

## **Appendix 33 Short-range Endemic Invertebrate Risk Assessment – Huntly and Willowdale Mines**

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# PHOENIX

ENVIRONMENTAL SCIENCES

## Short-range endemic invertebrate risk assessment for the Huntly and Willowdale Mine

Prepared for Alcoa of Australia Ltd.

September 2024

Final



Short-range endemic invertebrate risk assessment for the Huntly and Willowdale Mine Project  
Prepared for Alcoa of Australia Ltd.

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Author	Version	Version number	Date submitted	Submitted to
A. Jacks	Draft for client comments	0.1	19-Sep-24	S. Boys
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# 1 INTRODUCTION

Alcoa of Australia Ltd. (Alcoa) operates the Huntly and Willowdale Mine (the Project), in the Northern Jarrah Forest, Western Australia (WA; Figure 1-1). Alcoa is currently putting together an Environmental Review Document (ERD) for the Section 6 areas at Huntly and Willowdale (Figure 1). As part of this, an investigation into the occurrence, and gaps in knowledge of SREs is required.

## 1.1 SCOPE OF WORK

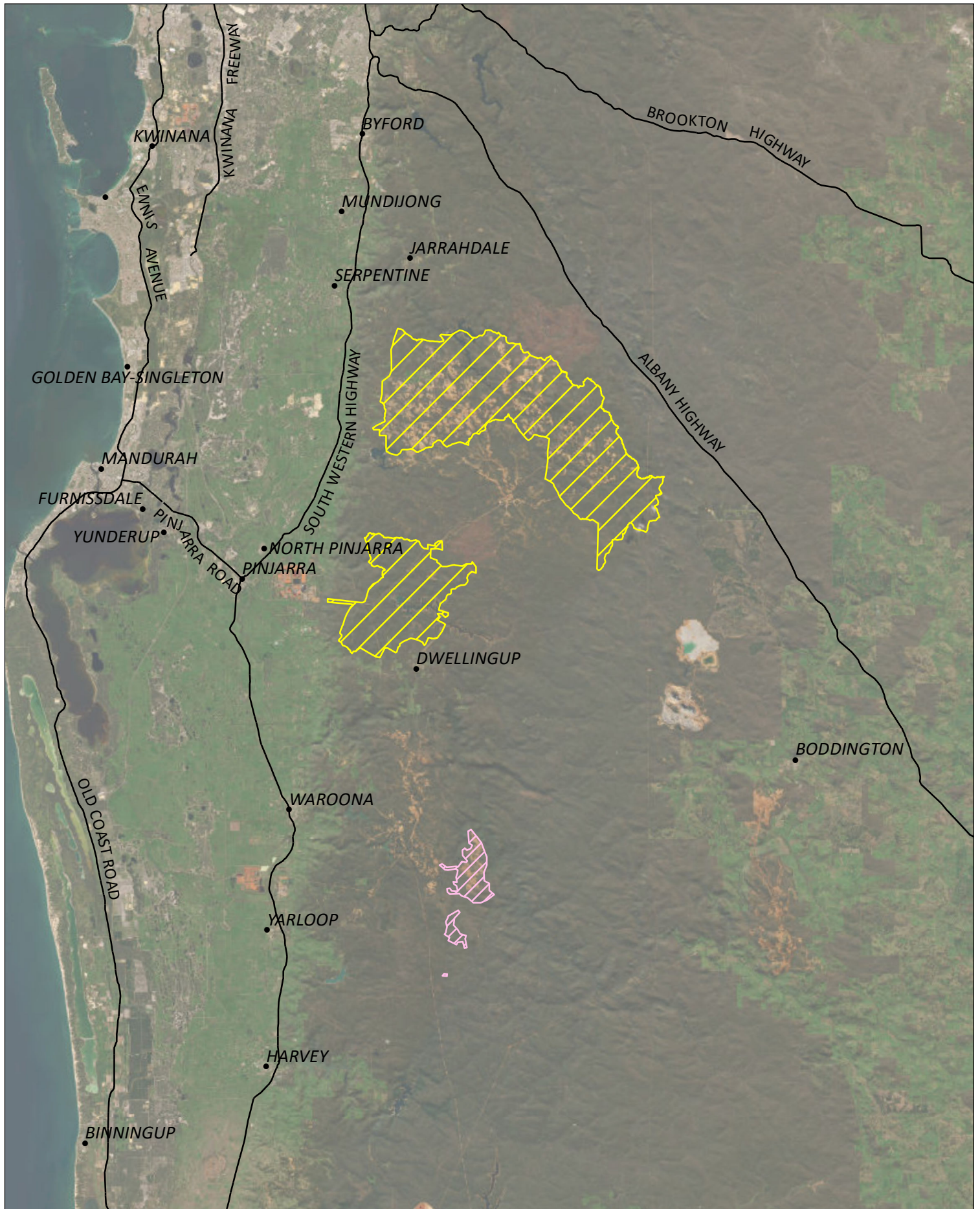
The scope of work is to undertake a desktop review of the SRE values by identifying:

- areas where previous surveys have/have not been undertaken, and survey effort
- species recorded
- areas where there is likely to be SRE values present.

## 1.2 STUDY AREA

The Huntly Mine Footprint (Section 6) (HMF) comprises of 2 areas to the east and north-east of Pinjarra and occupies an area of 39,046 ha (Figure 1-1). The northern portion is approximately 29,323 ha and encompasses currently active mining areas, and the southern portion is approximately 9,724 ha and encompasses a previously mined area.

The Willowdale Mine Footprint (Section 6) comprises of areas to the east of Wagerup and occupies an area of 2,136 ha (Figure 1-1).



	<b>Alcoa of Australia Ltd.</b> <b>Huntly and Willowdale Mines</b>			<b>Figure 1</b> <b>Project location and study area</b>	
	Project No   1673 Date   18/09/2024 Drawn by   AJ Map author   AJ				
					1:500,000 (at A4)      GDA 1994 MGA Zone 50
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## 2 LEGISLATIVE CONTEXT

The protection of fauna in WA is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

### 2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of Climate Change, Energy, the Environment and Water (DCCEEW). The EPBC Act provides for the listing of Threatened fauna as matters of National Environmental Significance (NES). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of NES, require approval from the Australian Government Minister for the Environment through a formal referral process. Key threats and habitat critical to the survival of EPBC Act Threatened species are usually defined in the conservation advice and/or recovery plan for the species.

Conservation categories applicable to Threatened fauna species under the EPBC Act are as follows:

- Extinct (EX)<sup>1</sup> – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent (CD)<sup>1</sup> – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

### 2.2 STATE

#### 2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened fauna species (Government of Western Australia 2018a, b) in the following categories:

- Critically Endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future<sup>2</sup>
- Endangered (EN) – species facing a very high risk of extinction in the wild in the near future<sup>2</sup>
- Vulnerable (VU) – species facing a high risk of extinction in the wild in the medium-term future<sup>2</sup>.

Species may also be listed as specially protected (SP) under the BC Act in one or more of the following categories:

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<sup>1</sup> Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

<sup>2</sup> As determined in accordance with criteria set out in the ministerial guidelines.

- species of special conservation interest (conservation dependent fauna, CD) – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- migratory species (Mig.), including birds subject to international agreement
- species otherwise in need of special protection (OS).

The Department of Biodiversity, Conservation and Attractions (DBCAs) administers the BC Act and also maintains a non-statutory list of Priority fauna. Priority species are still considered to be of conservation significance – that is they may be Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority fauna list are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

### 2.2.2 Other significant fauna

Under the EPA’s environmental factor guideline (EPA 2016a), fauna may be considered significant for reasons other than listing as a Threatened or Priority species, including:

- species with restricted distribution, such as short-range endemic invertebrates (see also section 2.2.3)
- species subject to a degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

### 2.2.3 Short-range endemic invertebrates

Short-range endemic (SRE) fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km<sup>2</sup>, that may also be disjunct and highly localised (Harvey 2002). EPA (2016a) identifies species with restricted distributions as being significant fauna in the context of environmental impact assessments (EIA). SRE fauna need to be considered in EIA as localised, small populations of species that are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa.

Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002):

- Relictual – where the drying climate reduced the area of suitable habitat available to a species, forcing a range contraction. Such habitats typically maintain historic mesic conditions (e.g. south-facing rock faces or slopes of mountains or gullies).
- Habitat speciality – where species settled in particular isolated habitat types (e.g. rocky outcrops) by means of dispersal and evolved in isolation into distinct species.

SRE invertebrates have however also been reported in more widespread habitats such as spinifex plains or woodlands, mainly in groups with low dispersal capabilities, for example mygalomorph spiders and millipedes (see for example Car & Harvey 2014; Rix et al. 2018).

There can be uncertainty in categorising a specimen as an SRE due to several factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

## 3 EXISTING ENVIRONMENT

### 3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is located in the Northern Jarrah Forest subregion (JF1) of the Jarrah Forest bioregion which is characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by woodlands of Wandoo - Marri on clayey soils. Eluvial and alluvial deposits support Agonis shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands. The climate is Warm Mediterranean (Williams & Mitchell 2001).

### 3.2 CONSERVATION RESERVES AND ENVIRONMENTALLY SENSITIVE AREAS

The HMF and WMF both occur primarily within state forest (Jarrahdale, Dwellingup and Marrinup State Forest). Serpentine National Park intersects the northern portion of the HMF and Lane Poole Reserve intersects the eastern and western perimeter of the WMF.

## 4 SURVEY GUIDELINES

The EPA Technical Guidance: Sampling of short-range endemic invertebrate fauna (EPA 2016b) stipulates survey effort that is expected for projects requiring environmental impact assessment in WA, these include:

- Timing: Winter to early spring (May-Oct) for surveys in the south-west
- Sampling methods:
  - **Wet pitfall trapping** is listed in the EPA survey guidelines but is not considered a standard component due to ethical concerns, however this technique is very effective for detecting SREs and properly installed wet pit fall traps have a very low vertebrate fauna by-catch rate and very low sequencing failure rate (Phoenix 2024a).
  - **Dry pitfall traps** is listed in the EPA survey guidelines but it is acknowledged that these are only practical when undertaking survey work concurrently with vertebrate fauna pitfall trapping and that this is method highly constrained by weather.
  - **Hand foraging**, including leaf litter and soil sieving, leaf litter and soil raking or blowing, and active searches in micro-habitats such as under rocks, tree bark etc.

The EPA guidelines do not state number of sites to be sampled, however has general guidance on where to sample:

- "proponents should ensure that surveys aim to sample proposed ground disturbance areas, and any other areas where the Project influence could indirectly affect SRE taxa... proponents are strongly encouraged to also carry out sampling in equivalent habitats outside of their proposal footprint".
- sheltered habitats and micro-habitats such as "relatively mesic environments such as slopes with south-west facing aspects, vine thickets, rock piles, drainage systems, deep gorges, mound springs/natural springs, fire refuge areas such as cliffs/isolated rock piles, and other similar habitats".
- habitat isolates such as islands and rock outcrops.

## 5 PREVIOUS SURVEYS

Searches of several biological databases were undertaken to identify previous surveys that have been undertaken within the study area:

- WA Museum Arachnid and Myriapod Database, Mollusca Database, Crustacea Database (WAM 2024)
- Index of Biodiversity Surveys for Assessment (IBSA) database (IBSA 2024)
- Phoenix biological database (Phoenix 2024a).

Reports obtained from the above sources (where available) were interrogated to determine survey effort and general outcomes.

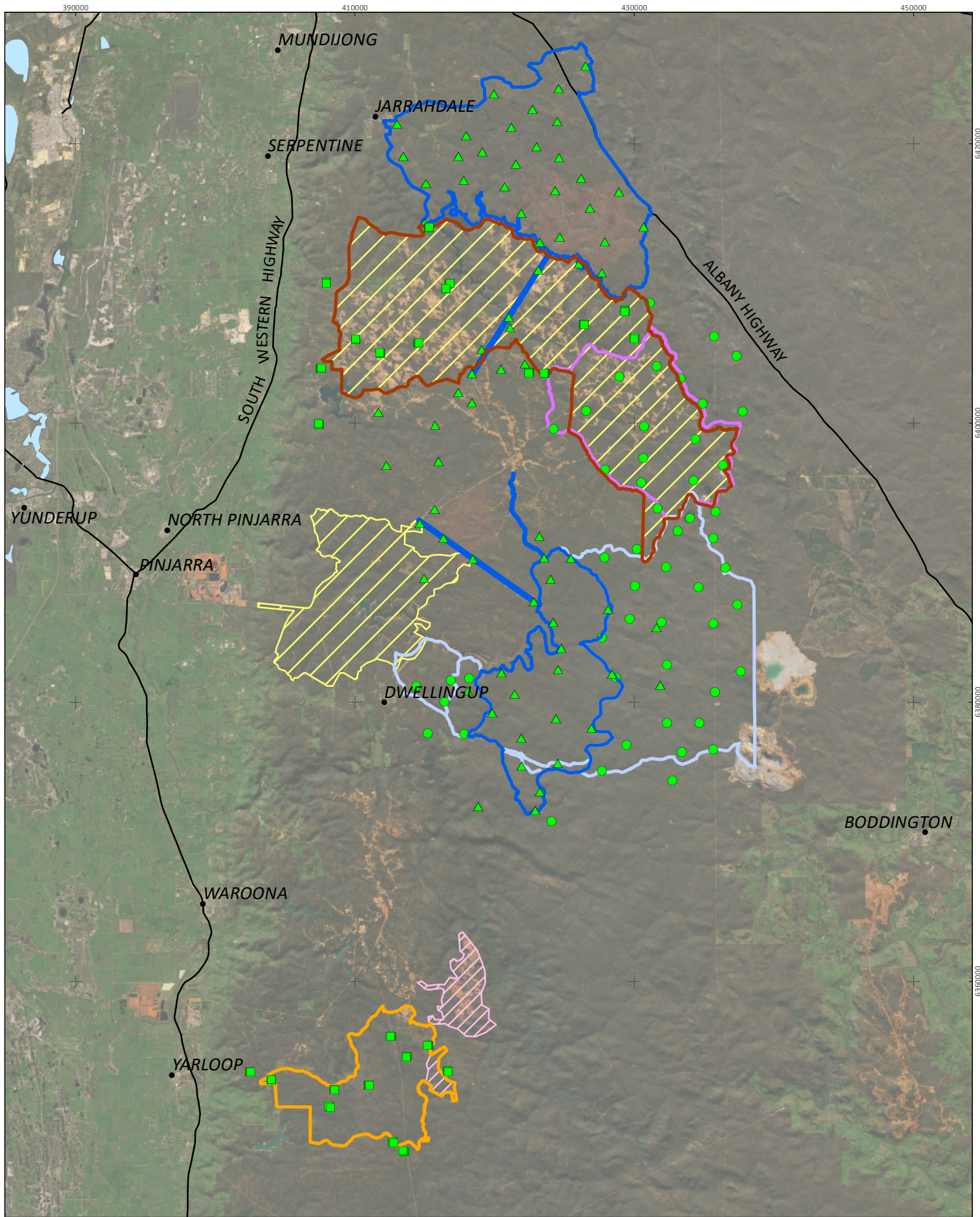
Several SRE surveys have been undertaken or are currently being undertaken in parts of the HMF and WMF area (Table 5-1). The SRE surveys which meet current EPA survey guidelines cover the northern portion of the HMF, however the southern portion of the HMF and the WMF are lacking appropriate survey effort. Several other surveys not overlapping the HMF and the WMF occur to the east and south of HMF and WMF and provide some regional data in which to compare results. The main findings of these surveys indicate a high diversity of taxa throughout the region, with some overlap in species assemblages. All systematic SRE surveys are associated with mining projects. Some data from research projects, opportunistic collections, and smaller projects is also available near the HMF and WMF, however, most of these are not comprehensive or only focus on one group of SRE invertebrates.

**Table 5-1 Surveys in or near the study area**

Survey name	Survey timing	Sampling methods	Intersects study area	Main findings
Myara (currently being surveyed)	Winter and spring 2024	2 phase wet pit traps Foraging, incl. litter sieves <b>Meets EPA survey guidelines</b>	<b>Yes, encompasses entire northern portion of the HMF</b>	No results yet
Larego (currently being surveyed)	Winter and spring 2024	2 phase wet pit traps Foraging, incl. litter sieves <b>Meets EPA survey guidelines</b>	<b>Yes, part of the WMF, however no sites were installed in this area</b>	No results yet
Holyoake East and Holyoake West (Phoenix in prep.)	Winter and spring 2022 (Holyoake East) and spring 2022 and winter 2023 (Holyoake West) <b>Meets EPA survey guidelines</b>	2 phase wet pit traps Foraging, incl. litter sieves <b>Meets EPA survey guidelines</b>	<b>Yes, Minor overlap at boundary of HMF</b>	2 study areas 101 taxa
O'Neil Mine Development (Phoenix 2024b)	Winter and spring 2023 <b>Meets EPA survey guidelines</b>	2 phase wet pit traps Foraging, incl. litter sieves <b>Meets EPA survey guidelines</b>	<b>Yes, overlaps south-eastern third of the HMF</b>	1 study area 64 taxa

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Survey name	Survey timing	Sampling methods	Intersects study area	Main findings
Myara North and Holyoake (Phoenix 2021)	Winter and spring 2020 <b>Meets EPA survey guidelines</b>	Wet pitfall traps Foraging, incl. Litter sieves <b>Meets EPA survey guidelines</b>	No – shares boundary with HMF	2 study areas, plus infrastructure corridors, plus rehabilitation survey 113 taxa
Worsley Mine Expansion Project (Phoenix 2019, 2020, 2023)	Spring 2019 (WMDE), autumn, winter spring 2020 (regional) <b>Meets EPA survey guidelines</b>	2 phase wet pit traps Foraging, incl. Litter sieves <b>Meets EPA survey guidelines</b>	No	3 study areas plus rehabilitation survey Large comparable survey located east and south of the study area 132 taxa
Worsley Alumina Primary Bauxite Area Expansion Project (Phoenix 2012)	Spring 2011, autumn 2012 <b>Meets EPA survey guidelines, though results may be outdated</b>	2 phase wet pit traps Foraging, incl. Litter sieves <b>Meets EPA survey guidelines</b>	No	Comparable survey located east and south of the study area 60 taxa
Boddington Gold Mine (Outback Ecology 2012)	<b>Meets EPA survey guidelines, though results may be outdated</b>	Wet pitfall traps Foraging, incl. Litter sieves <b>Meets EPA survey guidelines</b>	No	Comparable survey located east and south of the study area 69 taxa
Research projects (WA Museum, University research thesis etc.)	WAM records indicate records were collected in throughout the year	various	Some records	Research projects aimed at increasing and understanding biodiversity (WA Museum), or targeted species (e.g. D. Harms PhD on pseudoscorpion, S. Zuiddam PhD on harvestmen, and S. Judd PhD on isopods)
Alcoa staff opportunistic collections	WAM records indicate records were collected in throughout the year	Dry pitfall traps Small wet pitfall traps from ant monitoring	Some records	Opportunistic collections made recently (since 2020) revealed 15 species and 8 indeterminate species of Mygalomorph spiders, 1 species of harvestmen spider, Various SREs from historic (circa 2005-2001) ant monitoring wet pit trap samples
Other collections/surveys	WAM records indicate records were collected in throughout the year	various	Some records	Some small EIA projects – using dry pit traps and foraging Many records in the WAM database are over 25 years old, with several records dating back to early and mid-1900's. While these records are valuable, taxonomy and locality accuracy are less reliable



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Huntly and Willowdale Mines

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- Huntly Mine Footprint (Section 6)
- Willowdale Mine Footprint (Section 6)
- Larego (surveyed 2024, Phoenix)
- Myara (surveyed 2024, Phoenix)
- Holyoake and Myara North (surveyed 2020, Phoenix)
- Holyoak East and West (surveyed 2022 and 2023, Phoenix)
- O'Neil (surveyed 2023, Phoenix)
- Myara North and Holyoake 2-phase wet pit and forage sites
- Myara and Larego 2-phase wet pit and forage sites
- Holyoake East & West and O'Neil 2-phase wet pit and forage sites

**Figure 5-1**  
**Previous surveys within or adjacent to the study area**

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## 6 SPECIES ASSEMBLAGE

Searches of several biological databases were undertaken to identify and prepare lists of SREs that may occur within the study areas:

- WA Museum Arachnid and Myriapod Database, Mollusca Database (WAM 2024)
- Index of Biodiversity Surveys for Assessment (IBSA) database (IBSA 2024)
- Phoenix biological database (Phoenix 2024a).

Previous surveys have indicated that a diverse array of SRE invertebrates occupy the Jarrah Forest, with 365 taxa being recorded from the desktop review (Table 6-1, Appendix 1), noting that a small proportion of taxa are higher level taxa (e.g. 'sp. indet') that may represent taxon identified to species level. Mygalomorph spiders, millipedes, and pseudoscorpions, slaters are the most speciose SRE groups. The previous surveys in the region have all recorded a high diversity of SRE taxa from all recognised SRE groups (e.g. land snails, trapdoor spiders, scorpions, isopod slaters, velvet worms etc.). Each survey has continued to collect new species, but has also re-collected species that are either Widespread, known from a few records/surveys, or previously only known from a previous recent survey, indicating that the cumulative sampling effort is providing us with a better understanding of species ecology and distribution.

### 6.1.1 Huntly Mine Footprint

A total of 102 taxa have previously been recorded in the HMF, most of which have been collected from recent baseline surveys in the south-eastern part of the study area (Figure 6-1; Table 6-1). Further taxa are expected as a result of current surveys being undertaken in the western part of the Myara study area/northern portion of the HMF. Some SREs have been collected by Alcoa staff within the HMF and immediate vicinity, which mostly consists of mygalomorph spiders and a smaller number of harvestmen spiders from dry pitfall traps and opportunistic burrow excavations.

Of the 102 taxa recorded in the HMF, 6 are Confirmed SREs, comprising of 5 millipedes and one scorpion, 66 are Potential SREs owing data deficiency (indeterminate taxa or species with only a few records), and 28 are Widespread species.

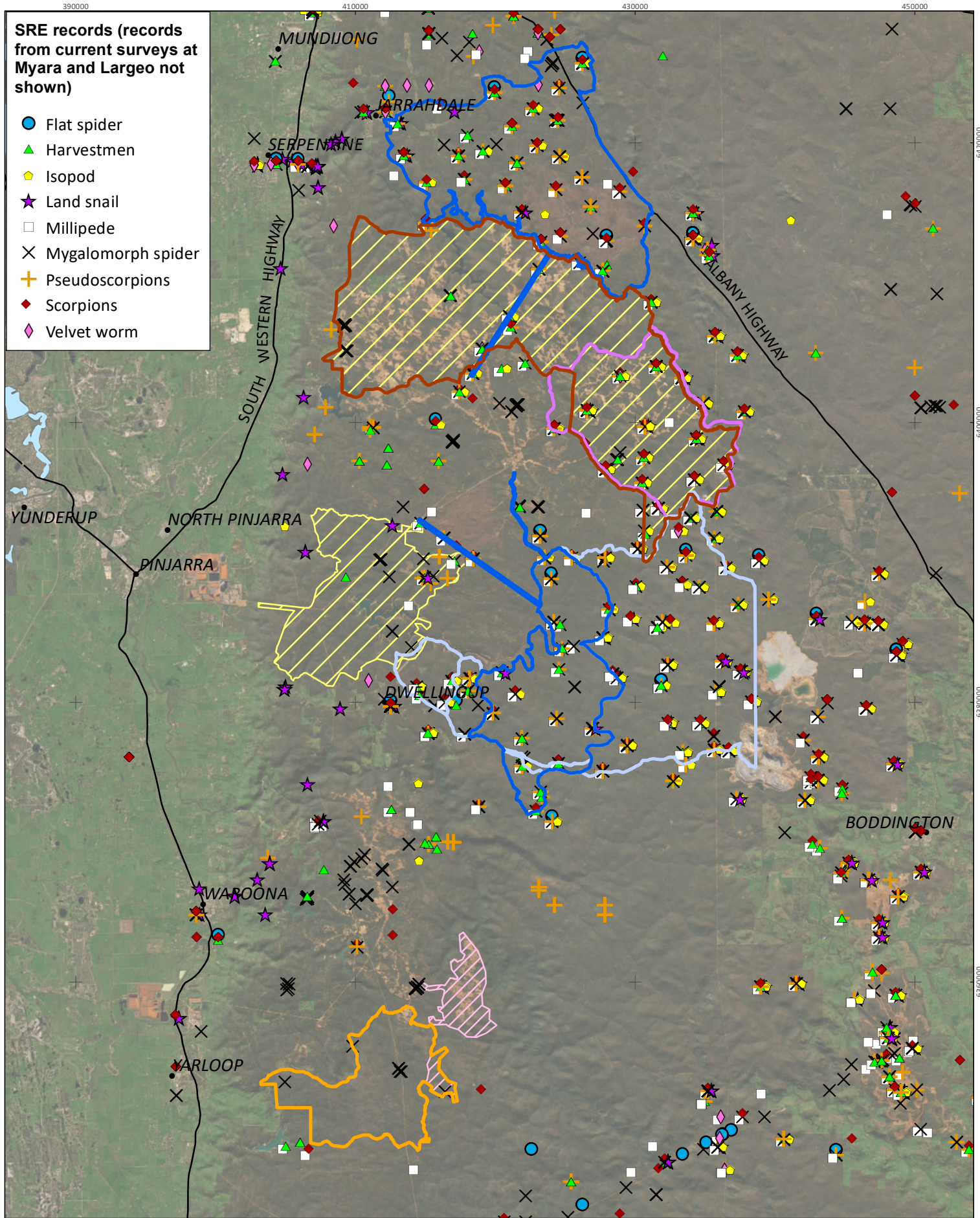
### 6.1.2 Willowdale Mine Footprint

One SRE has been recorded within the WMF study area, a mygalomorph spider (*Idiosoma* sp. indet.; Potential SRE) collected by Alcoa staff in 2022 (Figure 6-1). While there is a small overlap in study area from a current survey, no sites were located in this part of the WMF, however it is certain that SREs occur within native remnant vegetation within this study area.

Records located between the HMF and WMF that are not part of baseline surveys mostly comprise opportunistic or dry pitfall trap collections by Alcoa staff or academic research projects.

**Table 6-1 Summary of SREs within the desktop review. (Number of taxa recorded within the study area is in parentheses).**

<b>Group/ SRE status</b>	<b>Confirmed</b>	<b>Likely</b>	<b>Potential</b>	<b>Potential/P3</b>	<b>Widespread</b>	<b>Widespread/P3</b>	<b>Total</b>
Flat spider					3		3
Harvestmen			24 (15)		4		28
Isopod		1	29 (8)		12 (6)		42
Land snail			12 (4)		8 (2)		20
Millipede	45 (5)	4 (2)	18 (5)		5 (4)		72
Mygalomorph spider			121 (28)	1	10 (3)	1	133
Pseudoscorpion			30 (6)		16 (9)		46
Scorpion	1 (1)		7		10 (3)		18
Velvet worm			1		2 (1)		3
<b>Total</b>	<b>46 (6)</b>	<b>5 (2)</b>	<b>243 (66)</b>	<b>1</b>	<b>70 (28)</b>	<b>1</b>	<b>365 (102)</b>



- SRE records (records from current surveys at Myra and Largeo not shown)**
- Flat spider
  - ▲ Harvestmen
  - Isopod
  - ★ Land snail
  - Millipede
  - × Mygalomorph spider
  - ✚ Pseudoscorpions
  - ◆ Scorpions
  - ◇ Velvet worm



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- ▨ Huntly Mine Footprint (Section 6)
- ▨ Willowdale Mine Footprint (Section 6)
- ▨ Largeo (surveyed 2024, Phoenix)
- ▨ Myra (surveyed 2024, Phoenix)
- ▨ Holyoake and Myra North (surveyed 2020, Phoenix)
- ▨ Holyoak East and West (surveyed 2022 and 2023, Phoenix)
- ▨ O'Neil (surveyed 2023, Phoenix)

**Figure 5-2**  
**SRE records from the desktop review**

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## 7 HABITATS

SRE habitats were re-interpreted from existing vegetation mapping undertaken by (Mattiske 2024). This data includes areas that have been previously cleared and areas of rehabilitation.

Habitats are assessed for their potential to support endemic SRE species and communities. Potential SRE habitat is rated as follows:

- High – defined/known areas of habitat that contain elements that often give rise to specialisation or dependency in invertebrate fauna, such as aspect (e.g. south-facing slopes), geological features (e.g. granite), soil types that retain water (e.g. clay, loam). These habitats may also include habitat isolates which have the capacity to restrict dispersal.
- Low – areas of largely in-tact native vegetation that occur broadly across the landscape, are less incised and typically link more restricted habitats. This may include land that was cleared but has since been rehabilitated or is in the process of being rehabilitated.
- None – land that has been previously cleared for other uses that no longer contains native vegetation.

The HMF and WMF mostly comprise of Low Potential SRE habitat 4 (Table 7-1, Figure 7-1, Figure 7-2) which is characterised by “Open forest to woodland of Jarrah/Marri on sandy-loam gravelly soils on mid-slopes and ridges”.

The southern portion of the HMF is only mapped for rehabilitation, which occupies approximately one-quarter of the southern portion of the HMF; the remainder of this is remnant vegetation is likely to be SRE habitat 4 with minor occurrences of other habitat types. South Dandalup Dam (approx. 450 ha) also occurs in the southern portion of the HMF and does not have any SRE value.

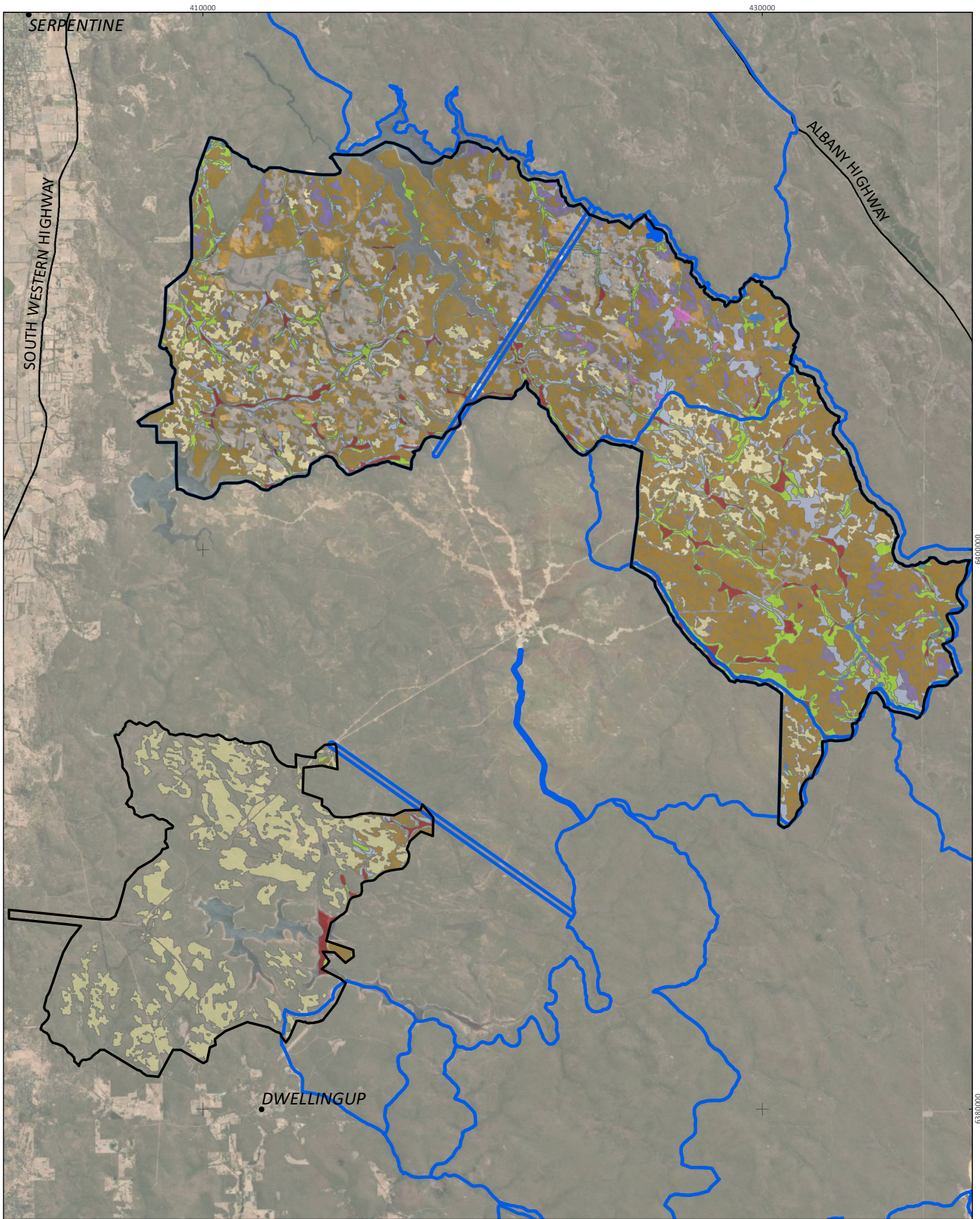
At least 19.2% of the HMF is comprised of High Potential SRE habitats, which are habitats which may support a high degree of refugia such as restricted micro-habitats or that have the tendency to retain more moisture, such as valley floors.

Although not shown in the mapping, approximately one-third of the WMF is cleared, mostly affecting what is likely habitat 4. At least 17.2 ha of the WMF supports High Potential SRE habitat.

Previous survey data in the region indicates both Low and High Potential SRE habitat supports SREs, however the Low Potential SRE habitats may have less restriction to dispersal and support species with wider habitat tolerances. Overall, the HMF and WMF comprise of approximately 29,094 ha (75%), and 1,410 ha (66%) remnant native vegetation and these areas are certain to support various SRE taxa.

**Table 7-1 Habitats within the Huntly Mine Footprint**

SRE habitat (code: description)	Habitat Potential	HMF Area (ha), (%)	WMF Area (ha), (%)
1. Melaleuca woodlands/shrublands on seasonally wet or waterlogged clays and clay-loams on valley floors	H	106 (0.3%)	-
2. Open Jarrah/Marri or Blackbutt on lower slopes and valley floors	H	2,692 (6.9%)	107 (5.0%)
3. Heath/shrubland/woodland on shallow soils on granite or outcrops	H	982 (2.5%)	3 (0.1%)
4. Open forest to woodland of Jarrah/Marri on sandy-loam gravelly soils on mid-slopes and ridges	L	14,827 (38%)	1,719 (80.5%)
5. Open forest of Jarrah/Marri, seasonally moist, sandy gravels on slopes	H	2,774 (7.1%)	207 (9.7%)
6. Cleared land, including plantations and dams	n/a	4,400 (11.3%)	-
7. Open forest to woodland of Jarrah/Marri on slopes and less undulating hills	L	145 (0.4%)	17 (0.8%)
10. Open woodlands of Wandoo and/or Flooded Gum on seasonally wet or waterlogged clays and clay-loams in valley floors	H	937 (2.4%)	52 (2.4%)
11. Open woodlands of Wandoo with clay-loams and some gravel on slopes	L	17 <0.1%)	-
12. Rehabilitation	L	5,102 (13.1%)	-
Un-mapped native vegetation		6,615 (16.9%)	30 (1.4%)
Un-mapped - dam	n/a	450 (1.1%)	-
<b>Total</b>		<b>39,046</b>	<b>2,136</b>



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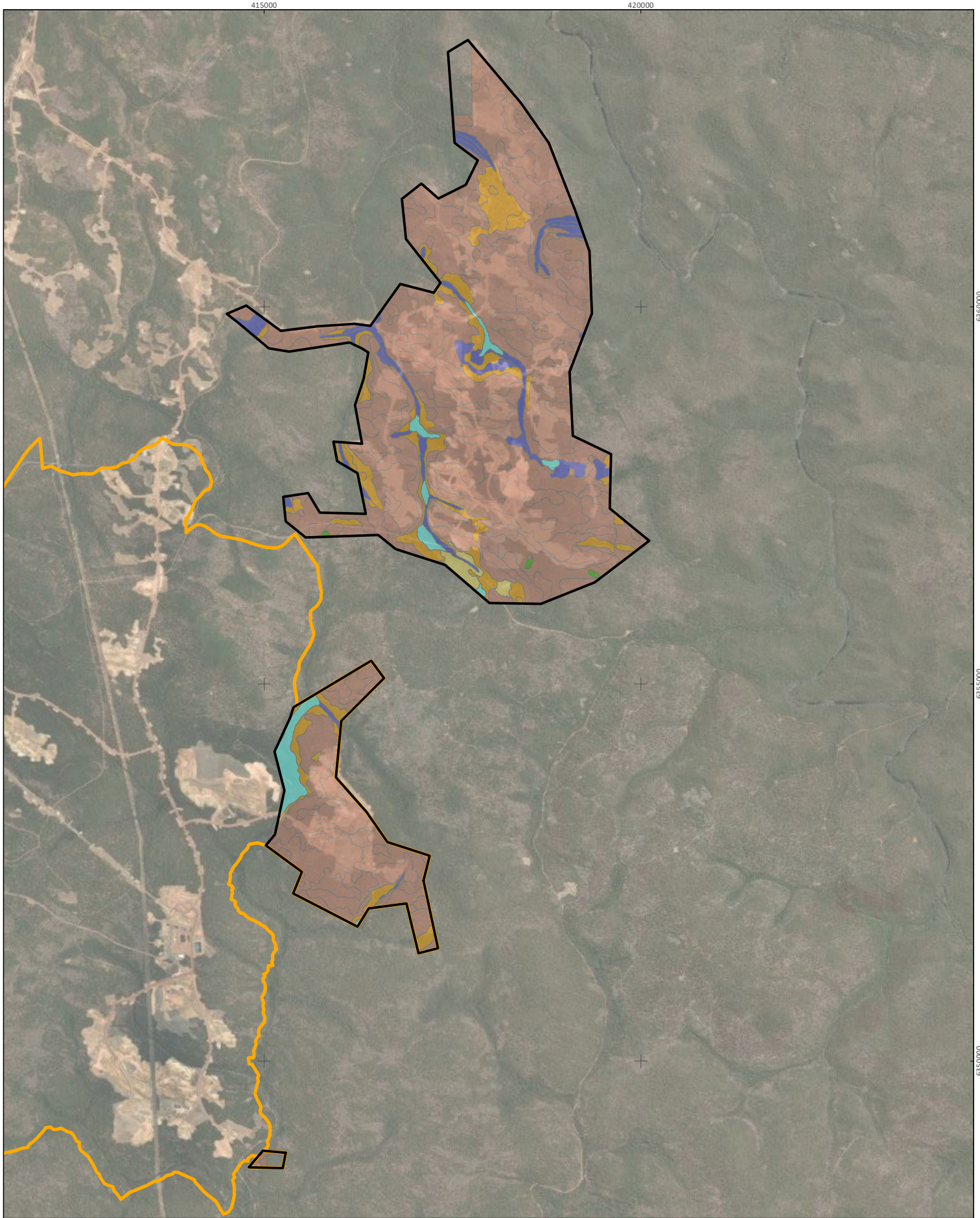
- Willowdale Mine Footprint (Section 6)
- Previous survey areas (Phoenix 2020 to 2024)

- SRE habitat code**
- |   |    |
|---|----|
| 1 | 6  |
| 2 | 7  |
| 3 | 10 |
| 4 | 11 |
| 5 | 12 |

**Figure 7-1**  
**SRE Habitats within the Huntly Mine Footprint**



\\Data\Projects\Huntly\Mine\1673-HM-ALC-TW\GIS\Mapping\Output\Section 6 ERO\Fig 5-3- SRE Habitats\_HMF.mxd



Alcoa of Australia Ltd.  
Huntly and Willowdale Mines

Project No	1673
Date	18/09/2024
Drawn by	AJ
Map author	AJ

0 1 2  
Kilometers

1:65,000 (at A4) GDA 1994 MGA Zone 50

- Willowdale Mine Footprint (Section 6)
- Larego (surveyed 2024, Phoenix)
- SRE habitat code**
- 10
- 2
- 3
- 4
- 5
- 7

**Figure 7-2**  
**SRE Habitats within the Willowdale Mine Footprint**



\*[Data\Projects\Huntly\Mine\1673-HM-ALC-TW\GIS\Mapping\Output\Section 6 ERO\Fig 5-4- SRE Habitats WMF.mxd

## 8 CONCLUSION

The results SRE surveys undertaken in and around the HMF and WMF and further afield in the Northern Jarrah Forest bioregion all indicate that SRE invertebrates are certain to occur within areas of native vegetation. Studies and opportunistic records from rehabilitation indicate these areas also provide habitat, however these areas are generally of lower value due to lower levels of habitat complexity.

The desktop review revealed abundant SRE data was available in some areas, mostly related to mining approvals in the region. A low abundance of regional records outside of these study areas hinders comparisons and assumptions on species distributions that can be made.

### 8.1 HUNTLY MINE FOOTPRINT

SRE surveys have been undertaken within the HMF include intensive sampling throughout the northern portion. These surveys have been undertaken recently (2023 and 2024) using approved sampling techniques and were undertaken within optimal survey period according to the EPA (2016b). These have focussed on areas of remnant vegetation which are considered the highest values habitats for SREs, including a range of SRE habitats available (e.g. granite outcrops, riparian/valley, upper slopes and mid-slopes) with some sampling also undertaken in rehabilitation. The southern portion of the HMF has not been adequately sampled for SREs.

### 8.2 WILLOWDALE MINE FOOTPRINT

SREs have not been adequately sampled within the WMF, with no systematic sampling sites occurring within the WMF. Approximately one-third of the WFM has been previously cleared, however the remaining native vegetation is certain to support SRE invertebrate taxa.

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**Appendix 1 Short-range endemic invertebrate desktop results**

Taxon	SRE status	in HMF or WMF
<b>Class: Araneae, Infraorder: Araneomorphae (Flat spiders)</b>		
Karaops `sp. indet.`	Widespread	
Karaops ellenae	Widespread	
Karaops jarrit	Widespread	
<b>Class: Araneae, Order: Opiliones (Harvestmen spiders)</b>		
Abaddon despoliator	Potential	HMF
Ballarra `sp. indet.`	Potential	HMF
Ballarra longipalpus	Potential	HMF
Calliuncus `genus 4`	Potential	
Calliuncus `sp. indet.`	Potential	HMF
Hesperopilio mainae	Potential	
Megalopsalis `sp. indet.`	Potential	HMF
Megalopsalis `worsley1`	Potential	
Megalopsalis `WorsleyDNA23`	Potential	HMF
Megalopsalis leptekes	Widespread	
Megalopsalis tanisphyros	Widespread	
Neopilionidae sp. indet.	Potential	HMF
Nunciella `sp. 6?`	Potential	
Nunciella `sp. indet.`	Potential	HMF
Nunciella `sp. nov.`	Potential	
Nunciella `WorsleyDNA25`	Potential	HMF
Nunciella aspera	Widespread	
Nunciella karriensis	Widespread	
Nunciella `sp. 6`	Potential	
Perthacantha `sp. indet.`	Potential	
Triaenonychidae `Genus 002` `sp. indet.`	Potential	
Triaenonychidae `Genus 003` `sp. indet.`	Potential	
Triaenonychidae `Genus 004` `sp. indet.`	Potential	HMF
Triaenonychidae `Genus 008/Nunciella?` `sp. indet.`	Potential	HMF
Triaenonychidae `genus 008` `Phoenix0269`	Potential	HMF
Triaenonychidae `Genus 008` `sp. indet.`	Potential	HMF
Triaenonychidae `sp. indet.`	Potential	HMF
Triaenonychidae `genus 004` `Phoenix0270`	Potential	HMF
<b>Class: Diplopoda (Millipedes)</b>		
Akamptogonus novarae	Widespread	
Antichiropus `cf DIP097, marradong`	Confirmed	
Antichiropus `DIP046, boddington`	Confirmed	
Antichiropus `DIP056, arfa`	Confirmed	
Antichiropus `DIP056`	Confirmed	
Antichiropus `DIP062, darling`	Confirmed	
Antichiropus `DIP066, boyagin`	Confirmed	
Antichiropus `DIP078?`	Confirmed	
Antichiropus `DIP078`	Confirmed	

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Antichiropus `DIP094, goldmine`	Confirmed	
Antichiropus `DIP097, marradong`	Confirmed	
Antichiropus `DIP105, bancroft`	Confirmed	
Antichiropus `DIP108, mt saddleback`	Confirmed	
Antichiropus `DIP112, Norman Road 1`	Confirmed	
Antichiropus `DIP125, tutanning`	Confirmed	
Antichiropus `DIP126`	Confirmed	
Antichiropus `DIP135, minnivale 2`	Confirmed	
Antichiropus `DIP137, saddleback 2`	Confirmed	
Antichiropus `DIP143, serpentine`	Confirmed	
Antichiropus `DIP166 whistlepipe`	Confirmed	
Antichiropus `DIP168`	Confirmed	
Antichiropus `DIP171, ellisbrook`	Confirmed	
Antichiropus `DIP178, bannister`	Confirmed	
Antichiropus `DIP180`	Confirmed	
Antichiropus `DIP181, lane poole`	Confirmed	
Antichiropus `DIP182, saddleback 3`	Confirmed	
Antichiropus `DIP183`	Confirmed	
Antichiropus `DIP183` `Phoenix0216`	Confirmed	
Antichiropus `DIP183` `Phoenix0217`	Confirmed	HMF
Antichiropus `DIP183` `Phoenix0218`	Confirmed	HMF
Antichiropus `DIP186, kirsten`	Confirmed	
Antichiropus `DIP202`	Confirmed	
Antichiropus `DIP220, mini`	Confirmed	
Antichiropus `DIP221, Myara`	Confirmed	HMF
Antichiropus `DIP222 forest`	Confirmed	
Antichiropus `DIP223 southern`	Confirmed	
Antichiropus `DIP224 dwellingup`	Confirmed	HMF
Antichiropus `DIP246`	Confirmed	
Antichiropus `sp. indet.`	Potential	
Antichiropus `worsley`	Potential	
Antichiropus minimus	Confirmed	
Antichiropus nanus	Confirmed	
Antichiropus variabilis	Widespread	HMF
Atelomastix `sp. indet.`	Widespread	HMF
Atelomastix nigrescens	Widespread	HMF
Dalodesmidae `Phoenix0038`	Potential	HMF
Dalodesmidae `sp. indet.`	Potential	HMF
Dinocambala ingens	Confirmed	
Paradoxosomatidae `Genus nov.` `sp. indet.`	Potential	
Podykipus `DIP241`	Potential	HMF
Podykipus collinus	Potential	HMF
Podykipus leptoiuloides	Widespread	HMF
Siphonotidae `DIPAAF` `DIP188`	Potential	
Siphonotidae `DIPAAF` `DIP188`	Confirmed	
Siphonotidae `DIPAAF` `Phoenix0043 / cf michaelsoni`	Likely	HMF

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Siphonotidae `DIPAAG` `sp. indet.`	Potential	
Siphonotidae `DIPAAG` michaelsoni	Likely	HMF
Siphonotidae `DIPAAG`/`DIP219, Phoenix0044`	Potential	
Siphonotidae `DIPAAG` `DIP189, /Phoenix0039` `collie`	Confirmed	
Siphonotidae `DIPAAG` `DIP192`	Confirmed	HMF
Siphonotidae `DIPAAG` `DIP192` `mt saddleback`	Confirmed	
Siphonotidae `DIPAAG` `DIP194, cocaio`	Potential	
Siphonotidae `DIPAAG` `sp. indet.`	Potential	
Siphonotidae `DIPAAG` `DIP190`	Confirmed	
Siphonotidae `DIPAAL` `DIP240`	Likely	
Siphonotidae `Megalosiphon` `WorsleyDNA14`	Potential	
Siphonotidae `Megalosiphon` `WorsleyDNA15`	Potential	
Siphonotidae `Rhinetus/DIPAAG` michaelsoni	Likely	
Siphonotidae `sp. indet.`	Potential	
Sphaerotrichopus `sp. indet.`	Potential	HMF
Sphaerotrichopus `S-W forests`	Potential	
Sphaerotrichopus ramosus	Potential	
<b>Class: Araneae, Infraorder: Mygalomorphae (Trapdoor spiders)</b>		
Aname `Brennan sp. 1`	Potential	
Aname `Brennan sp. 2`	Potential	
Aname `cf. mainae`	Potential	
Aname `Dwellingup`	Potential	
Aname `false black wish-bone`	Potential	
Aname `mainae grp`	Potential	
Aname `MYG010`	Potential	HMF
Aname `MYG119`	Potential	
Aname `MYG120`	Potential	
Aname `MYG121`	Potential	
Aname `MYG242`	Potential	
Aname `MYG383`	Potential	
Aname `MYG850`	Potential	HMF
Aname `Phoenix0004`	Potential	
Aname `Phoenix0006`	Potential	
Aname `Phoenix0010`	Potential	
Aname `Phoenix0020`	Potential	
Aname `Phoenix0036`	Potential	HMF
Aname `Phoenix0037`	Potential	HMF
Aname `sp. indet.`	Potential	
Aname `sp. nov.`	Potential	
Anamidae `Phoenix0009`	Potential	
Anamidae `sp. indet.`	Potential	HMF
Aureocrypta `Phoenix0014`	Potential	
Bertmainius opimus	Potential	
Bungulla disrupta	Potential	
Bungulla harrisonae	Potential	HMF
Bungulla parva	Potential	

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Cethegus `sp. indet.`	Potential	
Cethegus fugax	Potential	
Chenistonia `sp. indet.`	Potential	
Conothele `sp. indet.`	Potential	
Eucanippe nemestrina	Potential	
Eucyrtops `cf T118362`	Potential	
Eucyrtops `cf. T118377?, male`	Potential	HMF
Eucyrtops `collie`	Potential	
Eucyrtops `everted fovea sp.`	Potential	
Eucyrtops `MYG142`	Potential	
Eucyrtops `MYG645`	Potential	HMF
Eucyrtops `MYG731`	Potential	
Eucyrtops `Phoenix0018`	Potential	
Eucyrtops `Phoenix0029`	Potential	
Eucyrtops `Phoenix0030`	Potential	
Eucyrtops `Phoenix0032`	Potential	HMF
Eucyrtops `Phoenix0033`	Potential	HMF
Eucyrtops `Phoenix0044`	Potential	
Eucyrtops `sp. indet.`	Potential	
Eucyrtops `WorsleyDNA06`	Potential	
Eucyrtops latior	Potential	
Euoplos `minimus`	Potential	
Euoplos `Phoenix0011`	Potential	
Euoplos `Phoenix0012`	Potential	
Euoplos `sp. indet.`	Potential	HMF
Euoplos inornatus	Potential	
Gaius `sp. indet.`	Potential	
Gaius cooperi	Potential	
Idiommata `flare tip`	Potential	
Idiommata `FP-11150 (Dryandra)`	Potential	
Idiommata `sp. indet.`	Potential	
Idiommata blackwalli	Widespread	HMF
Idiosoma `MYG075`	Potential	
Idiosoma `MYG187`	Potential	HMF
Idiosoma `MYG790`	Potential	HMF
Idiosoma `MYG803`	Potential	
Idiosoma `MYG806`	Potential	
Idiosoma `MYG831`	Potential	
Idiosoma `Phoenix0002`	Potential	
Idiosoma `rhapsiduca group`	Potential	
Idiosoma `sp. indet.`	Potential	HMF and WMF
Idiosoma jarrah	Widespread	HMF
Idiosoma schoknechtorum	Potential/P3	
Idiosoma sigillatum	Widespread/P3	
Kwonkan `MYG060`	Potential	
Kwonkan `MYG339 (FP-10068)`	Potential	

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Kwonkan `MYG852`	Potential	HMF
Kwonkan `Phoenix0005`	Potential	
Kwonkan `Phoenix0008`	Potential	
Kwonkan `Phoenix0210`	Potential	
Kwonkan `sp. indet.`	Potential	
Kwonkan `sp. nov.`	Potential	
Mandjelia humphreysi	Widespread	
Missulena `black chelicerae`	Potential	
Missulena `cf. T132965? male`	Potential	HMF
Missulena `MYG198`	Potential	
Missulena `MYG639`	Potential	
Missulena `sp 5`	Potential	
Missulena `sp. indet.`	Potential	
Missulena `T132965`	Potential	HMF
Missulena granulosa	Widespread	
Missulena hoggi	Potential	
Missulena insignis	Widespread	
Missulena occatoria	Widespread	
Proshermacha `MYG449`	Potential	
Proshermacha `MYG471`	Potential	
Proshermacha `MYG485`	Potential	HMF
Proshermacha `MYG495`	Potential	HMF
Proshermacha `MYG596`	Potential	
Proshermacha `MYG646`	Potential	
Proshermacha `MYG658`	Potential	
Proshermacha `Phoenix0024`	Potential	
Proshermacha `Phoenix0027`	Potential	HMF
Proshermacha `Phoenix0028`	Potential	
Proshermacha `Phoenix0213`	Potential	
Proshermacha `sp. indet.`	Potential	HMF
Proshermacha `villosa`	Potential	
Proshermacha subarmata	Potential	
Synothele `MYG640`	Potential	
Synothele `sp. indet.`	Potential	
Synothele durokoppin	Widespread	
Synothele harveyi	Potential	
Synothele longbottomi	Widespread	
Synothele michaelsoni	Widespread	HMF
Synothele mullaloo	Potential	HMF
Synothele rubripes	Potential	HMF
Teyl `Brennan sp. 2`	Potential	
Teyl `FP-12522 (Hovea)`	Potential	
Teyl `luculentus?`	Potential	
Teyl `mandgedal sp. group`	Potential	
Teyl `MYG241`	Potential	HMF
Teyl `MYG245`	Potential	HMF

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Teyl `MYG249`	Potential	
Teyl `MYG355`	Potential	HMF
Teyl `MYG693`	Potential	
Teyl `MYG851`	Potential	
Teyl `Phoenix0007`	Potential	HMF
Teyl `Phoenix0019`	Potential	
Teyl `Phoenix0021`	Potential	
Teyl `Phoenix0212`	Potential	
Teyl `sp. indet.`	Potential	HMF
Teyl beaufortia	Potential	
Teyl luculentus	Potential	
Teyl nadineae	Widespread	
Teyl sampeyae	Potential	
<b>Class: Araneae, Order: Pseudoscorpiones (Pseudoscorpions)</b>		
Atemnidae `sp. indet.`	Potential	
Austrochthonius `grandis`	Widespread	
Austrochthonius `medium 2`	Potential	
Austrochthonius `PSE188, similis`	Widespread	HMF
Austrochthonius `PSE189, austini`	Potential	
Austrochthonius `PSE191, grandis`	Widespread	HMF
Austrochthonius `PSE192, lesueuri`	Potential	
Austrochthonius `sp. indet.`	Potential	HMF
Austrochthonius australis	Widespread	
Austrochthonius muchmorei	Widespread	HMF
Austrohorus `sp. indet.`	Potential	
Balgachernes occultus	Potential	HMF
Beierolpium `sp. 8/4 lge`	Potential	
Beierolpium `sp. 8/4`	Potential	HMF
Beierolpium `sp. indet.`	Potential	
Beierolpium `sp. nov.`	Potential	HMF
Beierolpium bornemisszai	Widespread	HMF
Cheliferidae `sp. indet.`	Potential	
Chernetidae `boddington`	Widespread	
Chernetidae `sp. indet.`	Potential	HMF
Chernetinae `tarsus IV without tactile seta`	Potential	
Chthoniidae `sp. indet.`	Potential	HMF
Euryolpium `sp. indet.`	Potential	
Geogarypus `sp. indet.`	Potential	
Geogarypus taylori	Widespread	HMF
Haplochernes ramosus	Potential	
Indolpium `sp. indet.`	Potential	
Lagynochthonius `sp. indet.`	Potential	
Lagynochthonius australicus	Widespread	HMF
Oratemnus `sp. indet.`	Potential	
Oratemnus curtus	Widespread	HMF
Protochelifer `boddington`	Widespread	HMF

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Protochelifer `sp. indet.`	Potential	
Protogarypinus `sp. indet.`	Potential	
Protogarypinus giganteus	Widespread	
Pseudotyranochthonius `Darling Range 1`	Potential	
Pseudotyranochthonius `Darling Range 2`	Widespread	HMF
Pseudotyranochthonius `Darling Range 3`	Potential	
Pseudotyranochthonius `sp. indet.`	Potential	
Solinus `sp. indet.`	Potential	
Solinus pingrup	Potential	
Synsphyronus `sp. indet.`	Widespread	
Synsphyronus magnus	Widespread	
Synsphyronus mimulus	Widespread	
Tyrannochthonius `sp. indet.`	Potential	
Tyrannochthonius australicus	Potential	
<b>Class: Araneae, Order: Scorpiones (Scorpions)</b>		
Cercophonius `sp. indet.`	Potential	
Cercophonius granulosus	Widespread	
Cercophonius squama	Widespread	
Cercophonius sulcatus	Widespread	HMF
Isometroides `jarrah`	Potential	
Isometroides `vescus`	Widespread	
Lychas `austroccidentalis`	Widespread	HMF
Lychas `majerorum`	Potential	
Lychas `prendinii`	Potential	
Lychas `sp. indet.`	Potential	
Lychas `subsplendens`	Potential	
Lychas jonesae	Widespread	
Lychas splendens	Widespread	
Urodacus `armatus`	Widespread	
Urodacus `woodwardii`	Potential	
Urodacus hartmeyeri	Widespread	
Urodacus novaehollandiae	Widespread	HMF
Urodacus planimanus	Confirmed	HMF
<b>Phylum: Onychophora (Velvet worms)</b>		
Kumbadjena `sp. indet.`	Potential	
Occiperipatooides `sp. indet.`	Widespread	
Occiperipatooides gilesii	Widespread	HMF
<b>Class: Crustacea, Order: Isopoda (Slaters)</b>		
Acanthodillo `sp. 1 (Judd 2002)`	Potential	HMF
Acanthodillo `sp. 2 (Judd 2002)`	Potential	
Acanthodillo `sp. 3 (Judd 2002)`	Potential	
Acanthodillo `sp. 5`	Potential	
Acanthodillo `sp. indet.`	Potential	
Acanthodillo `sp. worsley A`	Potential	
Acanthodillo `sp. worsley B`	Potential	
Acanthodillo flavus	Potential	HMF

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Buddelundia `sp. 1 (Judd 2002)`	Potential	
Buddelundia `sp. 4 (Judd 2002)`	Potential	
Buddelundia `sp. 5 (Judd 2002)`	Potential	HMF
Buddelundia `sp. 5 Worsley`	Potential	HMF
Buddelundia `sp. 6 (Judd 2002)`	Potential	
Buddelundia `sp. 7 (Judd 2002)`	Potential	
Buddelundia cinerascens	Potential	
Buddelundia nigripes	Potential	
Buddelundia nitidissima	Widespread	HMF
Buddelundia opaca	Widespread	
Cubaris `sp. 1 (Judd 2002)`	Potential	
Laevophiloscia `sp. 1 (Judd 2002)`	Widespread	HMF
Laevophiloscia `sp. 2 (Judd 2002)`	Widespread	HMF
Laevophiloscia cf. perlata	Potential	
Laevophiloscia cf. yalagoonensis	Potential	
Laevophiloscia perlata	Widespread	
Laevophiloscia yalagoonensis	Widespread	
Paraplatyarthus sp. indet.	Potential	
Philosciidae `Phoenix0208`	Potential	HMF
Philosciidae `Phoenix0209`	Potential	HMF
Philosciidae `s/1`	Potential	HMF
Pseudodiploexochus `Phoenix0214`	Potential	HMF
Pseudodiploexochus `sp. 1 (Judd 2002)`	Widespread	
Pseudodiploexochus `sp. 2 (Judd 2002)`	Widespread	
Pseudodiploexochus sp. indet.	Likely	
Pseudolaureola `sp. nov.`	Potential	
Spherillo `1`	Potential	
Spherillo `sp. 2 (Judd 2002)`	Potential	
Spherillo `sp. 4 (Judd 2002)`	Potential	
Spherillo `sp. 5 (Judd 2002)`	Widespread	HMF
Styloniscus `sp. 1 (Judd 2002)`	Widespread	HMF
Styloniscus `sp. 7 (Judd 2002)`	Widespread	HMF
Styloniscus cf. australiensis	Potential	
Trichorhina `sp. 1 (Judd 2002)`	Widespread	
<b>Class: Gastropoda, Superorder: Eupulmonata (Land snails)</b>		
Annoselix cf. dolosa	Widespread	HMF
Annoselix dolosa	Widespread	
Bothriembryon bradshawi	Widespread	
Bothriembryon bulla	Widespread	
Bothriembryon cf. bradshawi	Potential	HMF
Bothriembryon cf. bulla	Potential	
Bothriembryon cf. indutus	Potential	
Bothriembryon cf. kendricki	Potential	
Bothriembryon cf. serpentinus	Potential	HMF
Bothriembryon indutus	Widespread	
Bothriembryon kendricki	Widespread	

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Bothriembryon n.sp.	Potential	
Bothriembryon serpentinus	Potential	HMF
Bothriembryon sp.	Potential	
cf. Westralaoma sp. indet.	Potential	
Epinicium restifer	Potential	
Luinodiscus cf. sublestus	Widespread	HMF
Luinodiscus sp.	Widespread	
Westralaoma sp.	Potential	HMF
Whissonia cf. repens	Potential	

