Mulga woodland **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura, Acacia quadrimarginea* over an open shrubland of *Acacia tetragonophylla* and other species **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Grazing	
Site 5 **Habitat type:** Hills and slopes (stony) **Landform:** Slope **Vegetation:** Low open woodland of *Acacia aneura, Acacia quadrimarginea* over an open shrubland of *Acacia tetragonophylla* and Eremophila sp. **Leaf litter:** <10% **Substrate:** Loam **Disturbance:** Drilling activity	
Site 6 **Habitat type:** Hills and slopes (stony) **Landform:** Plain **Vegetation:** Low open *Acacia aneura, Acacia quadrimarginea* woodland over an open shrubland dominated by *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Drill lines	

Site 7 **Habitat type:** Stony plain (undulating) **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over an open shrubland of *Senna artemisioides, Maireana* sp **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	
Site 8 **Habitat type:** Drainage line **Landform:** Drainage line **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over a shrubland dominated by *Acacia tetragonophylla with sparse Maireana* sp. *Solanum lasiophyllum* **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	
Site 9 **Habitat type:** Stony plain (undulating) **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* over a shrubland of *Acacia tetragonophylla and sparse cover of Maireana* sp. and *Ptilotus obovatus* **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	

Site 10 **Habitat type:** Sparse Mulga woodland **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* over various *Acacia* species. **Leaf litter:** <10% **Substrate:** Clay loam **Disturbance:** Nil	
Site 11 **Habitat type:** Stony plain (undulating) **Landform:** Plain **Vegetation:** Open low shrubland of *Acacia aneura* and *Acacia tetragonophylla.* **Leaf litter:** <10% **Substrate:** Stones **Disturbance:** Nil	
Site 12 **Habitat type:** Internal drainage **Landform:** Basin **Vegetation:** Open woodland of *Eucalyptus socialis, and Acacia aneura* over shrubland of *Eragrostis eriopoda*. **Leaf litter:** 10-25% **Substrate:** Sandy clay loam **Disturbance:** Nil	

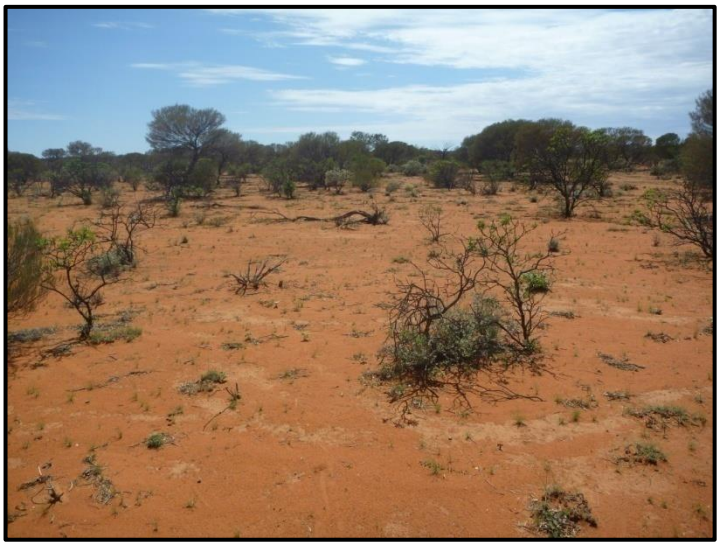
Site 13 **Habitat type:** Hills and slopes (stony) **Landform:** **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea over an open shrubland of Eragrostis eriopoda* over low shrubland of *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Tracks	
Site 14 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over an open shrubland dominated by *Ptilotus obovatus over Triodia basedowii* **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	
Site 15 **Habitat type:** Internal drainage **Landform:** Basin **Vegetation:** Bands of low closed forest of *Acacia aneura* and *Acacia quadrimarginea* interspersed by clear patches of limited vegetation. **Leaf litter:** <10% **Substrate:** Clay loam **Disturbance:** Nil	

Site 16 **Habitat type:** Hills and slopes (stony) **Landform:** Slope **Vegetation:** Low woodland of *Acacia aneura* and *Acacia quadrimarginea* over sparse shrubland of *Acacia tetragonophylla* and *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Some clearing of trees	
Site 17 **Habitat type:** Hills and slopes (stony) **Landform:** Slope **Vegetation:** Low woodland of *Acacia aneura* and *Acacia quadrimarginea* over sparse shrubland of *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	
Site 18 **Habitat type:** Stony plain (undulating) **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over a sparse shrubland of *Acacia tetragonophylla over a sparse understorey of Ptilotus obovatus.* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Grazing	

Site 19 **Habitat type:** Creek line **Landform:** Creek line **Vegetation:** Eucalyptus camaldulensis along drainage line. Banks fringed with *Acacia aneura*, *Acacia tetragonophylla, Acacia acuminate, and Eragrostis eriopoda* **Leaf litter:** 10-25% **Substrate:** Sandy loam **Disturbance:** Nil	
Site 20 **Habitat type:** Drainage line **Landform:** Drainage line **Vegetation:** Low open *Acacia aneura* and *Acacia quadrimarginea* woodland along drainage with an understorey of scattered *Acacia tetragonophylla* **Leaf litter:** <10% **Substrate:** Sandy clay loam **Disturbance:** Tracks	
Site 21 **Habitat type:** Hills and slopes (stony) **Landform:** Slope **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over sparse shrubs of *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Tracks	

Site 22 **Habitat type:** Drainage line **Landform:** Drainage line **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia* over an open shrubland of *Senna artemisioides* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Grazing	
Site 23 **Habitat type:** Stony plain (undulating) **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over sparse shrubs of *Senna artemisioides Acacia tetragonophylla* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Grazing	
Site 24 **Habitat type:** Internal Drainage **Landform:** Basin **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over an open shrubland of *Acacia tetragonophylla and Eragrostis eriopoda* grasses. **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	

Site 25 **Habitat type:** Internal drainage **Landform:** Basin **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over scattered shrubs of *Acacia tetragonophylla and Eragrostis eriopoda* grasses. **Leaf litter:** <10% **Substrate:** Sandy clay loam **Disturbance:** Nil	
Site 26 **Habitat type:** Drainage line **Landform:** Drainage line **Vegetation:** Low woodland of *Acacia aneura* and *Acacia quadrimarginea* over sparse *Eragrostis eriopoda* grasses around the base of trees. **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	
Site 27 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over scattered *Ptilotus obovatus and Triodia basedowii.* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	

Site 28 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open woodland of *Acacia aneura* and *Acacia quadrimarginea* over an open grassland of *Triodia basedowii.* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	
Site 29 **Habitat type:** Sparse Mulga woodland **Landform:** Plain **Vegetation:** Open shrubland of *Acacia aneura* and *Acacia quadrimarginea* with some *Ptilotus obovatus interspersed.* **Leaf litter:** <10% **Substrate:** Sandy clay loam **Disturbance:** Grazing	
Site 30 **Habitat type:** Sparse Mulga woodland **Landform:** Plain **Vegetation:** Tall open shrubland of *Acacia aneura* and *Acacia quadrimarginea* with *Ptilotus obovatus and Eragrostis eriopoda* grasses **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Grazing and eroded tracks	

Target 10 **Habitat type:** Breakaway **Landform:** Breakaway **Vegetation:** Scattered Mulga (*Acacia aneura* and *Acacia quadrimarginea)* over *Atriplex codonocarpa* **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Dill line through habitat	
Target 11 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	
Target 12 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Historic grazing	

Target 13 **Habitat type:** Breakaway **Landform:** Breakaway **Vegetation:** Scattered Mulga (*Acacia aneura* and *Acacia quadrimarginea)* over *Atriplex codonocarpa with the occasional Acacia ramulosa.* **Leaf litter:** <10% **Substrate:** Loamy Sand **Disturbance:** Nil	
Target 14 **Habitat type:** Creek line **Landform:** Creek line **Vegetation:** Eucalyptus camaldulensis fringing banks with Acacia (*Acacia aneura dominated)* shrubland and some grasses **Leaf litter:** <10% **Substrate:** Sandy loam over clay **Disturbance:** Grazing	
Target 15 **Habitat type:** Creek line **Landform:** Creek line **Vegetation:** Rivergum (*Eucalyptus camaldulensis*)fringing creek line, banks with *Acacia aneura and Acacia ramulosa* and various grass species **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	

Target 16 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low Mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <10% **Substrate:** Sandy loam **Disturbance:** Nil	
Target 17 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low Mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <20% **Substrate:** Sandy loam **Disturbance:** Nil	
Target 18 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open Mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	

Target 19 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open Mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <20% **Substrate:** Sand **Disturbance:** Nil	
Target 20 **Habitat type:** Mulga over Spinifex on sandplain **Landform:** Plain **Vegetation:** Low open Mulga (*Acacia aneura* and *Acacia quadrimarginea)* woodland over *Triodia basedowii*. **Leaf litter:** <10% **Substrate:** Sand **Disturbance:** Nil	

Appendix B Trapdoor Spiders (Araneae: Mygalomorphae) from Yakabindie, Western Australia

PHOENIX
ENVIRONMENTAL SCIENCES

Trapdoor spiders (Araneae: Mygalomorphae) from Yakabindie, Western Australia

Prepared for Outback Ecology

August 2011

Taxonomic Report

Trapdoor spiders (Araneae: Mygalomorphae) from Yakabindie, Western Australia

Prepared for Outback Ecology

Taxonomic report

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Date: 3 August 2011

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EXECUTIVE SUMMARY

In July 2011, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Outback Ecology (the Client) to identify trapdoor spiders (Mygalomorphae) collected at Yakabindie (central Western Australia). A total of 119 vials of spiders were identified and screened for short-range endemic (SRE) taxa.

There are uncertainties in determining the range-restrictions of many invertebrates in Western Australia due to lack of surveys, lack of taxonomic resolutions within target taxa and problems in identifying certain life stages. To account for these uncertainties Phoenix uses a three-tier categorisation for short-range endemism: confirmed SRE, likely SRE and potential SRE.

The material included one specimen that is here considered a likely SRE:

- *Aname* 'MYG235' (Nemesiidae – Wishbone Spiders): this species has not been recorded before and similar species in this distinct group of small *Aname* are known from very restricted ranges only.

The material included five potential SREs all represented by females or juveniles which could not be identified with certainty:

- *Conothele* sp. indet. (♀♀, juv.) (Ctenizidae): genus with high regional diversity.
- *Cethegus* sp. indet. (♀♀, juv.) (Dipluridae): genus with deep genetic divergence between populations in some regions suggesting low dispersal potential.
- *Aganippe* sp. indet. (♀♀, juv.) (Idiopidae – True Trapdoor Spiders): genus with many widespread, but also some range-restricted species
- *Anidiops* sp. indet. (♀♀, juv.) (Idiopidae – True Trapdoor Spiders): genus with many widespread, but also some range-restricted species
- *Yilgarnia* sp. indet. (juv.) (Nemesiidae – Wishbone Spiders): taxonomically poorly resolved genus with known range-restricted species.

The following species found at Yakabindie do not represent SREs:

- *Missulena* sp. indet. (juv.) (Actinopodidae – Mouse Spiders)
- *Mandjelia* 'MYG035' (Barychelidae – Brushfooted Trapdoor Spiders)
- *Synothele meadhunteri* Raven, 1994 (Barychelidae – Brushfooted Trapdoor Spiders)
- *Gaius* sp. indet. (♀♀, juv.) (Idiopidae – True Trapdoor Spiders)
- *Aname* 'MYG173' (Nemesiidae – Wishbone Spiders)
- *Aname* 'MYG177' (Nemesiidae – Wishbone Spiders)
- *Kwonkan* 'MYG175' (Nemesiidae – Wishbone Spiders)
- *Selenotholus foelschei* Hogg, 1902 (Theraphosidae – Tarantulas)

1 SCOPE OF WORKS

In May 2011, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Outback Ecology (the Client) to identify trapdoor spiders (Mygalomorphae) collected at Yakabindie (central Western Australia). A total of 119 records were screened for short-range endemic (SRE) taxa.

2 BACKGROUND

2.1.1 Short-range endemic invertebrates

Short-range endemic fauna (also known as narrow-range taxa) are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Short-range endemism in terrestrial arthropods is believed to have evolved through two primary processes (Harvey 2002; Ponder & Colgan 2002):

- **Relictual short-range endemism**: relictual SREs are thought to have had wider distributions during more mesic geological periods. Australia's aridification over the last 60 million years resulted in a contraction of the ranges of these species into relatively small habitat pockets where moist conditions persist (relictual Gondwanan habitats). Evolutionary processes over long periods of isolation typically resulted in each population developing into a distinctive species. Millipedes and terrestrial snails are typical relictual SREs and they are generally found in deep gullies often on the south-facing slopes of mountains, hills and ridges. Relictual SREs often inhabit areas with: high rainfall, areas where topography induces fog, areas with permanent water (swamps, creek lines and river systems) or deep litter beds. Sometimes habitats have various combinations of these features.
- **Habitat specialisation**: habitat specialist SREs are restricted to specific isolated habitat types. Unlike relictual SREs in mesic habitats, habitat specialist SREs are restricted by environmental parameters other than microclimatic, moist conditions. Such habitat islands include rocky outcrops (pseudoscorpions in the genus *Synsphyronus* or selenopid spiders are typical examples here), salt lakes (e.g. wolf spiders of the genus *Tetralycosa*) or isolated dune systems (species in the scorpion genus *Urodacus*).

Invertebrate groups that contain SRE taxa are generally well distributed across the Australian landscape and well adapted to semi-arid environments due to a variety of behavioural and morphological features that have developed to avoid desiccation and predation. They generally possess (Harvey 2002; Ponder & Colgan 2002):

- poor powers of dispersal
- confinement to discontinuous habitats
- seasonality, i.e. only active in cooler or wetter months
- slow growth
- low levels of fecundity.

The current knowledge of SREs in WA is relatively poor and the rarity of collections from certain regions makes it difficult to assess the distribution and likely occurrence of SRE species. Habitats such as mountains containing gullies/gorges and south-facing slopes, wetlands and rivers often include unique habitat attributes set amongst a relatively homogeneous surrounding landscape. These isolated micro habitats often harbour SRE taxa (Harvey 2002). Potential SRE taxa include the following groups (EPA 2009):

- spiders and relatives (Arachnida)
    - spiders (Araneae), in particular trapdoor spiders (Mygalomorphae) and selected modern spiders (Araneomorphae) (here mainly Flat Rock Spiders, Selenopidae)
    - harvestmen (Opiliones)
    - false scorpions (Pseudoscorpiones)
    - true scorpions (Scorpiones)
    - whip spiders (Schizomida) (although the majority of SREs in this order are troglobites) (Harvey *et al.* 2008; Harvey *et al.* 2011)
- multipedes (Myriapoda)
    - centipedes (Chilopoda), mainly the order Geophilomorpha and the Cryptopidae in the order Scolopendromorpha; other Scolopendromorpha are generally widespread and are not considered target taxa (e. g. Colloff *et al.* 2005; Koch 1982, 1983a, b, c)
    - millipedes (Diplopoda)
- crustaceans (Crustacea)
    - slaters (Isopoda)
- snails and relatives (Mollusca)
    - land snails (Eupulmonata, Gastropoda)
- earth worms (Oligochaeta).

Whilst other invertebrate groups have recently been proposed to contain a substantial proportion of range-restricted species, e.g. epigaeic (ground-dwelling), often wingless beetles in the Pilbara (Guthrie *et al.* 2010), these are currently not targeted in SRE invertebrate surveys (EPA 2009).

2.1.2 Categories of short-range endemism

There is currently no accepted system in place to define the varying probabilities of a species to be an SRE. The uncertainty in categorising a specimen as SRE originates in a number of factors including:

- **Poor regional survey density** (sometimes taxon-specific): A regional fauna is simply not known well enough to assess the distribution of species. This factor also considers the fact that, simply because a species has not been found regionally, does not mean it is really absent; this confirmation ('negative proof') is almost impossible to obtain ("absence of proof is not proof of absence").
- **Lack of taxonomic resolution**: many potential SRE taxa (based on preferences for typical SRE habitats, SRE status of closely related species, or morphological peculiarities such as troglomorphism) have never been taxonomically treated and identification to species level is very difficult or impossible as species-specific character systems have not been defined. Good taxonomic resolution does not necessarily require a published revision, but generally requires a taxonomist to be actively working on this group or a well-established, preferably publicly available, reference collection (i.e. museum collection).
- **Problems of identification**: SRE surveys often recover life stages of potential SRE taxa that cannot be confidently identified based on morphological characters, even if revisions exist. These include, for example, juvenile or female millipedes, mygalomorph spiders and scorpions. Molecular techniques are increasing being employed to overcome these identification problems.

Considering these factors of uncertainty, Phoenix currently employs a simple three-tier system to categorise the different probabilities of short-range endemism: confirmed, likely or potential SRE (Table 2-1). These categories are dynamic and can change with every survey.

Life stages of species that cannot be identified at the species level, e.g. some females and juveniles, are here assessed based on the knowledge of the higher taxon they belong to, i.e. family or genus. For example, all juvenile or female *Antichiropus* millipedes would be classified as 'confirmed SRE' as all but two of the known species in this genus are considered SREs (Wojcieszek *et al.* 2011).

The different categories of 'SRE-likelihood' may help to set conservation priorities; however, SRE taxa of all categories should be considered to determine appropriate conservation measures in order to adhere to the Precautionary Principle within Environmental Impact Assessments. That is, "*where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation*" (e. g. EPA 2002) .

Table 2-1 Phoenix SRE categories reflecting survey, taxonomic and identification uncertainties

SRE category	Criteria	Typical representative
(Confirmed) SRE	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group well represented in collections, in particular from the region in question; high levels of endemism in documented species; inference is often possible from immature specimens	*Antichiropus* millipedes and araneomorph spiders in the genus *Karaops* (Selenopidae)
Likely	Taxonomically poorly resolved group; unusual morphology for the group (i.e. some form of troglomorphism); often singleton in survey and few, if any, regional records	Opiliones, some pseudoscorpions and slaters, many mygalomorph spiders
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners often widespread	Cryptopidae, Geophilida

2.2 IDENTIFICATION AND PERSONNEL

All spiders were examined in 70% or 100% ethanol under Leica M205A and M80 stereomicroscopes.

The method of identification for each taxon, i.e. by taxonomic literature or comparison with type or other reference material, is indicated in the taxonomic part of this report. Phoenix personnel involved in the identification are listed in Table 2-2.

Table 2-2 Phoenix personnel involved in identification

Taxonomic group	Title	Qualification
Dr Volker Framenau	Manager, Terrestrial Invertebrates	One of Australia's leading arachnologists with taxonomic expertise in major araneomorph and mygalomorph spiders; established the WAM mygalomorph reference collection
Kate Penwarden	Zoologist	B.Sc. (Honours) (Zool., Cons. Biol.)

2.3 TAXONOMY AND NOMENCLATURE

The taxonomic nomenclature of spiders treated here follows Platnick (Platnick 2011).

Morphospecies designations of undescribed species are generally adopted from the systems of the scientist(s) working on the group. For mygalomorph spiders, the Western Australian Museum has established a morphological reference collection of males that aids in the identification of spiders. Morphospecies are numbered consecutively with the prefix "MYG", e.g. *Aname* 'MYG001' (Nemesiidae).

2.4 SPECIMEN DEPOSITORY

The EPA guidance statement No. 20 ('*Sampling of short-range invertebrate fauna for environmental impact assessment in Western Australia*') (EPA 2009) recommends that all specimens representing SRE target groups are lodged with the WAM to enhance the knowledge of the distribution of putatively rare species. Phoenix adheres to this recommendation and all of the survey specimens were returned to the Arachnology Department of the Western Australian Museum.

3 RESULTS

3.1 SUMMARY

The mygalomorph spiders identified belong to at least 14 morphospecies in 12 genera and seven families (Table 3-1, Appendix 1). One species, *Aname* 'MYG235' (Nemesiidae), is considered a likely SRE, five taxa represent potential SREs and eight species are not considered SREs.

Three araneomorph spiders were delivered for identification, including *Meedo yarragin* Platnick, 2002 and an unidentified male in the family Zodariidae (Appendix 1). None of these are SREs (e.g. Platnick 2002).

Table 3-1 SRE-status of mygalomorph spiders from Yakabindie

Taxon	SRE status	Remarks
Actinopodidae		
Missulena sp. indet. (juv.)	not SRE	only known from some widespread morphospecies in the area (WA Museum database)
Barychelidae		
Mandjelia 'MYG035'	not SRE	widespread in central WA
Synothele meadhunteri Raven, 1994	not SRE	widespread in central WA
Ctenizidae		
Conothele sp. indet.	potential SRE	genus with high diversity in some regions of WA; males required for accurate identification
Dipluridae		
Cethegus sp. indet.	potential SRE	genus with deep genetic divergence between populations suggesting limited dispersal potential; males required for accurate identification
Idiopidae		
Aganippe sp. indet.	potential SRE	many known morphospecies of *Aganippe* widespread, but some range-restricted (WA Museum database); males required for accurate identification

(continued next page)

(Table 3-1 continued)

Taxon	SRE status	Remarks
Anidiops sp. indet.	potential SRE	many known morphospecies of *Anidiops* widespread, but some range-restricted (WA Museum database); males required for accurate identification
Gaius sp. indet.	not SRE	known morphospecies of *Gaius* widespread (WA Museum database); males required for accurate identification
Idiopidae sp. indet.		either *Anidiops* or *Gaius*, similar ratings as above apply
Nemesiidae		
Aname 'MYG173'	not SRE	also known from Lake Way and Lake Maitland
Aname 'MYG177'	not SRE	also known from Lake Way
Aname 'MYG235'	likely SRE	Belongs to a distinct group of small *Aname*, all known from only single locality
Aname sp. indet.		males required for accurate identification
Kwonkan 'MYG175'	not SRE	more recently recorded as far south as Leinster and Koolyanobbing
Kwonkan sp. indet.		possibly conspecific with *Kwonkan* 'MYG175'; same rating applies
Yilgarnia sp. indet.	potential SRE	genus previously not known from the area; males required for accurate identification
Theraphosidae		
Selenotholus foelschei Hogg, 1902	not SRE	widespread throughout WA (WA Museum database)

3.2 MYGALOMORPHAE (TRAPDOOR SPIDERS)

Trapdoor spiders represent one of the focal groups in surveys of short-range endemic taxa (EPA 2009; Harvey 2002). A number of mygalomorph spiders, e.g. *Idiosoma nigrum* Main, 1952, *Kwonkan eboracum* Main, 1983, and *Moggridgea tingle* Main, 1991, are listed on Schedule 1 ("Fauna that is rare or likely to become extinct") of the Wildlife Conservation (Specially Protected Fauna) Notice 2010(2) of the Western Australian Government (Western Australian Government 2010).

The Western Australian mygalomorph fauna is vast and remains taxonomically poorly known for many families and genera (e.g. Barychelidae: *Idiommata*; Idiopidae: *Aganippe*; Nemesiidae: *Aname*, *Chenistonia*, *Kwonkan*).

3.2.1 Family Actinopodidae (Mouse Spiders)

In Australia, the trapdoor spider family Actinopodidae is represented only by the genus *Missulena*. Spiders within this family are medium to large spiders with an extremely raised head region and widely spaced eyes (in contrast to most other trapdoor spider families in which the eyes are grouped closely together). Actinopodids can be found in a variety of habitats from open-forest to semi-arid shrubland.

3.2.1.1 Genus *Missulena*

Spiders of the genus *Missulena* are commonly known as "Mouse Spiders". With the exception of a single species from Chile, the genus is restricted to the Australian mainland, where currently 10 species are described (Faulder 1995b). Western Australia is the centre of diversity for the genus with seven named species, however, many more undescribed species, in particular from the arid northern and central parts of the state are present in the WA Museum morphospecies collection.

Whilst females are generally uniformly black in colour, males are often strikingly coloured with a distinctly red cephalic area and chelicerae, contrasting against a black thoracic part and abdomen, although some species have a black cephalic region. The abdomen itself often has a velvety shine. The entrance of the burrow of Missulena is ovoid in shape and equipped with two neighbouring doors (Main 1956). Emergent juveniles of some *Missulena* species have been reported to disperse via ballooning (Faulder 1995a), however this may only happen over a few metres thus limiting long-distance dispersal (R. J Raven, personal communication).

***Missulena* sp. indet. (juv.)**

A single juvenile *Missulena* was collected at Yakabindie (Appendix 1) and species identification is not possible. However, a number of common and more or less widespread species have been found around the survey area, e.g. *Missulena* 'MYG48' and *Missulena* 'MYG049' (WA Museum database). The juvenile *Missulena* is therefore not considered to represent an SRE although it is recommended to collect a male to confirm its identity and distribution.

3.2.2 Family Barychelidae (Brush-footed Trapdoor Spiders)

Barychelid spiders, commonly called Brush-footed Trapdoor Spiders, are small to fairly large in size with well-developed claw tufts and short terminal segment of the posterior lateral spinnerets (Raven 1994). In Western Australia, the genera Aurecocrypta, Idiommata, Mandjelia and Synothele are known to occur from the Southwest region into the Pilbara region and Moruga has been found in the Kimberleys (Raven 1994). Of all trapdoor spiders, few are as cryptic as the Barychelidae. Their burrows tend to be less than 60 cm deep and often lack the firm thick door of the Ctenizidae or the extensive webs of Dipluridae.

3.2.2.1 Genus *Mandjelia*

The genus *Mandjelia* differs from most other genera of the Barychelidae by the large (i.e. > 30) number of maxillary cuspules. Twenty-two species are currently described from Australia, most of them from the eastern states (Raven 1994). Two described species are known from WA, *M. humphreysi* Raven & Churchill, 1994 from the Goldfields region and *M. madura* Raven & Churchill, 1994 from the south-east coast (Raven 1994).

***Mandjelia* 'MYG035'**

Mandjelia 'MYG035' is fairly widespread in central WA and can be found from Lorna Glen Station in the north to Laverton in the south. The species has also been found at Lake Way and Albion Downs (WA Museum database). It is not an SRE.

3.2.2.2 Genus *Synothele*

The genus *Synothele* can be identified by the low number of maxillary cuspules in combination with the lack of lyra (specialised clubbed setae) on the maxillae, and the often mottled abdomen (uniformly dark in the similar *Aurecocrypta*). The genus is widespread throughout Western (21 species) and South Australia (3 species) with most species known only from very limited ranges (Raven 1994).

***Synothele meadhunteri* Raven, 1994**

Following its description, *S. meadhunteri* has been shown to be widespread throughout central WA (WA Museum database). It is not an SRE.

3.2.3 Family Ctenizidae (Cork-lid Trapdoor Spiders)

The Ctenizidae are represented in Australia by a single genus, *Conothele*. Spiders in this genus can be identified by a distinct dorsal depression in the tibia of the third leg (Raven 1985c).

3.2.3.1 Genus *Conothele*

Members of the genus *Conothele* are found across much of arid and semi-arid Western Australia. The burrows are usually difficult to find as they are sealed with a tight-fitting lid. At least one species is arboreal, living in burrows constructed on the side of tree holes (Main 1985). As in the genus *Missulena*, juvenile *Conothele* are believed to disperse via ballooning (Main 1957b, 1976) limiting their predisposition as short-range endemics.

The taxonomic status of the Western Australian fauna is uncertain, with the entire fauna representing unnamed species. The precise distributions of each species are unknown, and much taxonomic work at the species level is required before the status of individual populations can be ascertained. With seven morphospecies, the WAM/DEC Carnarvon survey recovered a surprisingly high diversity within the genus (Main *et al.* 2000). In contrast, the DEC Pilbara survey found only a single widespread species (Durrant *et al.* 2010).

***Conothele* sp. indet. (♀♀, juv.)**

The material from Yakabindie only contained females and juveniles which could not be identified to species level (Appendix 1). Taking the apparent regional diversity of the genus into account as reported from the Carnarvon Basin (Main *et al.* 2000), the Conothele specimens are here considered to be potential SREs.

3.2.4 Family Dipluridae (Curtain-web Spiders)

Six genera of the Dipluridae are currently known from Australia, including *Australothele*, *Caledothele*, *Carrai*, *Cethegus*, *Masteria* and *Namirea*, of which only *Cethegus* is found in Western Australia (Raven 1984, 1985a). 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.

3.2.4.1 Genus *Cethegus*

The genus *Cethegus* currently includes 11 named species in Australia, including two, *C. fugax* (Simon, 1908) and *C. ischnotheloides* Raven, 1985, from Western Australia (Ecologia 2009; Main 1960; Raven 1984). A number of undescribed species from many different regions of the state are known from the collection of the Western Australian Museum. The status and distribution of these species are not well understood and detailed taxonomic work is needed to understand the Western Australian fauna. A recent molecular study on species in the *C. fugax*-complex from the Murchison region of WA discovered these spiders to be different to the nominal species *C. fugax* from the Jarrah forests around Perth and showed high intra-specific genetic divergence between subpopulation of different mountain ranges within the region, possibly caused by limited dispersal capabilities (Ecologia 2009). Most species from WA appear to belong to the *C. fugax*-complex which is characterised by dark patches on the booklung covers a long, curved embolus of the male pedipalp (Raven 1984).

The nest of *Cethegus* includes vertical, curtain‐like strands of silk with adherent soil. At the centre of the nest are two or three funnel‐like tubes that join into a common tube leading into a shallow burrow. Radiating from the main web are catching strands which entrap both crawling and flying insects. The nests may be up to thirty centimetres in height and width and they are generally supported against stems of trees or shrubs, tussocks of grass, logs or irregularities in soil such as banks or rocks. Mating and reproduction appears to depend on prevailing seasonal conditions in relation to region or location. Emergent spiderlings may be aerially dispersed over short distances (i.e. several meters) (Main 1995).

***Cethegus* sp. indet. (♀♀, juv.)**

The *Cethegus* specimens from Yakabindie could not be identified to species level but belong to the *Cethegus-fugax* group. Taking the distribution pattern of this group into account (see above), the specimens are here considered potential SREs.

3.2.5 Family Idiopidae (True Trapdoor Spiders)

The mygalomorph spider family Idiopidae includes a number of genera in Western Australia, including *Anidiops*, *Gaius* (currently listed as junior synonym of Anidiops), *Euoplos*, *Blakistonia*, *Cataxia*, *Eucyrtops*, *Idiosoma* and *Misgolas* (Main 1985; Raven & 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).

3.2.5.1 Genus *Aganippe*

The idiopid genus *Aganippe* is common throughout Western Australia. Fourteen species are described from Australia and many new species await description (Main 1985). The genus differs from all other genera in the family Idiopidae by the presence of abdominal sigillae and the presence of two processes on the male pedipalp tibia (Main 1985).

***Aganippe* sp. indet. (♀♀, juv.)**

The *Aganippe* specimens from Yakabindie are female and juvenile and could not be identified to species level (Appendix 1). Western Australian *Aganippe* include both widespread and range-restricted species and the specimens from this survey are therefore considered potential SREs.

3.2.5.2 Genus *Anidiops*

Currently two species of *Anidiops* are described from Western Australia, *A. manstridgei* and *A. villosus* (Main 1985). Pedipalp morphology of both species suggests these to belong to different genera and although not published in the scientific literature, the latter species is often reported as representing a different genus, *Gaius* (see below). *Anidiops* and *Gaius* females can be separated mainly by size with *Gaius* specimens being considerably larger. Spiders in both genera construct leave decorated burrows with a trapdoor. The burrow also includes a 'sock', i.e. the lower section of silk lining has a collar-like structure that the spider can retract to provide a false bottom, presumably serving as anti-predatory mechanism (Main 1985).

A number of undescribed species of *Anidiops* are known from the collection of the WA Museum including some widespread species and some with restricted ranges.

***Anidiops* sp. indet. (♀♀, juv.)**

The females and juveniles from Yakabindie (Appendix 1) cannot be identified to species level, but based on the known distribution of *Anidiops* species, they are here considered potential SREs.

3.2.5.3 Genus *Gaius*

The genus *Gaius* (family Idiopidae) is well represented throughout WA and into the Pilbara region based on WA Museum records. All species have a fairly wide distribution (Framenau *et al.* 2008; Main 1957a, 1978; Schmidt 2007).

***Gaius* sp. indet. (♀♀, juv.)**

No male *Gaius* were found at Yakabindie to allow for accurate species identification. Based on the distribution of known morphospecies within the genus, the females and juveniles from Yakabindie (Appendix 1) are not considered SREs.

3.2.6 Family Nemesiidae (Wishbone Spiders

3.2.6.1 Genus *Aname*

The genus *Aname* currently includes 33 named species in Australia and is well represented by four named and numerous unnamed species from many different regions in Western Australia. *Aname* currently represent a highly diverse array of species of very small to large spiders. Males generally have a spur and spine on the first tibia of males opposing an often incrassate metatarsus. Members of the genus *Aname* are believed to be most common in sclerophyll forest, but are also known from rainforests and deserts (Raven 1981). *Aname* regularly belongs to the most diverse mygalomorph genera in biological spider surveys and with 12 species the Pilbara survey (Durrant *et al.* 2010) resulted in a similar number as found during the Carnarvon Basin survey (13 species) (Main *et al.* 2000). Many *Aname* species appear to have restricted distributions as shown by a review of species from northern Australia (Raven 1985b).

***Aname* 'MYG173'**

Aname 'MYG173' is a species with remarkable colour variation for the genus, but conservative genital morphology. The species has previously been found at Lake Way and Lake Maitland and is therefore not considered an SRE.

***Aname* 'MYG177'**

Aname 'MYG177' belongs to the *Aname* 'MYG001'-group which is characterised by an overall light colouration and dark-reddish cephalic area in males. *Aname* 'MYG177' was the most commonly collected spider of the Yakabindie survey (Appendix 1). The species has previously been found at Lake Way and is therefore not considered an SRE.

***Aname* 'MYG235'**

Aname 'MYG235' belongs to a distinct group of small *Aname* with a group of stout setae on the retrolateral side of the male tibia. A generic review of the genus *Aname* may show these to represent a different, undescribed genus. Currently, three other species are known in this group, all from very restricted ranges, *Aname* 'MYG098' (Hamersley region), *Aname* 'MYG170' (Yeelirrie) and *Aname* 'MYG209' (Port Hedland). *Aname* 'MYG235' distinctly differs from all these species by unusually short setae and spines on body and legs and details in genital morphology.

Taking the limited ranges of all species of this group into account, *Aname* 'MYG235' is considered a likely SRE.

***Aname* sp. indet. (juv.)**

It is not possible to identify the six very small juveniles from the survey (Appendix 1) to species level, but they most likely belong to one of the species listed above.

3.2.6.2 Genus *Kwonkan*

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 2010(2) (Western Australian Government 2010). *Kwonkan* includes those nemesiid spiders that have spines on their pedal tarsi.

***Kwonkan* 'MYG175'**

Kwonkan 'MYG175' has initially been considered a potential SRE (Framenau & Harvey 2010), but has since been found widespread in central WA (WA Museum database). It is not an SRE.

The juveniles of *Kwonkan* found during the survey at Yakabindie (Appendix 1) may also belong to this species.

3.2.6.3 Genus *Yilgarnia*

The genus *Yilgarnia* is currently known from two described species in Western Australia (Main 2008), but many more undescribed species are known from collections. Generic boundaries between *Yilgarnia* and *Kwonkan* remain uncertain as some species have the characteristics of both genera, i.e. cuspules on the coxae of the third and fourth leg (*Yilgarnia*) and tarsal spines (*Kwonkan*). This intermittent group was listed as "*Kwonkan/Yilgarnia*" in the WAM/DEC Carnarvon survey, where three species were recovered at a variety of sites (Main *et al.* 2000).

***Yilgarnia* sp. indet. (juv.)**

It is impossible to identify the *Yilgarnia* specimens from this survey as they are immature (Appendix 1). The genus has not been collected in the area around Yakabindie despite intensive surveys at Lake Way and Lake Maitland. Therefore, the specimens are here considered a potential SRE.

3.2.7 Family Theraphosidae (Tarantulas)

The Theraphosidae share with the Barychelidae the presence of claw-tufts, but differ in their much longer spinnerets, the presence of a distinct lobe on the anterior maxillae and generally much larger size (Raven 1985c). They belong to the largest spiders of Australia and are frequently collected to be sold in the pet trade (Raven 2005).

Currently, four genera of Theraphosidae are described from throughout Australia (except Tasmania), *Coremiocnemis* (one species), *Selenocosmia* (four species), *Selenotholus* (one species) and *Selenotypus* (one species) (Platnick 2011), although all Australian *Selenocosmia* appear to be misplaced in this genus (R. J. Raven personal communication, email 12 March 2009). A further genus, *Phlogiellus*, is also believed to occur here, but no species has been formerly described (Raven 2005). Whilst a family revision has not been published recently, the taxonomy is fairly well resolved due to ongoing research by R. J. Raven (Queensland Museum).

3.2.7.1 Genus *Selenotholus*

Selenotholus differs from all other Australian genera of Theraphosidae by the equal length of the first and fourth leg; the first leg is longer than the fourth in *Phlogiellus* and *Coremiocnemis*. The genus can be found throughout the tropical and arid zones of the country.

***Selenotholus foelschei* Hogg, 1902**

Selenotholus foelschei is currently the only described species of *Selenotholus* and is common throughout northern and central WA. It was originally described from the Northern Territory. It is not an SRE.

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APPENDIX 1 IDENTIFICATION OF SPIDERS (ARANEAE) FROM YAKABINDIE

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
Araneomorphae									
112436	Site 22-503	Gallieniellidae	*Meedo yarragin*	27°26'49.2"S	120°34'24.3"E		1		
112433	Site 26-742	Gallieniellidae	*Meedo yarragin*	27°19'28"S	120°40'18.1"E		1		
112392	Site 10-472	Zodariidae	Zodariidae sp. indet.	27°25'0.7"S	120°35'35.4"E	1			
Mygalomorphae									
114045	Site 17-695	Actinopodidae	*Missulena* sp. indet.	27°28'34.3"S	120°35'53.7"E			1	
114044	Site 16-644	Barychelidae	*Mandjelia* 'MYG035'	27°28'9.5"S	120°34'51.1"E	1			
112394	Site 1-666	Barychelidae	*Mandjelia* 'MYG035'	27°25'36.3"S	120°34'22.5"E			2	
112428	Site 19-766	Barychelidae	*Mandjelia* 'MYG035'	27°24'44.4"S	120°35'18.7"E			1	
112389	Site 20-096	Barychelidae	*Mandjelia* 'MYG035'	27°27'24.7"S	120°35'28"E		1		
112434	Site 21-307	Barychelidae	*Mandjelia* 'MYG035'	27°27'47.3"S	120°35'38.5"E			1	
112358	Site 21-630	Barychelidae	*Mandjelia* 'MYG035'	27°27'47.3"S	120°35'38.5"E	1			
112431	Site 25-361	Barychelidae	*Mandjelia* 'MYG035'	27°17'46.2"S	120°41'5.7"E				
112362	Site 3-017	Barychelidae	*Mandjelia* 'MYG035'	27°25'18.8"S	120°34'37.2"E		1		
112437	Site 3-450	Barychelidae	*Mandjelia* 'MYG035'	27°25'18.8"S	120°34'37.2"E			1	
112374	Site 3-523	Barychelidae	*Mandjelia* 'MYG035'	27°25'18.8"S	120°34'37.2"E	1			
112414	Site 5-046	Barychelidae	*Mandjelia* 'MYG035'	27°26'37.6"S	120°35'22.3"E			1	
112468	Site 12-062	Barychelidae	*Synothele meadhunteri*	27°25'53.2"S	120°35'53.6"E			1	
112441	Site 18-382	Barychelidae	*Synothele meadhunteri*	27°28'50.1"S	120°37'14.8"E			1	
112469	Site 21-634	Barychelidae	*Synothele meadhunteri*	27°27'47.3"S	120°35'38.5"E	1			

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
112378	Site 12-065	Ctenizidae	*Conothele* sp. indet.	27°25'53.2"S	120°35'53.6"E		1		with eggsac
114041	Site 12-067	Ctenizidae	*Conothele* sp. indet.	27°25'53.2"S	120°35'53.6"E			1	
112361	Site 15-074	Ctenizidae	*Conothele* sp. indet.	27°25'29.8"S	120°36'26.1"E		1		
112453	Site 3-019	Ctenizidae	*Conothele* sp. indet.	27°25'18.8"S	120°34'37.2"E		1		
112446	Target 18-170	Dipluridae	*Cethegus* sp. indet.	27°25'52.2"S	120°40'16.3"E		1		
112407	Target 4-147	Dipluridae	*Cethegus* sp. indet.	26°58'25.3"S	120°37'30.5"E			1	
112409	Target 6-148	Dipluridae	*Cethegus* sp. indet.	26°58'49.8"S	120°40'59.8"E			1	
112463	Target 6-149	Dipluridae	*Cethegus* sp. indet.	26°58'49.8"S	120°40'59.8"E		1		
112464	Site 1-014	Idiopidae	*Aganippe* sp. indet.	27°25'36.3"S	120°34'22.5"E		1		
112366	Site 12-188	Idiopidae	*Aganippe* sp. indet.	27°25'53.2"S	120°35'53.6"E		1		not in original list
112399	Site 17-080	Idiopidae	*Aganippe* sp. indet.	27°28'34.3"S	120°35'53.7"E		1		
112427	Site 17-081	Idiopidae	*Aganippe* sp. indet.	27°28'34.3"S	120°35'53.7"E		1	6	
114038	Site 19-090	Idiopidae	*Aganippe* sp. indet.	27°24'44.4"S	120°35'18.7"E		1	21	
112376	Site 21-136	Idiopidae	*Aganippe* sp. indet.	27°27'47.3"S	120°36'38.5"E		1		not in original list
112360	Site 3-020	Idiopidae	*Aganippe* sp. indet.	27°25'18.8"S	120°34'37.2"E		1		
112451	Site 7-048	Idiopidae	*Aganippe* sp. indet.	27°27'15.1"S	120°36'20.3"E			1	
112382	Target 1-142	Idiopidae	*Aganippe* sp. indet.	26°59'58.9"S	120°33'46"E		1		
112379	Site 25-111	Idiopidae	*Anidiops* sp. indet.	27°17'46.2"S	120°41'5.7"E		1		
112462	Site 30-133	Idiopidae	*Anidiops* sp. indet.	27°26'25.3"S	120°41'25.9"E		1		
112365	Target 2-145	Idiopidae	*Anidiops* sp. indet.	26°57'22.7"S	120°31'41.9"E		1		
112402	Site 14-070	Idiopidae	*Gaius* sp. indet.	27°26'15.6"S	120°36'35.4"E		1		
112459	Site 18-083	Idiopidae	*Gaius* sp. indet.	27°28'50.1"S	120°37'14.8"E		1		

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
112375	Site 20-099	Idiopidae	*Gaius* sp. indet.	27°27'24.7"S	120°35'28"E			1	
112421	Site 24-103	Idiopidae	*Gaius* sp. indet.	27°17'57.8"S	120°36'6.3"E		1		
114042	Site 25-110	Idiopidae	*Gaius* sp. indet.	27°17'46.2"S	120°41'5.7"E		1	13	
112370	Target 8-150	Idiopidae	*Gaius* sp. indet.	26°59'36.1"S	120°37'9.4"E		1		
112412	Site 12-063	Idiopidae	*Idiopidae* sp. indet.	27°25'53.2"S	120°35'53.6"E			1	
112425	Site 17-079	Idiopidae	*Idiopidae* sp. indet.	27°28'34.3"S	120°35'53.7"E			1	
112385	Site 17-771	Idiopidae	*Idiopidae* sp. indet.	27°28'34.3"S	120°35'53.7"E			1	
112449	Site 19-092	Idiopidae	*Idiopidae* sp. indet.	27°24'44.4"S	120°35'18.7"E			2	
112367	Site 2-002	Idiopidae	*Idiopidae* sp. indet.	27°25'27.5"S	120°34'53.3"E			1	
112422	Site 28-121	Idiopidae	*Idiopidae* sp. indet.	27°21'40.8"S	120°40'59"E			1	
112373	Site 28-127	Idiopidae	*Idiopidae* sp. indet.	27°21'40.8"S	120°40'59"E			1	
112415	Site 30-132	Idiopidae	*Idiopidae* sp. indet.	27°26'25.3"S	120°41'25.9"E			1	
112448	Site 8-051	Idiopidae	*Idiopidae* sp. indet.	27°26'59.2"S	120°36'16"E			1	
114043	Target 9-156	Idiopidae	*Idiopidae* sp. indet.	27°17'20.24"S	120°34'28.35"E			1	
112458	Site 14-398	Nemesiidae	*Aname* 'MYG173'	27°26'15.6"S	120°36'35.4"E	1			
112384	Site 14-442	Nemesiidae	*Aname* 'MYG173'	27°26'15.6"S	120°36'35.4"E	1			
112450	Site 10-059	Nemesiidae	*Aname* 'MYG177'	27°25'0.7"S	120°35'35.4"E		1		
112447	Site 10-060	Nemesiidae	*Aname* 'MYG177'	27°25'0.7"S	120°35'35.4"E		1		
112454	Site 10-061	Nemesiidae	*Aname* 'MYG177'	27°25'0.7"S	120°35'35.4"E		1		
112395	Site 10-472	Nemesiidae	*Aname* 'MYG177'	27°25'0.7"S	120°35'35.4"E	1			
114039	Site 14-071	Nemesiidae	*Aname* 'MYG177'	27°26'15.6"S	120°36'35.4"E		1		
112403	Site 15-075	Nemesiidae	*Aname* 'MYG177'	27°25'29.8"S	120°36'26.1"E		1		
112455	Site 18-084	Nemesiidae	*Aname* 'MYG177'	27°28'50.1"S	120°37'14.8"E		1		

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
112457	Site 18-085	Nemesiidae	*Aname* 'MYG177'	27°28'50.1"S	120°37'14.8"E		1		
112398	Site 18-511	Nemesiidae	*Aname* 'MYG177'	27°28'50.1"S	120°37'14.8"E	1			
112456	Site 19-088	Nemesiidae	*Aname* 'MYG177'	27°24'44.4"S	120°35'18.7"E		1		
112359	Site 19-093	Nemesiidae	*Aname* 'MYG177'	27°24'44.4"S	120°35'18.7"E		1		
114040	Site 22-676	Nemesiidae	*Aname* 'MYG177'	27°26'49.2"S	120°34'24.3"E	1			
112380	Site 23-102	Nemesiidae	*Aname* 'MYG177'	27°19'19.8"S	120°38'4.7"E	1			
112424	Site 25-112	Nemesiidae	*Aname* 'MYG177'	27°17'46.2"S	120°41'5.7"E		1		
112411	Site 26-115	Nemesiidae	*Aname* 'MYG177'	27°19'28"S	120°40'18.1"E		1		
112442	Site 27-116	Nemesiidae	*Aname* 'MYG177'	27°28'30.1"S	120°41'24.8"E		1		
112408	Site 27-119	Nemesiidae	*Aname* 'MYG177'	27°28'30.1"S	120°41'24.8"E		1		
112405	Site 28-122	Nemesiidae	*Aname* 'MYG177'	27°21'40.8"S	120°40'59"E		1		
112364	Site 28-123	Nemesiidae	*Aname* 'MYG177'	27°21'40.8"S	120°40'59"E		1		
112418	Site 28-124	Nemesiidae	*Aname* 'MYG177'	27°21'40.8"S	120°40'59"E		1		
112420	Site 29-128	Nemesiidae	*Aname* 'MYG177'	27°21'3.4"S	120°37'57.9"E		1		
112444	Site 29-129	Nemesiidae	*Aname* 'MYG177'	27°21'3.4"S	120°37'57.9"E		1		
112465	Site 29-130	Nemesiidae	*Aname* 'MYG177'	27°21'3.4"S	120°37'57.9"E	1			
112443	Site 29-131	Nemesiidae	*Aname* 'MYG177'	27°21'3.4"S	120°37'57.9"E		1		
112413	Site 30-134	Nemesiidae	*Aname* 'MYG177'	27°26'25.3"S	120°41'25.9"E	1			
112416	Site 30-135	Nemesiidae	*Aname* 'MYG177'	27°26'25.3"S	120°41'25.9"E		1		
112381	Site 4-033	Nemesiidae	*Aname* 'MYG177'	27°25'45.2"S	120°34'18.3"E	1			
112446	Site 4-034	Nemesiidae	*Aname* 'MYG177'	27°25'45.2"S	120°34'18.3"E		1		
112452	Site 7-049	Nemesiidae	*Aname* 'MYG177'	27°27'15.1"S	120°36'20.3"E		1		
112404	Site 7-050	Nemesiidae	*Aname* 'MYG177'	27°27'15.1"S	120°36'20.3"E		1		

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
112363	Site 9-056	Nemesiidae	*Aname* 'MYG177'	27°26'35.7"S	120°36'2.7"E	1			
112410	Target 1-139	Nemesiidae	*Aname* 'MYG177'	26°59'58.9"S	120°33'46"E		1		
112417	Target 1-140	Nemesiidae	*Aname* 'MYG177'	26°59'58.9"S	120°33'46"E		1		
112419	Target 1-141	Nemesiidae	*Aname* 'MYG177'	26°59'58.9"S	120°33'46"E		1		
112393	Target 12-157	Nemesiidae	*Aname* 'MYG177'	27°20'27.1"S	120°35'22.6"E		1		
112387	Target 12-158	Nemesiidae	*Aname* 'MYG177'	27°20'27.1"S	120°35'22.6"E		1		
112432	Target 12-159	Nemesiidae	*Aname* 'MYG177'	27°20'27.1"S	120°35'22.6"E		1		not in original list
112423	Target 2-143	Nemesiidae	*Aname* 'MYG177'	26°57'22.7"S	120°31'41.9"E		1		
112440	Target 2-144	Nemesiidae	*Aname* 'MYG177'	26°57'22.7"S	120°31'41.9"E		1		
112406	Target 4-146	Nemesiidae	*Aname* 'MYG177'	26°58'25.3"S	120°37'30.5"E		1		
112391	Target 9-152	Nemesiidae	*Aname* 'MYG177'	27°17'20.24"S	120°34'28.35"E		1		
112386	Target 9-153	Nemesiidae	*Aname* 'MYG177'	27°17'20.24"S	120°34'28.35"E		1		
112388	Target 9-154	Nemesiidae	*Aname* 'MYG177'	27°17'20.24"S	120°34'28.35"E		1		
112390	Target 9-155	Nemesiidae	*Aname* 'MYG177'	27°17'20.24"S	120°34'28.35"E		1		
112397	Site 16-776	Nemesiidae	*Aname* 'MYG235'	27°28'9.5"S	120°34'51.1"E	1			
112401	Site 15-073	Nemesiidae	*Aname* sp. indet.	27°25'29.8"S	120°36'26.1"E			1	
112430	Site 1-513	Nemesiidae	*Aname* sp. indet.	27°25'36.3"S	120°34'22.5"E			1	
112369	Site 15-192	Nemesiidae	*Aname* sp. indet.	27°25'29.8"S	120°36'26.1"E			1	
112396	Site 19-803	Nemesiidae	*Aname* sp. indet.	27°24'44.4"S	120°35'18.7"E			1	
112429	Site 2-568	Nemesiidae	*Aname* sp. indet.	27°25'27.5"S	120°34'53.3"E			1	
112371	Site 30-589	Nemesiidae	*Aname* sp. indet.	27°26'25.3"S	120°41'25.9"E			1	

WAM registration (T-number)	Field number	Family	Genus and species	Latitude	Longitude	♂♂	♀♀	juv.	Remarks
112426	Site 24-359	Nemesiidae	*Kwonkan* 'MYG175'	27°17'57.8"S	120°36'6.3"E	1			
112377	Site 24-453	Nemesiidae	*Kwonkan* 'MYG175'	27°17'57.8"S	120°36'6.3"E	1			
112439	Site 18-382	Nemesiidae	*Kwonkan* sp. indet.	27°28'50.1"S	120°37'14.8"E			1	
112438	Site 26-742	Nemesiidae	*Kwonkan* sp. indet.	27°19'28"S	120°40'18.1"E			1	
112368	Site 5-587	Nemesiidae	*Kwonkan* sp. indet.	27°26'37.6"S	120°35'22.3"E			1	
112435	Site 6-452	Nemesiidae	*Kwonkan* sp. indet.	27°26'56.2"S	120°35'12.8"E	1			
112400	Site 13-066	Nemesiidae	*Yilgarnia* sp. indet.	27°26'0"S	120°35'23.8"E			1	
112470	Site 1-666	Nemesiidae	*Yilgarnia* sp. indet.	27°25'36.3"S	120°34'22.5"E			1	
112445	Target 20-171	Nemesiidae	*Yilgarnia* sp. indet.	27°17'27"S	120°41'11"E			1	
112467	Site 27-117	Theraphosidae	*Selenotholus foelschei*	27°28'30.1"S	120°41'24.8"E			1	
112372	Site 3-018	Theraphosidae	*Selenotholus foelschei*	27°25'18.8"S	120°34'37.2"E			1	
112383	Site 4-045	Theraphosidae	*Selenotholus foelschei*	27°25'45.2"S	120°34'18.3"E			1	

Appendix C Phylogenetic Tree For All Specimens Of Idiopidae

Helix
Molecular
Solutions

School of Animal Biology The University of Western Australia
Hackett Entrance No. 4 Hackett Drive Crawley WA 6009

PO Box 155
Leederville WA 6903

t: (08) 6488 4509 | f: (08) 6488 1029 | abn: 32 133 230 243 | w: www.helixsolutions.com.au

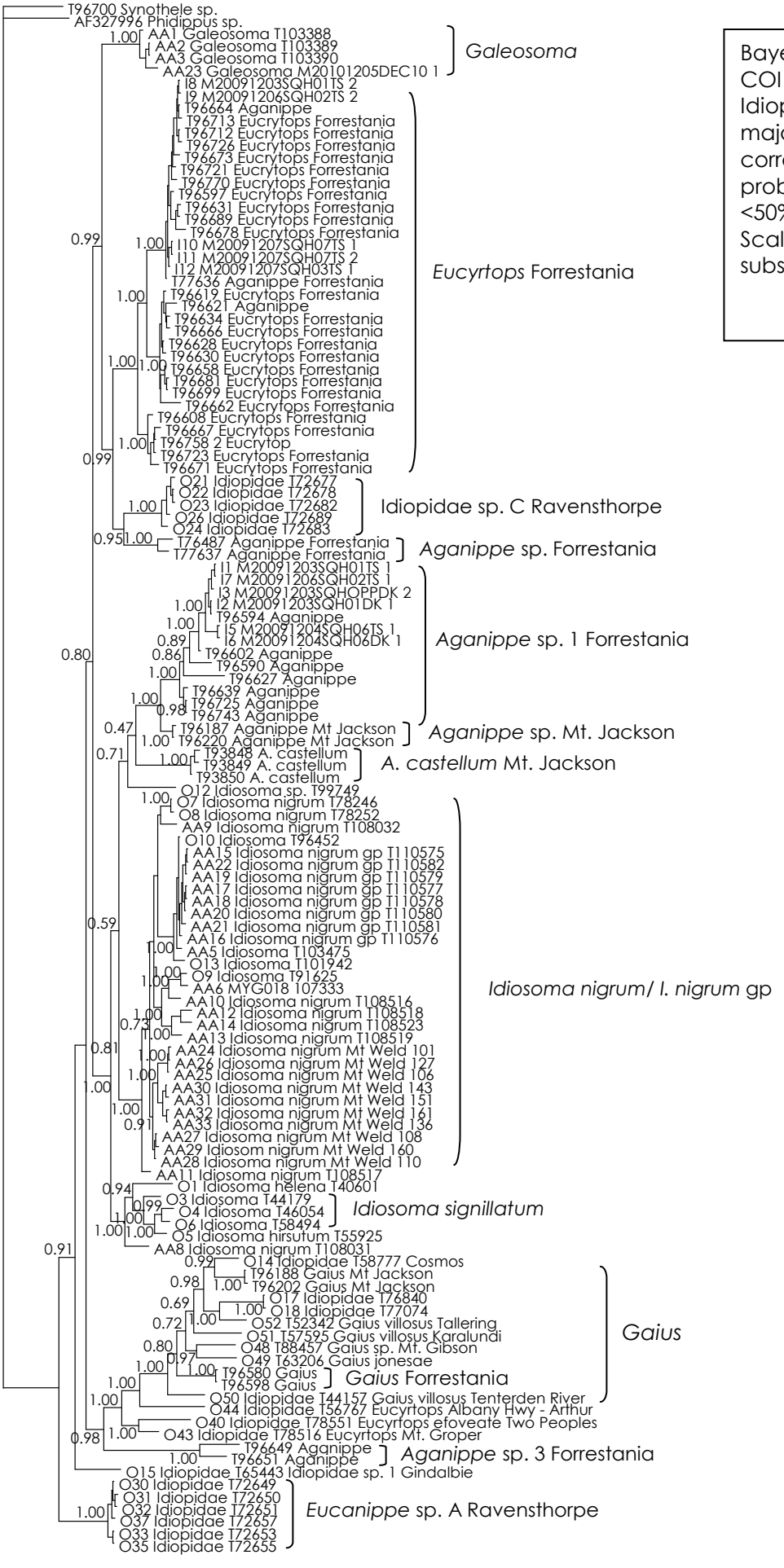
11 April 2011

Re. Phylogenetic tree for all specimens of Idiopidae

Dear Roy and Mark,

Following is the tree generated in MrBayes for all specimens of Idiopidae sequenced to date. The analysis places the specimens of *Idiosoma nigrum* and *I. nigrum* gp. into a single well-supported clade that is characterised by short branch lengths. The *I. nigrum* clade forms a poorly-supported clade with several species of *Aganippe*, to the exclusion of the remaining species of *Idiosoma*. Two genera (*Aganippe*, *Eucyrtops*) appear to be polyphyletic. These features, which contradict the morphology, suggest that the resolution is poor. This is likely attributed to the fact that the number of base-pairs used in the analysis is small compared to the number of haplotypes, and while posterior probabilities are generally high for most major nodes, a more robust resolution of the phylogenetic relationships would likely be attained by including additional genes in the analysis.

Cheers,
Terrie



Bayesian analysis of COI haplotypes of Idiopidae. Numbers on major nodes correspond to posterior probabilities; values <50% are not shown. Scale bar= number of substitutions per site.

Appendix D Yakabindie Scorpion Identification Report

ScorpionID

4 / 76 Royal St, Tuart Hill, WA, 6060 | Ph: 0457 11 13 17 | email: evolschen@gmail.com

Yakabindie Scorpion Identification Report

Report ID: OE-YA-201107
Prepared for: Outback Ecology
By Dr Erich S. Volschenk
Monday, 5 September 2011

Outback Ecology is undertaking a short-range endemic survey at Yakabindie, and has requested:
- Taxonomic identifications of scorpion from the survey;
- SRE assessment of the species represented in the collection, and;
- Lodgement of these specimens in the Western Australian Museum Arachnology Collection

The collection is comprised of 195 samples.

One species present is flagged as a potential SRE: *Urodacus* cf 'gibson 5'

FAMILY: Buthidae

The family Buthidae is the most diverse and wide spread of all scorpion families (Fet & Lowe 2000). In Australia, Buthidae is represented by the genera *Australobuthus* Locket; *Isometrus* Ehrenberg; *Isometroides* Keyserling , *Lychas* C.L. Koch, and *Hemilychas* Hirst. In Western Australia, only the *Isometrus*, *Isometroides* and *Lychas*, have been recorded. The taxonomy of the constituent species of *Isometrus*, *Isometroides* and *Lychas* is very problematic and each genus contains numerous undescribed species, most notably in the genus *Lychas* (Volschenk unpublished data). Most Authors refer to LE Koch (1977) for keys and identification. That revision represents an important study of the Australian scorpions; however, several taxonomic decisions made by LE Koch (1977) have been rejected by subsequent authors and the taxonomy in that publication is not up to date. Most Australian buthid species appear to have wide distributions; however, a few taxa have confirmed SRE distributions (Volschenk unpublished data).

GENUS: *Isometroides*

The taxonomy of the species in this genus is extremely poorly known. Only two species are presently recognised; however, many undescribed species are known. *Isometroides* scorpions are ground dwelling scorpions and are the only scorpion species known to be a predatory specialist. Main (Main) described the association of this species with burrowing spiders and numerous records have followed of this species preying on, and being found in trapdoor spider (Mygalorphae and Lycosidae) burrows (Volschenk Pers. Obs.). Species in this genus never appear to be abundant in pitfall trapping samples; the ground disturbance near the entrance top of the pitfall trap may deter them. While their taxonomy is poorly resolved, most morphospecies appear to have fairly wide distributions; however this may change with further work on their systematics.

Species: *Isometroides* sp. indet.

SRE STATUS
Isometroides sp. indet. is unlikely to be an SRE.

TAXONOMIC RESOLUTION
Isometroides sp. indet. specimen/s could not be identified owing to incorrect sex and/or life history stage.

DISTRIBUTION
Isometroides sp. indet. cannot be defined as this is not a clear species. See comments for the genus.

RECOMENDATIONS
Isometroides sp. indet. management is impossible since it is not clear which species this is.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105808	Site 7-354			1		Volschenk E.S.
T105823	Site 19-086		1			Volschenk E.S.

Number of samples: 2

==========

GENUS: *Lychas*

The genus *Lychas* is widespread across the Australian mainland. The taxonomy of this genus is problematic, with numerous undescribed species known in Australia (Volschenk *et al.* 2010). The situation is further complicated with the genus being also represented in Africa, India and eastern Asia (Fet & Lowe 2000). All of the Australian species are endemic and are currently under revision by ES Volschenk. Most species of *Lychas* appear to have wide distributions; however, a small number of species are known to be SRE's.

Species: *Lychas* 'adonis'

SRE STATUS

Lychas 'adonis' is not an SRE.

TAXONOMIC RESOLUTION

Lychas 'adonis' is a well-defined and clearly recognised morphospecies.

DISTRIBUTION

Lychas 'adonis' has wide distribution across arid Australia. Its distribution is Eyrean, where it inhabits various habitats including sparse Mallee forests on sand to Spinifex covered dunes. This species has been recorded from Victoria, South Australia and Western Australia. This species appears to prefer sandy spinifex dominated habitats.

RECOMENDATIONS

Lychas 'adonis' is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T114062	Site 14-489			1		Volschenk E.S.
T105658	Site 24-454	1		2		Volschenk E.S.
T114064	Site 27-344	1		1		Volschenk E.S.
T105795	Site 14-401	2		1		Volschenk E.S.
T114099	Site 28-285			1		Volschenk E.S.
T114063	Site 28-792			1		Volschenk E.S.
T114065	Site 26-231	1				Volschenk E.S.
T114059	Site 15-214	1				Volschenk E.S.
T105657	Site 24-505			1		Volschenk E.S.
T114061	Site 24-347			1		Volschenk E.S.

Number of samples: 10

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Species: *Lychas* annulatus

SRE STATUS

Lychas annulatus is not an SRE.

TAXONOMIC RESOLUTION

Lychas annulatus is highly variable and is likely to represent a species complex.

DISTRIBUTION

Lychas annulatus has wide distribution across arid Australia. Its distribution is Eyrean, where it inhabits various habitats including sparse Mallee forests on sand to Spinifex covered dunes. This species has been recorded from Victoria, South Australia and Western Australia. This species appears to prefer sandy spinifex dominated habitats.

RECOMENDATIONS

Lychas annulatus is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105678	Site 9-682			1		Volschenk E.S.
T105676	Site 7-662			1		Volschenk E.S.
T105677	Site 16-658			2		Volschenk E.S.
T105675	Site 30-689			2		Volschenk E.S.
T105674	Site 16-778		1			Volschenk E.S.
T105673	Site 5-702			1		Volschenk E.S.

Number of samples: 6

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Species: *Lychas jonesae*

SRE STATUS

Lychas jonesae is not an SRE.

TAXONOMIC RESOLUTION

Lychas jonesae is a well-defined and clearly recognised species.

DISTRIBUTION

Lychas jonesae has a wide distribution across arid Australia. Its distribution is Eyrean, where it inhabits various habitats including sparse Mallee forests on sand to Spinifex covered dunes. This species has been recorded from Victoria, South Australia and Western Australia.

RECOMENDATIONS

Lychas jonesae is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T114080	Site 29-551			1		Volschenk E.S.
T105842	Site 2-569			1		Volschenk E.S.
T105664	Site 3-521		1			Volschenk E.S.
T105707	Site 27-758			2		Volschenk E.S.
T114060	Site 27-697	1				Volschenk E.S.
T114074	Site 5-588	1				Volschenk E.S.
T105840	Site 10-706			1		Volschenk E.S.
T105660	Site 5-768	1	1			Volschenk E.S.
T105717	Site 22-321			1		Volschenk E.S.
T114079	Site 4-653	1				Volschenk E.S.
T114084	Site 7-480			1		Volschenk E.S.
T105723	Site 5-402		1			Volschenk E.S.
T105838	Site 4-211	1				Volschenk E.S.
T114075	Site 23-494			1		Volschenk E.S.
T105725	Site 8-395	1	1	3		Volschenk E.S.
T114088	Site 27-423			1		Volschenk E.S.
T105848	Site 29-440			3		Volschenk E.S.
T105720	Site 28-735			2		Volschenk E.S.
T114077	Site 9-410	1				Volschenk E.S.
T105712	Site 29-304			2		Volschenk E.S.
T105668	Site 28-672		1			Volschenk E.S.
T114078	Site 7-329			1		Volschenk E.S.
T114093	Site 9-421		1	1		Volschenk E.S.
T105714	Site 21-378			2		Volschenk E.S.

T105670	Site 9-781		1	1		Volschenk E.S.
T105845	Site 10-279		1			Volschenk E.S.
WAM Rego.	**Client Rego.**	♂	♀	**Juv.**	**Notes**	**Identified by**
T105671	Site 8-373			2		Volschenk E.S.
T114085	Site 22-561			1		Volschenk E.S.
T105663	Site 22-501			2		Volschenk E.S.
T105706	Site 3-316			3		Volschenk E.S.
T114092	Site 3-445			2		Volschenk E.S.
T105661	Site 5-783	2				Volschenk E.S.
T105665	Site 21-747			1		Volschenk E.S.
T114058	Site 8-534		1	1		Volschenk E.S.
T105837	Site 21-358	1	1	2		Volschenk E.S.
T105839	Site 28-294	1				Volschenk E.S.
T105718	Site 19-310			1		Volschenk E.S.
T105844	Site 25-223	1				Volschenk E.S.
T105716	Site 11-657			1		Volschenk E.S.
T105715	Site 25-303		1	3		Volschenk E.S.
T105841	Site 11-281			1		Volschenk E.S.
T114089	Site 30-553	1				Volschenk E.S.
T105849	Site 13-694		1			Volschenk E.S.
T114097	Site 7-592			1		Volschenk E.S.
T114071	Site 19-621			1		Volschenk E.S.
T105722	Site 27-397			3		Volschenk E.S.
T105713	Site 11-763			1		Volschenk E.S.
T105667	Site 19-518		1			Volschenk E.S.
T114072	Site 11-715			1		Volschenk E.S.
T114098	Site 19-255			1		Volschenk E.S.
T114094	Site 16-432			1		Volschenk E.S.
T105662	site 8-308		1			Volschenk E.S.
T114100	Site 18-610	1				Volschenk E.S.
T105666	Site 18-509	1				Volschenk E.S.
T105721	Site 18-384			1		Volschenk E.S.
T105711	Site 17-773			1		Volschenk E.S.
T114081	Site 17-418		1	1		Volschenk E.S.
T105708	Site 2-750		1	2		Volschenk E.S.
T105672	Site 19-529	2		1		Volschenk E.S.
T114087	Site 7-354			2		Volschenk E.S.
T114095	Site 12-690			3		Volschenk E.S.
T114076	Site 6-254			1		Volschenk E.S.
T105724	Site 6-434			1		Volschenk E.S.
T105659	Site 7-483			1		Volschenk E.S.
T105709	Site 13-371			2		Volschenk E.S.
T114083	Site 8-390			1		Volschenk E.S.
T114082	Site 13-785		1	1		Volschenk E.S.
T114096	Site 14-408			1		Volschenk E.S.
T114070	Site 6-451			2		Volschenk E.S.
T105669	Site 6-745			1		Volschenk E.S.
T105719	Site 19-799			1		Volschenk E.S.

Number of samples: 71

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Species: *Lychas* 'splendens'

SRE STATUS
Lychas 'splendens' is not an SRE.

TAXONOMIC RESOLUTION
Lychas 'splendens' is a well-defined and clearly recognised morphospecies.

DISTRIBUTION
Lychas 'splendens' is relatively widespread and is distributed throughout the Wheat Belt and Goldfields of WA.

RECOMENDATIONS
Lychas 'splendens' is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105679	site 8-308		1			Volschenk E.S.
T114069	Site 1-016		1			Volschenk E.S.
T114066	Site 12-541		1			Volschenk E.S.
T114067	Site 10-475			1		Volschenk E.S.
T114068	Target 13-161			1		Volschenk E.S.
T105682	Site 19-761	1				Volschenk E.S.
T105710	Site 12-800	1				Volschenk E.S.
T105681	Site 12-700		1			Volschenk E.S.
T105680	Site 3-668		1			Volschenk E.S.
T105683	Site 2-664	1				Volschenk E.S.

Number of samples: 10

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FAMILY: Urodacidae

The family Urodacidae is endemic to Australia (Fet 2000; Prendini 2000; Prendini 2003) where it is represented by the genera *Urodacus* Peters, 1861 and *Aops* Volschenk and Prendini, 2008 .

GENUS: *Urodacus*

Urodacus has been considered a member of the family Scorpionoidea for many years, but in a revision of the superfamily Scorpionoidea Latreille, Prendini (Prendini) placed *Urodacus* in its own family. Unlike the species designations for Buthidae, LE Koch's (Koch) species' of *Urodacus* have been mostly supported by subsequent authors {Volschenk, 2000 #4517; Harvey, 2002 #9333; (Volschenk 2008). The biggest issue confronting *Urodacus* taxonomy is the number of undescribed species being uncovered through current revisionary work (Volschenk unpublished data). Currently 22 species of *Urodacus* are described; however, this may represent only 15-20% of the real diversity of this genus in Australia. *Urodacus* is most diverse in Western Australia and few species are recorded east of the Great Dividing Range in eastern Australia. *Urodacus* contains both widespread and SRE species.

Species: *Urodacus* 'gibson 1'

SRE STATUS
Urodacus 'gibson 1' is not an SRE.

TAXONOMIC RESOLUTION
Urodacus 'gibson 1' is a well-defined and clearly recognised morphospecies.

DISTRIBUTION
Urodacus 'gibson 1' is known from several specimens collected from the Western and Eastern Murchison bioregions. While represented by relatively few specimens their distribution spans 300km.

RECOMENDATIONS
Urodacus 'gibson 1' is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105744	Site 28-789		1			Volschenk E.S.
T105738	Site 26-739	1				Volschenk E.S.
T105747	Site 26-725	1				Volschenk E.S.
T105743	Site 26-740	1				Volschenk E.S.
T105739	Site 30-688	1				Volschenk E.S.
T105745	Site 26-749	1				Volschenk E.S.
T105749	Site 26-723	1				Volschenk E.S.
T105748	Site 26-722	1				Volschenk E.S.
T105727	Site 26-724	1				Volschenk E.S.
T105746	Site 25-367	1				Volschenk E.S.
T105735	Site 26-721	1				Volschenk E.S.
T105731	Site 12-532	1				Volschenk E.S.
T105726	Site 25-647	1				Volschenk E.S.
T105733	Site 25-324	1				Volschenk E.S.
T105730	Site 25-364	1				Volschenk E.S.
T105740	Site 26-114			1		Volschenk E.S.
T105737	Site 26-247	1				Volschenk E.S.
T105732	Site 29-573	1				Volschenk E.S.
T105728	Site 26-684	1				Volschenk E.S.
T105729	Site 26-720	1				Volschenk E.S.
T105750	Site 9-419	1				Volschenk E.S.
T105741	Site 9-646	1				Volschenk E.S.
T105742	Site 10-058	1				Volschenk E.S.
T105736	Site 26-253	1				Volschenk E.S.

Number of samples: 24

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Species: *Urodacus* cf 'gibson 5'

SRE STATUS
Urodacus cf 'gibson 5' is a potential SRE.

TAXONOMIC RESOLUTION
Urodacus cf 'gibson 5' appears morphologically similar to *U*. 'gibson5' and may represent a range extension of that species; but, may also represent a new species. Additional comparisons between specimens from each population are necessary in order to determine the relationships between these two potential species.

DISTRIBUTION
Urodacus 'gibson 5' is only known from Mount Gibson area, Avon Wheatbelt bioregion of WA, where *U.* cf 'gibson 5' is known only from a restricted population in the Eastern Murchison bioregion. The two populations are separate from each other by approximately 400 km.

RECOMENDATIONS
Urodacus cf 'gibson 5' should be managed as an SRE until more is known about its relationship with *U.* 'gibson 5'. A genomic comparison between specimens from each population may be the most cost efficient way to determine this without spending large amounts of time comparing morphology.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105832	Target 10-167	1				Volschenk E.S.
T105810	Site 8-054	1				Volschenk E.S.
T105767	Site 8-053	1				Volschenk E.S.
T105751	Site 8-052		1			Volschenk E.S.
T105797	Site 8-572	3				Volschenk E.S.
T105836	Site 8-391	1				Volschenk E.S.
T105765	Site 8-649	1				Volschenk E.S.
T105762	Site 4-043	1				Volschenk E.S.
T105809	Target 14-162	1				Volschenk E.S.
T105812	Target 14-163	1				Volschenk E.S.
T105758	Site 10-057		1			Volschenk E.S.
T105826	Site 8-560	1				Volschenk E.S.
T105794	Site 10-243	1				Volschenk E.S.
T105766	Site 8-640	1				Volschenk E.S.
T105831	Site 1-512	1				Volschenk E.S.
T105786	Site 20-097	1				Volschenk E.S.
T105792	Site 4-211	1				Volschenk E.S.
T105846	Site 2-204			1		Volschenk E.S.
T105829	Site 20-280	2				Volschenk E.S.
T105793	Site 20-248	1				Volschenk E.S.
T105828	Site 20-218	1				Volschenk E.S.
T114090	Site 20-100			1		Volschenk E.S.
T105755	Site 24-107			1		Volschenk E.S.
T105834	Site 2-478	1				Volschenk E.S.
T105805	Site 1-331	2				Volschenk E.S.
T105830	Site 22-496	1				Volschenk E.S.
T105759	Site 16-076	1				Volschenk E.S.
T114073	Site 22-138			1		Volschenk E.S.
T105824	Site 20-098	1				Volschenk E.S.
T105827	Site 16-613	1				Volschenk E.S.
T105790	Site 19-087		1			Volschenk E.S.
T105798	Site 19-797	1				Volschenk E.S.
T105782	Site 19-601	1				Volschenk E.S.
T105760	Site 19-530	1				Volschenk E.S.
T105785	Site 19-465	1				Volschenk E.S.
T105756	Site 19-089	1				Volschenk E.S.
T105783	Site 16-490	1				Volschenk E.S.
T105781	Site 16-775	1				Volschenk E.S.
T105784	Site 1-635	2	1	1		Volschenk E.S.
T105821	Site 22-600	1				Volschenk E.S.
T105763	Site 24-105		1			Volschenk E.S.
T105835	Site 19-091	1				Volschenk E.S.
T105761	Site 22-137	1				Volschenk E.S.
T105796	Site 4-044	1				Volschenk E.S.
T105833	Site 20-603	2				Volschenk E.S.
T105780	Site 22-562	1				Volschenk E.S.
T105764	Site 29-648	1				Volschenk E.S.

Number of samples: 47

Species: *Urodacus* 'laverton 2'

SRE STATUS
Urodacus 'laverton 2' is not an SRE

TAXONOMIC RESOLUTION
Urodacus 'laverton 2' is a well-defined and clearly recognised morphospecies.

DISTRIBUTION
Urodacus 'laverton 2' is known from a number of samples collected from the Eastern Murchison bioregion of WA.

RECOMENDATIONS
Urodacus 'laverton 2' is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105802	Site 29-436	1				Volschenk E.S.
T105801	Site 29-527	1				Volschenk E.S.
T105818	Site 24-106			1		Volschenk E.S.
T105800	Site 29-525		1			Volschenk E.S.
T105814	Site 28-790	1				Volschenk E.S.
T105799	Site 28-737		1			Volschenk E.S.

Number of samples: 6

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Species: *Urodacus* 'laverton 5'

SRE STATUS
Urodacus 'laverton 5' is not an SRE

TAXONOMIC RESOLUTION
Urodacus 'laverton 5' is a well-defined and clearly recognised morphospecies.

DISTRIBUTION
Urodacus 'laverton 5' is known from a number of samples collected from the Eastern Murchison bioregion of WA.

RECOMENDATIONS
Urodacus 'laverton 5' is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105776	Site 29-566		1			Volschenk E.S.
T105774	Site 29-850	1				Volschenk E.S.
T105753	Site 28-506	1				Volschenk E.S.
T105777	Site 27-118			1		Volschenk E.S.
T105772	Site 28-237	1				Volschenk E.S.
T105752	Site 28-226	1				Volschenk E.S.
T105775	Site 30-564	1				Volschenk E.S.
T105734	Site 1-457	1				Volschenk E.S.
T105757	Site 29-550	1				Volschenk E.S.
T105769	Site 29-526	1				Volschenk E.S.
T105847	Site 25-113			1		Volschenk E.S.
T105770	Site 25-363	1				Volschenk E.S.
T105754	Site 25-366	1				Volschenk E.S.

WAM Rego.	Client Rego.	♂	♀	Juv.	Notes	Identified by
T105773	Site 25-368	1				Volschenk E.S.
T105768	Site 10-471	1				Volschenk E.S.
T105778	Site 29-425	1				Volschenk E.S.
T105843	Site 24-104			1		Volschenk E.S.
T114091	Target 8-151			1		Volschenk E.S.
T105771	Site 29-449	1				Volschenk E.S.

Number of samples: 19

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Appendix E Pseudoscorpions (Arachnida) and Millipedes (Diplopoda) from Yakabindie, Western Australia

Pseudoscorpions (Arachnida) and Millipedes (Diplopoda) from the Yakabindie, Western Australia

Report to *Outback Ecology*

18 November 2011

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Summary

The samples submitted to the Western Australian Museum on the 30th June 2011 (accession no. A7071) from Yakabindie included millipedes from the family Paradoxosomatidae; and pseudoscorpions from the families Atemnidae (*Oratemnus*), Cheiridiidae (`*PSEAAB*`), Chernetidae (`*PSEAAC*` and *Sundochernes*), Chthoniidae (*Austrochthonius*), Garypidae (*Synsphyronus*), and Olpiidae (*Austrohorus*, *Beierolpium, Indolpium, Linnaeolpium,* and `Genus 7/4`). Most of the pseudoscorpion genera need taxonomic revision and it is therefore difficult to determine if these samples represent short range endemics.

Putative short range endemics:

- ***Antichiropus* `sp. nov. Yakabindie` (Paradoxosomatidae):** This species has only been recorded from this survey from a very small area. As *Antichiropus* species are often have limited distributions, it is highly likely that this species is a short-range endemic.
- ***Synsphyronus* `sp. PSE023` (Garypidae):** This is the first record of this species. It may represent a short-range endemic as some species of *Synsphyronus* are, however more sampling would help determine this species' range.

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, Harvey 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, Moir et al. 2008), but there are many poorly known species and gaps in our understanding of the distributions of many species.

Methods

Terrestrial invertebrates (millipedes and pseudoscorpions) that were collected by *Outback Ecology* from Yakabindie, north of Leinster, were submitted to the Western Australian Museum on 30th June 2011. The millipedes and pseudoscorpions were examined at the WAM museum using Leica dissecting microscopes (MZ6, MZ16).

DIPLOPODA

Order Polydesmida
Family Paradoxosomatidae

Genus *Antichiropus*

The genus *Antichiropus* is the most abundant and diverse millipede group in Western Australia. This genus was first named in 1911 for seven species (Attems 1911), and additional species were added by Jeekel (1982) and Shear (Shear 1992). As the result of large field surveys and taxonomic work at the Western Australian Museum, the genus is now known to consist of over 110 species, ranging as far north as the Pilbara, and extending onto the Nullarbor Plain and the Eyre Peninsula in South Australia (figure below). With the exception of *Antichiropus variabilis*, which inhabits the jarrah forests of south-western WA, and *Antichiropus* 'PM1' from the northern Wheatbelt and the Geraldton sandplain, all species of the genus are known to be short-range endemics, and many are known from only a few hundred square kilometres (Harvey, Sampey et al. 2000; Harvey 2002).

Although the vast majority of *Antichiropus* species currently lack formal taxonomic descriptions and scientific names, MSH has spent the past decade comparing different species of the genus and assigning temporary codes to each of the species. The distinction between species is largely based upon differences in the structure of the male gonopods. These are modified legs on the seventh abdominal segment that are used to store sperm prior to mating. The shape of the gonopod of each *Antichiropus* species is different, making the identification of individual species a relatively simple task. These differences in gonopod morphology have been used in millipede taxonomy for 150 years, and have been shown to be good indicators of valid biological species.

***Antichiropus* 'sp. nov. Yackabindie'**

Antichiropus `sp. nov. Yakabindie` is only known from the small number specimens recovered during this survey (Appendix 1) and is therefore considered a short-range endemic species.

ARACHNIDA

Order Pseudoscorpiones

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 this survey included 439 individuals from six families: Atemnidae, Cheiridiidae, Chernetidae, Chthoniidae, Garypidae, and Olpiidae (Appendix 1).

Family Atemnidae

***Oratemnus sp.* (family Atemnidae)**

Seven specimens of *Oratemnus* sp. were collected during the survey (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 most 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 these specimens represent a short-range endemic species.

Family Cheiridiidae

Genus `*PSEAAB*`

One male and three females of an unidentified cheiridiid were collected during the survey (Appendix 1). The systematic status of the many populations of Cheiridiidae is currently unknown but it is very unlikely that any represent short-range endemic species.

Family Chernetidae

Some of the juvenile pseudoscorpions from the family Chernetidae collected during this survey were not identifiable beyond family level. These are indicated as `Genus indet.` `sp. juv.` in Appendix 1.

`PSEAAC` `sp. PSE022` (family Chernetidae)

Chernetidae are the most diverse of all pseudoscorpion families with 113 named genera and 652 named species worldwide. The Australian fauna is quite extensive, with 37 described species (Harvey 2011). Two females were collected from this undescribed genus/species. It is unlikely that they represent short-range endemic species as most chernetids tend to have relatively wide distributions.

***Sundochernes* `sp. PSE020` (family Chernetidae)**

There are two other named species of *Sundochernes* in Western Australia, *S. dubius* from Augusta, and *S. australiensis* from Denmark (Harvey and Volschenk 2007). The specimens from this survey are unlike the descriptions of these two species and are given the species code PSE020. Again, it is unlikely that these specimens represent short-range endemic species as most chernetids tend to have relatively wide distributions.

Family Chthoniidae

***Austrochthonius* `spp. nov.` (family Chthoniidae)**

Twelve specimens of new species of *Austrochthonius* were collected during the survey (Appendix 1). Species of *Austrochthonius* occur in leaf litter and soil environments throughout much of Western Australia, as well as subterranean ecosystems in Cape Range and near Busselton (Harvey 1991; Harvey and Mould 2006). The taxonomy of the Western Australian representatives is not resolved but there are clearly several species represented in the collections of the Western Australian Museum. Most species appear to be widespread and the specimens collected during this project are not believed to represent a short-range endemic species.

Family Garypidae

***Synsphyronus* `sp. PSE023` (family Garypidae)**

One female and possibly one juvenile of a new species of *Synsphyronus* were collected during the survey. Many species of *Synsphyronus* may represent short-range endemic species (Harvey 1987), but these species are generally found in ground habitats such as under rocks; the tree-dwelling species tend to be much more widely distributed, and are not short-range endemics.

Family Olpiidae

Austrohorus spp. (family Olpiidae)

There were 31 specimens of *Austrohorus* collected during the survey (Appendix 1). Extremely similar specimens have been collected from other regions of Western Australia, but there was some obvious morphological variation between some of the samples within this genus which could possibly represent more than one species. More taxonomic investigation is required to determine the number of species represented and their distributions.

Beierolpium spp. (family Olpiidae)

Eighty-seven specimens of *Beierolpium* were collected during this project (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. The `sp. 8/2`, `sp. 8/3` and `sp. 8/4` species representation refers to the number of trichobothria (sensory hairs) on the fixed and movable chelal fingers in the adults, which is a feature that is likely to coincide at least partly with species distinction. 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 (family Olpiidae)

Two hundred and forty specimens of *Indolpium* were collected during the survey (Appendix 1). Extremely similar specimens have been collected from other regions of Western Australia. There was some obvious morphological variation between some of the samples within this genus which could possibly represent more than one species. More taxonomic investigation is required to determine the number of species represented, but based on our current levels of knowledge; it is unlikely that these specimens represent short-range endemic species.

Linnaeolpium (family Olpiidae)

Five specimens of this pseudoscorpion genus were collected during the survey (Appendix 1). This genus was recently described for a single troglobitic species (*L. linnaei*) from the Robe River Valley, Pilbara (Harvey and Leng 2008). The species from this survey represents a different species, and while it may eventually be found to represent a short-range endemic species, at present we have insufficient information to establish its status.

Genus `*7/4*` (family Olpiidae)

Twenty-two specimens of `Genus 7/4` were collected during this survey (Appendix 1). Based on our current levels of knowledge, it is not possible to state whether this species is a short-range endemic species.

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Appendix 1. Specimen data for millipedes and pseudoscorpions collected from Yakabindie

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113403	Site 13-430	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`00.0"S	120°35`23.8"E				1
113832	Site 10-217	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°25`00.7"S	120°35`35.4"E		1		1
113833	Site 10-224	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°25`00.7"S	120°35`35.4"E				1
113834	Site 10-474	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`00.7"S	120°35`35.4"E				2
113835	Site 10-476	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`00.7"S	120°35`35.4"E				6
113836	Site 10-705	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`00.7"S	120°35`35.4"E				1
113837	Site 10-718	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`00.7"S	120°35`35.4"E				1
113838	Site 10-788	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`00.7"S	120°35`35.4"E			1	1
113839	Site 11-271	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`00.2"S	120°35`47.5"E				1
113840	Site 11-584	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.2"S	120°35`47.5"E			1	1
113841	Site 11-769	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.2"S	120°35`47.5"E				10
113842	Site 1-177	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`36.3"S	120°34`22.5"E	2	2	4	8
113843	Site 12-376	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`53.2"S	120°35`53.6"E	2			2
113844	Site 12-466	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`53.2"S	120°35`53.6"E				3
113845	Site 12-536	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`53.2"S	120°35`53.6"E	1		1	2
113846	Site 12-687	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`53.2"S	120°35`53.6"E	1	1		2
113847	Site 13-246	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`00.0"S	120°35`23.8"E				1
113848	Site 13-286	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.0"S	120°35`23.8"E				1
113849	Site 13-299	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°26`00.0"S	120°35`23.8"E	1			1
113850	Site 13-415	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`00.0"S	120°35`23.8"E				1
113851	Site 1-345	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`36.3"S	120°34`22.5"E	1			1
113852	Site 13-583	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.0"S	120°35`23.8"E				1
113853	Site 13-680	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.0"S	120°35`23.8"E				5
113854	Site 13-786	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.0"S	120°35`23.8"E			1	1
113855	Site 14-212	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`15.6"S	120°36`35.4"E				1
113856	Site 14-319	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`15.6"S	120°36`35.4"E				1
113857	Site 14-400	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`15.6"S	120°36`35.4"E		1	1	2
113858	Site 14-441	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`15.6"S	120°36`35.4"E				5

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113859	Site 14-485	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`15.6"S	120°36`35.4"E				1
113860	Site 1-459	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus indet.`*	`sp. juv.`	27°25`36.3"S	120°34`22.5"E			1	1
113861	Site 1-515	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`36.3"S	120°34`22.5"E			1	1
113862	Site 15-275	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°25`29.8"S	120°36`26.1"E				1
113863	Site 15-325	Arachnida	Psuedoscorpiones	Olpiidae	*Linnaeolpium*		27°25`29.8"S	120°36`26.1"E		1		1
113864	Site 15-638	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`29.8"S	120°36`26.1"E				1
113865	Site 15-650	Arachnida	Psuedoscorpiones	Garypidae	*Synsphyronus*	`PSE023`	27°25`29.8"S	120°36`26.1"E		1		1
113866	Site 16-077	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`09.5"S	120°34`51.1"E				2
113867	Site 16-183	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°28`09.5"S	120°34`51.1"E		1		1
113868	Site 16-491	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`09.5"S	120°34`51.1"E				1
113869	Site 10-473	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`00.7"S	120°35`35.4"E	3	1		4
113870	Site 16-619	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°28`09.5"S	120°34`51.1"E		1		1
113871	Site 16-643	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°28`09.5"S	120°34`51.1"E				1
113872	Site 16-659	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°28`09.5"S	120°34`51.1"E				2
113873	Site 17-082	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`34.3"S	120°35`53.7"E				2
113874	Site 17-413	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`34.3"S	120°35`53.7"E		1		1
113875	Site 17-417	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`34.3"S	120°35`53.7"E				4
113876	Site 17-616	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`34.3"S	120°35`53.7"E		1		1
113877	Site 17-774	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`34.3"S	120°35`53.7"E				5
113878	Site 18-229	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`50.1"S	120°37`14.8"E				1
113879	Site 18-272	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`50.1"S	120°37`14.8"E				1
113880	Site 13-429	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°26`00.0"S	120°35`23.8"E	1		1	1
113881	Site 18-314	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`50.1"S	120°37`14.8"E				1
113882	Site 18-383	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`50.1"S	120°37`14.8"E				3
113883	Site 18-426	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`50.1"S	120°37`14.8"E				1
113884	Site 19-180	Arachnida	Psuedoscorpiones	Chernetidae	*`Genus indet.`*	`sp. juv.`	27°24`44.4"S	120°35`18.7"E				5
113885	Site 19-608	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°24`44.4"S	120°35`18.7"E				1
113886	Site 19-652	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°24`44.4"S	120°35`18.7"E	1			1
113887	Site 19-752	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°24`44.4"S	120°35`18.7"E				1
113888	Site 19-782	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°24`44.4"S	120°35`18.7"E				1
113889	Site 19-796	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°24`44.4"S	120°35`18.7"E			1	1

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113890	Site 19-95	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°24`44.4"S	120°35`18.7"E				1
113891	Site 2-001	Arachnida	Psuedoscorpiones	Chernetidae	`*PSEAAC*`	`PSE022`	27°25`27.5"S	120°34`53.3"E		1		1
113892	Site 20-463	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus indet.*`	`sp. juv.`	27°27`24.7"S	120°35`28.0"E			1	1
113893	Site 21-309	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`47.3"S	120°35`38.5"E				1
113894	Site 19-607	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°24`44.4"S	120°35`18.7"E				2
113895	Site 21-362	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`47.3"S	120°35`38.5"E				3
113896	Site 21-553	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. 8`	27°27`47.3"S	120°35`38.5"E	1	3		4
113897	Site 21-631	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°27`47.3"S	120°35`38.5"E	1	2		3
113898	Site 21-633	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°27`47.3"S	120°35`38.5"E	1	1	1	3
113899	Site 2-178	Arachnida	Psuedoscorpiones	Chernetidae	`*PSEAAC*`	`PSE022`	27°25`27.5"S	120°34`53.3"E		1		1
113900	Site 2-203	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°25`27.5"S	120°34`53.3"E				1
113901	Site 22-181	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus indet.*`	`sp. juv.`	27°26`49.2"S	120°34`24.3"E			1	1
113902	Site 22-320	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`49.2"S	120°34`24.3"E				1
113903	Site 22-497	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`49.2"S	120°34`24.3"E				2
113904	Site 22-502	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus 7/4*`		27°26`49.2"S	120°34`24.3"E			1	1
113905	Site 22-577	Arachnida	Psuedoscorpiones	Atemnidae	*Oratemnus*		27°26`49.2"S	120°34`24.3"E				1
113906	Site 22-606	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°26`49.2"S	120°34`24.3"E		1		1
113907	Site 22-677	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`49.2"S	120°34`24.3"E				1
113908	Site 23-101	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`19.8"S	120°38`04.7"E				1
113909	Site 2-327	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°25`27.5"S	120°34`53.3"E			1	1
113910	Site 23-356	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`19.8"S	120°38`04.7"E				5
113911	Site 23-407	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`19.8"S	120°38`04.7"E				4
113912	Site 23-493	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`19.8"S	120°38`04.7"E				2
113913	Site 23-498	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`19.8"S	120°38`04.7"E				4
113914	Site 23-552	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°19`19.8"S	120°38`04.7"E		1		1
113915	Site 23-576	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°19`19.8"S	120°38`04.7"E	1			1
113916	Site 2-416	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`27.5"S	120°34`53.3"E				1
113917	Site 24-184	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°17`57.8"S	120°36`06.3"E			1	1
113918	Site 24-360	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°17`57.8"S	120°36`06.3"E				3
113919	Site 24-455	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°17`57.8"S	120°36`06.3"E				9
113920	Site 24-624	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°17`57.8"S	120°36`06.3"E			1	1

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113921	Site 24-625	Arachnida	Psuedoscorpiones	Cheiridiidae	`*PSEAAB*`		27°17`57.8"S	120°36`06.3"E	1	1		2
113922	Site 24-628	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°17`57.8"S	120°36`06.3"E			1	1
113923	Site 24-691	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°17`57.8"S	120°36`06.3"E				3
113924	Site 25-108	Arachnida	Psuedoscorpiones	Atemnidae	*Oratemnus*		27°17`46.2"S	120°41`05.7"E				1
113925	Site 25-182	Arachnida	Psuedoscorpiones	Atemnidae	*Oratemnus*		27°17`46.2"S	120°41`05.7"E				4
113926	Site 25-317	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°17`46.2"S	120°41`05.7"E				1
113927	Site 25-365	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°17`46.2"S	120°41`05.7"E				3
113928	Site 25-596	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°17`46.2"S	120°41`05.7"E				1
113929	Site 26-232	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°19`28.0"S	120°40`18.1"E				1
113930	Site 26-245	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°19`28.0"S	120°40`18.1"E				1
113931	Site 2-665	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/2`	27°25`27.5"S	120°34`53.3"E		1		1
113932	Site 26-673	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`28.0"S	120°40`18.1"E			1	1
113933	Site 26-712	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°19`28.0"S	120°40`18.1"E				2
113934	Site 19-755	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°24`44.4"S	120°35`18.7"E	3	2	9	14
113935	Site 27-265	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`30.1"S	120°41`24.8"E		1		1
113936	Site 27-333	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`30.1"S	120°41`24.8"E	2			2
113937	Site 27-340	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`30.1"S	120°41`24.8"E				2
113938	Site 27-380	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`30.1"S	120°41`24.8"E				4
113939	Site 27-396	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°28`30.1"S	120°41`24.8"E			1	1
113940	Site 27-574	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`30.1"S	120°41`24.8"E				1
113941	Site 27-698	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`30.1"S	120°41`24.8"E				2
113942	Site 27-713	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus 7/4*`		27°28`30.1"S	120°41`24.8"E				1
113943	Site 27-757	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°28`30.1"S	120°41`24.8"E				2
113944	Site 28-240	Arachnida	Psuedoscorpiones	Atemnidae	*Oratemnus*		27°21`40.8"S	120°40`59.0"E			1	1
113945	Site 28-277	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°21`40.8"S	120°40`59.0"E				1
113946	Site 28-293	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°21`40.8"S	120°40`59.0"E	2	1		3
113947	Site 28-460	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°21`40.8"S	120°40`59.0"E				2
113948	Site 28-671	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°21`40.8"S	120°40`59.0"E				7
113949	Site 28-732	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°21`40.8"S	120°40`59.0"E			1	1
113950	Site 28-791	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus 7/4*`		27°21`40.8"S	120°40`59.0"E				1
113951	Site 29-301	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°21`03.4"S	120°37`57.9"E				2

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113952	Site 29-539	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°21`03.4"S	120°37`57.9"E		1		1
113953	Site 29-637	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°21`03.4"S	120°37`57.9"E				1
113954	Site 30-545	Arachnida	Psuedoscorpiones	Cheiridiidae	*`PSEAAB`*		27°26`25.3"S	120°41`25.9"E		1		1
113955	Site 19-793	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°24`44.4"S	120°35`18.7"E	3			3
113956	Site 30-598	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`25.3"S	120°41`25.9"E		1		1
113957	Site 3-199	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`18.8"S	120°34`37.2"E				1
113958	Site 3-206	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`18.8"S	120°34`37.2"E				1
113959	Site 3-208	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°25`18.8"S	120°34`37.2"E				3
113960	Site 3-313	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°25`18.8"S	120°34`37.2"E				1
113961	Site 4-655	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°25`45.2"S	120°34`18.3"E	1			1
113962	Site 5-266	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`37.6"S	120°35`22.3"E				1
113963	Site 5-404	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`37.6"S	120°35`22.3"E	1		1	2
113964	Site 5-703	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°26`37.6"S	120°35`22.3"E				1
113965	Site 5-710	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°26`37.6"S	120°35`22.3"E				7
113966	Site 5-760	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`37.6"S	120°35`22.3"E				17
113967	Site 6-047	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`56.2"S	120°35`12.8"E				1
113968	Site 6-256	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`56.2"S	120°35`12.8"E				1
113969	Site 6-258	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°26`56.2"S	120°35`12.8"E				1
113970	Site 6-388	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°26`56.2"S	120°35`12.8"E			2	2
113971	Site 6-433	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`56.2"S	120°35`12.8"E				15
113972	Site 6-446	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`56.2"S	120°35`12.8"E				8
113973	Site 6-487	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`56.2"S	120°35`12.8"E				13
113974	Site 6-582	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`56.2"S	120°35`12.8"E				6
113975	Site 6-741	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°26`56.2"S	120°35`12.8"E				1
113976	Site 7-305	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`15.1"S	120°36`20.3"E				10
113977	Site 7-482	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`15.1"S	120°36`20.3"E				2
113978	Site 7-484	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°27`15.1"S	120°36`20.3"E				3
113979	Site 7-556	Arachnida	Psuedoscorpiones	Olpiidae	*Linnaeolpium*		27°27`15.1"S	120°36`20.3"E				1
113980	Site 7-595	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°27`15.1"S	120°36`20.3"E				2
113981	Site 7-661	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`15.1"S	120°36`20.3"E				2
113982	Site 8-372	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`59.2"S	120°36`16.0"E				4

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
113983	Site 8-394	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`59.2"S	120°36`16.0"E	1			1
113984	Site 8-538	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`59.2"S	120°36`16.0"E		1		1
113985	Site 8-558	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`59.2"S	120°36`16.0"E				2
113986	Site 8-641	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`59.2"S	120°36`16.0"E	1		1	2
113987	Site 9-055	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`35.7"S	120°36`02.7"E				1
113988	Site 9-295	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`35.7"S	120°36`02.7"E				1
113989	Site 9-385	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`35.7"S	120°36`02.7"E				5
113990	Site 9-411	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`35.7"S	120°36`02.7"E				11
113991	Site 9-420	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`35.7"S	120°36`02.7"E				10
113992	Site 9-683	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`35.7"S	120°36`02.7"E				10
113993	Site 9-779	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`35.7"S	120°36`02.7"E	1			1
114635	Target 10-166	Arachnida	Psuedoscorpiones	Olpiidae	*Linnaeolpium*		27°26`46.3"S	120°35`15.3"E				1
114636	Target 13-160	Arachnida	Psuedoscorpiones	Chernetidae	`*Genus indet.*`	`sp. juv.`	27°21`40.0"S	120°35`16.3"E			1	1
114637	Target 14-164	Arachnida	Psuedoscorpiones	Olpiidae	`*Genus 7/4*`		27°25`52.2"S	120°34`39.1"E				1
114638	Target 15-168	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°26`50.0"S	120°34`11.3"E			1	1
114639	Target 15-259	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`50.0"S	120°34`11.3"E		1		1
114640	Site 19-802	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°24`44.4"S	120°35`18.7"E		1		1
114641	Site 3-302	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`18.8"S	120°34`37.2"E	2			2
114642	Site 3-431	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`18.8"S	120°34`37.2"E	1			1
114643	Site 3-448	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`18.8"S	120°34`37.2"E	2			2
114644	Site 3-522	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`18.8"S	120°34`37.2"E	2	1		3
114645	Site 3-670	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`18.8"S	120°34`37.2"E	1			1
114646	Site 4-734	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`sp. nov. Yakabindie`	27°25`45.2"S	120°34`18.3"E	2			2
118827	Site 21-323	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°27`47.3"S	120°35`38.5"E				1
118828	Site 13-430	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°26`00.0"S	120°35`23.8"E				1
118829	Site 13-430	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`00.0"S	120°35`23.8"E				1
118830	Site 13-415	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`00.0"S	120°35`23.8"E				1
118831	Site 10-217	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 small`	27°25`00.7"S	120°35`35.4"E	1			1

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
118832	Site 12-687	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`53.2"S	120°35`53.6"E	2	1		3
118833	Site 14-485	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`15.6"S	120°36`35.4"E				1
118834	Site 15-650	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°25`29.8"S	120°36`26.1"E			1	1
118835	Site 16-659	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`09.5"S	120°34`51.1"E				2
118836	Site 17-616	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°28`34.3"S	120°35`53.7"E	1			1
118837	Site 18-383	Arachnida	Psuedoscorpiones	Olpiidae	*Linnaeolpium*		27°28`50.1"S	120°37`14.8"E				1
118838	Site 19-752	Arachnida	Psuedoscorpiones	Chernetidae	*`Genus indet.`*	`sp. juv.`	27°24`44.4"S	120°35`18.7"E			1	1
118839	Site 21-309	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°27`47.3"S	120°35`38.5"E			3	3
118840	Site 21-362	Arachnida	Psuedoscorpiones	Olpiidae	*Linnaeolpium*		27°27`47.3"S	120°35`38.5"E				1
118841	Site 23-407	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°19`19.8"S	120°38`04.7"E			1	1
118842	Site 23-498	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°19`19.8"S	120°38`04.7"E	1			1
118843	Site 23-552	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°19`19.8"S	120°38`04.7"E			1	1
118844	Site 23-576	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°19`19.8"S	120°38`04.7"E		1		1
118845	Site 2-416	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°25`27.5"S	120°34`53.3"E				1
118846	Site 27-265	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`30.1"S	120°41`24.8"E	2	2		4
118847	Site 27-333	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°28`30.1"S	120°41`24.8"E		1		1
118848	Site 27-333	Arachnida	Psuedoscorpiones	Cheiridiidae	*`PSEAAB`*		27°28`30.1"S	120°41`24.8"E		1		1
118849	Site 28-240	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/3`	27°21`40.8"S	120°40`59.0"E	1	1		2
118850	Site 28-293	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°21`40.8"S	120°40`59.0"E				1
118851	Site 28-460	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°21`40.8"S	120°40`59.0"E				1
118852	Site 3-199	Arachnida	Psuedoscorpiones	Chthoniidae	*Austrochthonius*	`sp. nov. Pilbara`	27°25`18.8"S	120°34`37.2"E	1	1		1
118853	Site 3-199	Arachnida	Psuedoscorpiones	Chernetidae	*Sundochernes*	`PSE020`	27°25`18.8"S	120°34`37.2"E		1		1
118854	Site 3-313	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°25`18.8"S	120°34`37.2"E			1	1
118855	Site 5-404	Arachnida	Psuedoscorpiones	Garypidae	*Synsphyronus*	`sp. juv.`	27°26`37.6"S	120°35`22.3"E			1	1
118856	Site 6-047	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`56.2"S	120°35`12.8"E				7
118857	Site 6-256	Arachnida	Psuedoscorpiones	Olpiidae	*Indolpium*		27°26`56.2"S	120°35`12.8"E				1
118858	Site 7-661	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°27`15.1"S	120°36`20.3"E				1
118859	Site 8-641	Arachnida	Psuedoscorpiones	Olpiidae	*`Genus 7/4`*		27°26`59.2"S	120°36`16.0"E			1	1
118860	Target 10-166	Arachnida	Psuedoscorpiones	Olpiidae	*Austrohorus*		27°26`46.3"S	120°35`15.3"E			1	1
118861	Site 1-345	Arachnida	Psuedoscorpiones	Olpiidae	*Beierolpium*	`sp. juv.`	27°25`36.3"S	120°34`22.5"E				3

Appendix F Diplopods from Yakabindie, Western Australia

Diplopods from Yakabindie, Western Australia

Report to *Outback Ecology*

16 April 2012

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Summary

The samples submitted to the Western Australian Museum on the 10th February and 13th April 2012 included two millipedes from the genus *Antichiropus,* from two undescribed species. This is the first record of *Antichiropus* `DIP002`. The second species is *A.* `DIP003` (formerly known as *Antichiropus* sp. `Yakabindie`) which has a current known distribution of less than 7 km^2. Both of these species are considered a short-range endemic species and of conservation concern.

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, Harvey 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 modification proved daunting because of the large numbers of unknown species. These animals were largely ignored, as they were too diverse and their taxonomy too little known for them to be considered in environmental surveys that require a rapid turn-around time.

In a recent publication, the issue of Short-Range Endemism in the Australian invertebrate fauna was examined (Harvey 2002),. Species that could be defined as Short-Range Endemics (SRE) were those that had a naturally small range of less than 10,000 km^2. Harvey (2002) found that those species possessed a series of distinct ecological and life-history traits that contributed to their limited distributions, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

A number of major invertebrate groups have a high proportion of individual species that show these traits and can be considered SRE's. 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, Moir et al. 2008), but there are many poorly known species and gaps in our understanding of the distributions of many species.

Methods

Two millipedes collected by *Outback Ecology* from Yakabindie was submitted to the Western Australian Museum on 10th February and 13th April 2012. The specimens were examined at the WA museum using Leica dissecting microscopes (MZ6).

DIPLOPODA

ORDER POLYDESMIDA (FLAT BACKED MILLIPEDES)

Family Paradoxosomatidae

Genus *Antichiropus*

The genus *Antichiropus* is the most abundant and diverse millipede group in WA. This genus was first named in 1911 for seven species (Attems 1911), and additional species were added by Jeekel (1982) and Shear (1992). As the result of large field surveys and taxonomic work at the WA Museum, the genus is now known to consist of over 130 species, ranging as far north as the Pilbara, and extending onto the Nullarbor Plain and the Eyre Peninsula in South Australia. With the exception of *Antichiropus variabilis* Attems,1911, which inhabits the jarrah forests of south-western WA, and *Antichiropus* 'PM1' from the northern Wheatbelt and the Geraldton sandplain, most species of the genus are known to be SREs, and many are known from only a few hundred square kilometres (Harvey, Sampey et al. 2000; Harvey 2002).

Although the vast majority of *Antichiropus* species currently lack formal taxonomic descriptions and scientific names, Dr Mark Harvey has spent the past decade comparing different species of the genus and assigning temporary codes to each of the species. The distinction between species is largely based upon differences in the structure of the male gonopods. These are modified legs on the seventh abdominal segment that are used to store sperm prior to mating. The shape of the gonopod of each *Antichiropus* species is different, making the identification of individual species a relatively simple task. These differences in gonopod morphology have been used in millipede taxonomy for 150 years, and have been shown to be good indicators of valid biological species.

Antichiropus `DIP002`

A single male *Antichiropus* was submitted from this survey (Appendix 1). The specimen was the first record of this species and would be considered a short-range endemic species.

***Antichiropus* `DIP003` (formerly *Antichiropus* sp. `Yakabindie`)**

A single male *Antichiropus* was submitted from this survey (Appendix 1). The specimen was identified as being *Antichiropus* `DIP003`, a species only sampled from a previous survey done by Outback Ecology early in 2011 (Harvey, Car et al. 2011) where 20 males, 5 females, and 10 juveniles of this species were collected from less than a 7 km^2 area (see Figure 1). Our knowledge of the known distribution of most *Antichiropus* species, indicates most strongly that *Antichiropus* `DIP003` (`Yakabindie`) is a short-range endemic species.

Figure 1. Current geographic distribution of *Antichiropus* `DIP003`. Numbers indicate WAM registration numbers.

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Appendix 1. Specimen data for diplopods collected from Yakabindie

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	Juv.	TOTAL
120381	Site 1 – 5	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`DIP002`	27°24`44.6"S	120°35`19.7"E	1			1
122645	Site 5-4	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus*	`DIP003`	27°24`44.6"S	120°35`19.7"E	1			1

Appendix G Terrestrial Isopod Identification from Yakabindie, WA

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MWH Global
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Attn: Paul Bolton

17th June 2016

Re: Terrestrial Isopod Identification for Yakabindie Project.

This project has contributed significantly to the knowledge of the terrestrial isopod fauna of the region in question. The only material suitable for comparison and determination of distributions of the taxa comes from the Lake Maitland and Yeelirrie area. Examination of the material collected by this survey has shown the area to have a unique suite of terrestrial isopods. The terrestrial isopod fauna is fundamentally different to the south-west, the Goldfields and the Pilbara regions. The fauna is also significant because of the lack of dominance of the genus *Buddelundia* among the specimens collected. *Buddelundia* normally account for more than 80% of samples from the arid regions of Western Australia (Judd & Taiti, 2011). The specimens are well represented by at least three other genera of the family Armadillidae. The morphospecies collected have morphological affinities with the wetter parts south-west of Western Australia.

This report is accompanied by a datasheet. The material has been registered with the Western Australian Museum (WAM) and the registration numbers are given in the column headed "REGNO". The datasheet is condensed version of the original dataset. The survey was extensive and yielded a lot of isopods. Specimens of the same taxon collected at the same site, on the same day and by the same method, have been grouped in the datasheet. The datasheet therefore shows only a single record for each taxon at each site. This significantly reduces the amount of vials that have to be deposited at the WAM.

The bulk of the specimens belonged to the family Armadillidae. The taxonomy of the Australian Armadillidae is confused and in need of revision. The genera mentioned here reflect the current state of taxonomy and are useful only in the sense that they allow for comparison to the terrestrial isopods found elsewhere in Australia or in previous reports. A brief summary of the taxa and an assessment of their SRE status are given below. Nine taxa were determined and all are considered to be potential or likely SRE species.

Family ARMADILLIDAE

***Budddelundia* 96**

This morphospecies has been collected from the Yeelirrie and Yakabindie area. Its wider distribution is unknown and it should be considered a potential SRE species.

***Budddelundia* 45**

This morphospecies was collected at only 3 sites (Site14, 15 and 29) and is only known from this survey. It is typical of arid-zone *Buddelundia* and may possibly be distributed more widely outside of the project area. It should be considered a potential SRE species.

***Cubaris* yeelirrie1**

This was the most common morphospecies collected and there were about 200 specimens present. What appears to be the same morphospecies is also found at Lake Maitland and Yeelirrie, but further work beyond the scope of this report is required to establish this. These locations are nearby and it is likely that this species has a restricted distribution. It should be considered a potential SRE species.

***Cubaris* yeelirrie2**

This morphospecies was represented by only a few specimens and, like *Buddelundia* 45, these were found at only three sites (Site 14, 27 & 29.). With limited material I can't be certain that there were any fully mature specimens present but the largest specimens present were definitely a different morphospecies from the one above. I have a single specimen of a similar morphospecies that occurs about 150 km to the south of the project area and there is nothing to suggest that the species is more widely distributed outside the project area. There are many similar morphospecies occurring throughout southern WA and many of these are likely SRE species. This should be considered a potential SRE species.

***Pseudodiploexochus* yakabindie**

There are many species undescribed of *Pseudodiploexochus* in the south-west of Western Australia and nearly almost all of these are SRE species. The genus is more commonly found in higher rainfall areas which suggests that *Pseudodiploexochus* yakabindie is a moisture-dependant relictual taxon. I have a single specimen from Yeelirrie which is possibly the same morphospecies, but more material of the latter is needed for comparison. These two locations are about 100 km apart and, therefore, this species is a likely SRE.

Armadillidae yakabindie a

This is very small morphospecies that also possibly occurs at Yeelirrie and Lake Maitland. There are many similar morphospecies throughout WA. These are very small animals and widely distributed, but because of the infrequent collection and cryptic nature, all have potential to be SRE species. The distribution of this taxon is possibly similar to *Cubaris yeelirrie1.* In previous reports isopods of this type have been referred to as "*Spherillo*". This is a potential SRE species.

Armadillidae yakabindie b

This is a very unusual species of Armadillidae. I have only seen two other species with morphologically similar characters, one was collected in the higher rainfall part of the jarrah forest and the other in the Goldfields region. This morphospecies looks superficially very similar to some *Buddelundia*. This is a likely SRE species.

Armadillidae sp. indet.

These species have not been determined because they could not be located at the time of writing. They are of the "*Spherillo*" habit and are likely to belong to Armadillidae yakabindie a. They should be considered potential SRE species and will be determined when they are located.

Family PHILOSCIIDAE

The taxonomy of the Philosciidae is very poorly known in WA. Philosciids are very rarely collected outside of the wetter south-west region and in such areas all considered to be potential SRE species.

Family PLATYARTHRIDAE

***Trichorhina* sp. indet.**

There is one described species of *Trichorhina* from WA and many worldwide. There are many undescribed species in WA. They are very small, occupy cryptic habitats and are widely distributed. They are never regularly collected and in this study they were found at only four sites . Many of the *Trichorhina* are now part of the Trichorhinidae but the WA species have not been included in a formal revision. This is an ancient group and therefore this taxon constitutes one or more potential SRE species.

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Appendix H Land Snails from the area of Yakabindie, 50km North of Leinster, Western Australia

Report to ***Outback Ecology***

Land Snails from the area of Yakabindie, 50km north of Leinster, Western Australia

collected by *Outback Ecology* in January 2011

Corey Whisson

July 2011

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Background

Seventeen lots of land snail specimens were collected by the environmental consultancy *Outback Ecology* in January 2011 during a faunal survey of the Yakabindie area, approximately 50km north of Leinster. These specimens were presented to the Mollusc Section of the Western Australian Museum for identification and comment on the 30th June, 2011 (Accession No. A7072).

Specimen data, giving the site numbers, habitat data, co-ordinates and the collecting methods employed were provided with the specimens (Appendix A). No information was provided on the habitat of the sampling sites, or on the spatial relationship of these sample sites to the tenement boundaries.

Procedures

The land snail specimens received from *Outback Ecology* were examined under a *Leica* MZ95 dissecting microscope. They were then 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 Yakabindie 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 (Table 1).

All of 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 Yakabindie area during January 2011.

Station	Family	Genus	Species	Reg. No. (WAM S)	No. Specimens
2-187	Pupillidae	*Gastrocopta*	cf. *larapinta*	65909	1 dead-taken
2-187	Pupillidae	*Pupoides*	*myoporinae*	65910	1 dead-taken
2-179	Pupillidae	*Gastrocopta*	cf. *larapinta*	65911	2 dead-taken
2-191	Pupillidae	*Pupoides*	*adelaidae*	65912	1 dead-taken
2-191	Pupillidae	*Gastrocopta*	cf. *larapinta*	65913	1 dead-taken
2-175	Pupillidae	*Gastrocopta*	cf. *larapinta*	65914	1 dead-taken
2-175	Pupillidae	*Gastrocopta*	*bannertonensis*	65915	2 dead-taken
19-094	Pupillidae	*Gastrocopta*	cf. *larapinta*	65916	1 dead-taken
16-176	Pupillidae	*Pupoides*	*adelaidae*	65917	6 dead-taken
16-176	Pupillidae	*Pupoides*	*myoporinae*	65918	3 dead-taken
16-176	Pupillidae	*Gastrocopta*	*bannertonensis*	65919	3 dead-taken
2-003	Pupillidae	*Pupoides*	*adelaidae*	65920	1 dead-taken
2-003	Pupillidae	*Pupoides*	*myoporinae*	65921	3 dead-taken
1-173	Pupillidae	*Pupoides*	cf. *adelaidae*	65922	1 dead-taken
16-078	Pupillidae	*Pupoides*	*adelaidae*	65923	4 dead-taken
16-078	Pupillidae	*Pupoides*	*myoporinae*	65924	2 dead-taken
20-174	Pupillidae	Pupoides	*adelaidae*	65925	1 dead-taken

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 adelaidae (Adams & Angas, 1864)

The specimens collected during this survey most closely resemble the relatively large (height 4.38-6.8mm) dextral pupillid species *Pupoides adelaidae* (Adams & Angas, 1864). That species has a wide geographic distribution that is considered to extend from New South Wales and north-western Victoria, across southern South Australia into the wheatbelt areas of Western Australia and as far to the north-west as Morawa (Solem 1986, Solem 1991). It may possibly also extend from Shark Bay north to North West Cape on the west coast of Western Australia (Solem 1986).

Pupoides myoporinae (Tate, 1880)

The specimens collected during this survey most closely resemble the medium-sized (height 4.18-5.29mm) sinistral pupillid species *Pupoides 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).

Subfamily *Gastrocoptinae*

Gastrocopta cf. *larapinta* (Tate, 1896)

Gastrocopta larapinta is a minute dextrally-coiled species that has a wide but apparently-patchy distribution in central Australia (southern part of the Northern Territory), with a few records from the north-western region of Queensland and along its eastern coasts. There is a single published record of this species from the Oscar Range, located in the southern part of the Kimberley region of Western Australia (Pokryszko 1996).

Recently-collected specimens housed in the Mollusc Collections of the Western Australian Museum indicate that this species is widespread throughout the Pilbara region with an isolated occurrence at Lake Way to the south.

Because the Yakabindie specimens would indicate a small range extension southward for *G. larapinta*, and because there are slight differences in shell morphology, the specimens have only been tentatively identified as belonging to that species.

Subfamily *Gastrocoptinae*

Gastrocopta bannertonensis (Gabriel, 1930)

The specimens collected during this survey exhibit shell characters most consistent with those of the tiny dextral species *Gastrocopta bannertonensis* (Gabriel, 1930). This species has a wide geographic distribution in southern Australia, having been recorded from the southern regions of

Western Australia; South Australia and New South Wales. There is also an isolated record of its presence in an area to the north-west of Alice Springs in the Northern Territory (Pokryszko 1996).

Remarks

All of the species collected during this survey have, or are likely to have, wide distributional ranges.

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Appendix A. Locality data from *Outback Ecology's* survey of the Yakabindie area during January 2011.

Station	Latitude	Longitude	Survey Date	Collector	Collecting Method	Habitat
2-187	27°25`27.5"S	120°34`53.3"E	10/01/2011	Rakimov, A.	Sieved soil	Drainage Line
2-179	27°25`27.5"S	120°34`53.3"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage Line
2-191	27°25`27.5"S	120°34`53.3"E	10/01/2011	Rakimov, A.	Sieved soil	Drainage Line
2-175	27°25`27.5"S	120°34`53.3"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage Line
19-094	27°24`44.4"S	120°35`18.7"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage Line
16-176	27°28`09.5"S	120°34`51.1"E	10/01/2011	Rakimov, A.	Leaf litter	Mulga on sand
2-003	27°25`27.5"S	120°34`53.3"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage line
1-173	27°25`36.3"S	120°34`22.5"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage line
16-078	27°28`09.5"S	120°34`51.1"E	10/01/2011	Rakimov, A.	Leaf litter	Mulga on sand
20-174	27°27`24.7"S	120°35`28.0"E	10/01/2011	Rakimov, A.	Leaf litter	Drainage Line