

**Attachment 6 – Short Range Endemic (SRE) Desktop Habitat Assessment report
(Invertebrate Solutions, 2019)**

Conservation Significant and Short Range Endemic invertebrate desktop habitat assessment for Thornlie-Cockburn Link Proposal, Perth, Western Australia.



Technical Memorandum by
Invertebrate Solutions The Public
Transport Authority, Western Australia

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Frontispiece: The tree cricket *Pachysaga munggai* from the Swan Coastal Plain

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1 Introduction

The Public Transport Authority (PTA) proposes to construct and operate a new 14.5 kilometre (km) dual railway track to extend the existing Thornlie passenger line to Cockburn Central Station on the Mandurah line and duplicate the existing 3 km of single track between Beckenham Junction and Thornlie Station (Figure 1). The Thornlie-Cockburn Link proposal (the proposal) requires the relocation of 11 km of freight line within the existing rail reserve.

The proposal requires the construction and operation of two new stations at Ranford and Nicholson Roads in Canning Vale and modification of the existing stations at Thornlie and Cockburn Central. The passenger rail bridge over the Canning River will be duplicated and a principal shared path will be constructed along the new railway.

The proposal would require the clearing of up to 32.12 hectares (ha) of native vegetation, including 29.45 ha in Bush Forever areas. Up to 2.32 ha of Banksia Woodland of the Swan Coastal Plain Threatened Ecological Community (TEC), 24.59 ha of black cockatoo foraging habitat and 64 potential black cockatoo habitat trees are proposed to be cleared.

The Level of Assessment was set as Referral Information with Additional Information (4 week public review). The referral information has been revised and additional information prepared by the PTA and is currently released for public review for four weeks commencing 20 May 2019 and closing 17 June 2019.

Invertebrate Solutions has been requested by PTA to undertake a desktop habitat assessment for Conservation Significant and SRE invertebrates for the Thornlie-Cockburn Link Proposal Development Envelope (Figure 1) and specifically address the following:

- Provide information about the about the suitable habitats for SRE invertebrates within Development Envelope and the immediately adjacent area.
- Provide an assessment of the SRE and conservation significant species that are likely to be present within the Development Envelope.
- Provide a technical memorandum containing the above items.



Figure 1 Thornlie-Cockburn Rail Proposal Development Envelope.

1.1 Memorandum Limitations and Exclusions

This technical memorandum was limited to the written scope provided in the Introduction. This study was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

Invertebrate Solutions has prepared this report on the basis of information provided by PTA and others (including Government authorities), which Invertebrate Solutions has not independently verified or checked beyond the agreed scope of work. Invertebrate Solutions does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2 Desktop SRE Invertebrate Review

2.1 SRE Habitat in Development Envelope

The vegetation units and condition mapping identified in the flora and vegetation assessment (GHD 2019) were used to assess the proposed Development Envelope for potential SRE habitat (Table 1). None of the habitats identified would provide habitat isolates that would be likely to contain SRE taxa within the limited extent of the Development Envelope. The vegetation condition is largely degraded to completely degraded and offers little habitat for SRE invertebrates except for some small patches of Banksia Woodland and Melaleuca woodland/dampland (Aurora 2019, GHD 2019).

No high value SRE habitat is present within the Thornlie-Cockburn Link proposal Development Envelope, and 6.53 ha of Moderate value SRE habitat is present although some of this habitat is in a degraded condition thus reducing its habitat value. The remainder of the Development Envelope is considered to be of Low or Nil habitat value for SRE and Conservation Significant invertebrates (Table 1). This assessment is based upon the absence of any dramatic habitat isolates, such as deep moist gullies or large mountains that would be likely to contain SRE taxa within the limited extent of the Thornlie-Cockburn Link Development Envelope. Furthermore, all the vegetation units are laterally continuous within the region and not limited to the Thornlie-Cockburn Link Development Envelope.

Generally on the Swan Coastal Plain (SCP) native vegetation has a Low/Moderate likelihood of containing a SRE taxa (Invertebrate Solutions 2018), whilst on the Darling scarp the likelihood increases for high quality vegetation due to the presence of sheltered gullies, rocky granite outcrops and other potential habitat isolates and *refugia*. Although urban areas are broadly considered to have no suitability for SRE fauna, small remnant bushland patches can and do support SRE fauna within the Perth metropolitan area (Rix *et al.* 2018).

2.2 SRE and Conservation Significant Invertebrate species potentially within the Development Envelope

A list of conservation significant fauna for the Development Envelope was compiled from the Department of Biodiversity, Conservation and Attractions (DBCA) Wildlife Conservation (Specially Protected Fauna) Notice 2019 (DBCA 2019) and the Department of Environment and Energy's (DEE) Protected Matters Search Tool (PMST). SRE species that are listed under the *Biodiversity Conservation Act* (2016) and/or the EPBC Act and are likely to occur or have known habitat within the Development Envelope are shown in Table 2 along with their conservation code. The PMST results listed two native bee species (*Leioproctus douglasiellus* and *Neopasiphae simplicior*) as having the potential for habitat based upon bioclimatic modelling to occur within the Development Envelope.

Definitions for SRE status and likelihood of occurrence are found in Appendix 1 and conservation status definitions from BCA and the Federal EPBC Act are shown in Appendix 2. All assessments for likelihood of occurrence of conservation significant and SRE invertebrate species were undertaken with regard to the Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA 2016).

Table 1 Vegetation units in Development Envelope and SRE invertebrate habitat potential (after GHD 2019 and Aurora 2019)¹.

Vegetation Unit (after GHD 2019)	Vegetation description (after GHD 2019)	SRE habitat Suitability	Area within GHD Survey Area	Area (Ha within Development Envelope - Aurora 2019 Table K)
<i>Banksia menziesii</i> and <i>B. attenuata</i> woodland (VT01)	<i>Eucalyptus tottiana</i> , <i>Nuytsia floribunda</i> , <i>Banksia illicifolia</i> isolated trees over <i>B. menziesii</i> , <i>B. attenuata</i> woodland over <i>Xanthorrhoea preissii</i> , <i>Hibbertia</i> spp. sparse shrubland over diverse heathland	Moderate	9.68 ha (surveyed) 4.88 ² ha (not surveyed) 14.56 ha total	3.88 ha (surveyed) 0.01 ha (not surveyed) ³
<i>Regelia inops</i> <i>Hypocalymma angustifolium</i> shrubland (VT02)	<i>Melaleuca preissiana</i> / <i>Banksia illicifolia</i> / <i>B. littoralis</i> isolated trees over <i>Regelia inops</i> , <i>Hypocalymma angustifolium</i> shrubland over <i>Phlebocarya ciliatum</i> , <i>Dasypogon bromeliifolius</i> closed herbland	Moderate	6.44 ha	2.16 ha
<i>Banksia</i> spp. isolated trees <i>Regelia inops</i> <i>Hypocalymma angustifolium</i> shrubland (VT02a)	<i>B. attenuata</i> / <i>B. illicifolia</i> isolated clumps of trees over <i>Regelia inops</i> , <i>Hypocalymma angustifolium</i> shrubland over <i>Phlebocarya ciliatum</i> , <i>Dasypogon bromeliifolius</i> closed herbland	Moderate	0.49 ha	0.49 ha
<i>Melaleuca preissiana</i> open woodland (VT02b)	<i>Melaleuca preissiana</i> open woodland over <i>Regelia inops</i> , <i>Hypocalymma angustifolium</i> , <i>Astartea fascicularis</i> shrubland with <i>Lepidosperma longitudinale</i> , <i>Lyginia imberbis</i> , <i>Hypolaena exsulca</i> sparse sedgeland over <i>Phlebocarya ciliatum</i> , <i>Dasypogon bromeliifolius</i> herbland	Moderate	1.92 ha	-
<i>Melaleuca preissiana</i> <i>M. raphiophylla</i> open woodland (VT03)	<i>Melaleuca preissiana</i> , <i>M. raphiophylla</i> open woodland over <i>Juncus pallidus</i> isolated clumps of sedges over <i>*Cynodon dactylon</i> , <i>*Cenchrus clandestinus</i> closed grassland	Low	2.94 ha	2.89 ha
<i>Adenanthos cygnorum</i> shrubland (VT04)	<i>Corymbia calophylla</i> , <i>Eucalyptus tottiana</i> isolated clumps of trees over <i>Adenanthos cygnorum</i> sparse shrubland over <i>*Cenchrus setaceus</i> sparse grassland	Low	3.95 ha	2.98 ha
<i>Eucalyptus rudis</i> , <i>Melaleuca raphiophylla</i> open forest (VT05)	<i>Eucalyptus rudis</i> , <i>Melaleuca raphiophylla</i> open forest over introduced herbland/ grassland	Nil	1.06 ha	0.09 ha
Scattered natives amongst weeds (VT06)	<i>Corymbia calophylla</i> / <i>Eucalyptus rudis</i> / <i>E. tottiana</i> / <i>E. gomphocephala</i> / <i>*Eucalyptus</i> spp. isolated trees over introduced herbland/ grassland	Nil	26.69 ha	19.56 ha
Grassland/ Herbland (VT07)	Weedy closed grassland/herbland with occasional natives	Nil	23.21 ha	20.80 ha
<i>Corymbia calophylla</i> open woodland (VT08)	<i>Corymbia calophylla</i> open woodland over <i>Jacksonia furcellata</i> , <i>Acacia pulchella</i> sparse mid shrubland over <i>Phlebocarya ciliatum</i> <i>Dasypogon bromeliifolius</i> herbland	Low	1.14 ha	0.07 ha
<i>Melaleuca raphiophylla</i> woodland (VT09)	<i>Melaleuca raphiophylla</i> , <i>Eucalyptus rudis</i> woodland over <i>Lepidosperma longitudinale</i> , <i>Juncus pallidus</i> open sedgeland over <i>Centella asiatica</i> closed herbland	Low	0.40 ha	-
Road, rail and/ or infrastructure	Cleared of vegetation	Nil	75.10 ha	66.49 ha

¹ Reference: Aurora Environmental 2019, Thornlie-Cockburn Link, *Referral Information with Additional Information 16 May 2019*

² Area not surveyed due to restricted access, however areas were observed to be synonymous to VT01

³ 2.32 ha of this is considered to be consistent with the *Banksia* Woodlands of the Swan Coastal Plain TEC.

Within the Development Envelope, there are 10 SRE/conservation significant invertebrate species that have the potential for habitat to be present, and four with no habitat present based upon desktop resources only (Table 2). Of the 10 species with habitat present within the Development Envelope, three species have a High likelihood of occurrence, four have Moderate likelihood of occurrence and three have a Low likelihood of occurrence within the Development Envelope. These species were assessed using desktop methods to determine their likelihood of occurrence within the Proposal Development Envelope and their subsequent potential for significant impact from the development if they were determined likely to occur.

Two mygalomorph spiders (*Synothele michaelsoni* – Likely SRE, and *Idiosoma sigillatum* – Priority 3) were determined to have habitat present (Table 2) due to the presence of Banksia woodland on sandy soils within the Development Envelope (GHD 2019). Combined with potential habitat within the Development Envelope and the proximity of known occurrences of both these species, they are both considered to have a High likelihood of occurrence within the Development Envelope. It should be noted, however, that the amount of potential habitat is within the Development Envelope is extremely limited and largely degraded thus no significant impacts to these species' are anticipated. It is for these reasons above that the PTA will adopt a risk based approach in accordance with Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA2016) without the need for survey.

Four Conservation Significant tree crickets are known to potentially occur on the SCP, ranging in conservation status from Priority 1 – 3. One of these four species, *Throscodectes xederoides* was determined not to have potential habitat present within the Development Envelope and therefore was determined to have a Low likelihood of occurrence within the Development envelope and no significant impacts to this species are anticipated. The remaining three species are considered to have a Moderate (*Austrosaga spinifer* and *Kawaniphila pachomai*) to High (*Throscodectes xiphos*) likelihood of occurrence within the Development Envelope, however, due to the small amount of potential habitat to be impacted, no significant impacts to these species are anticipated. It is for these reasons above that the PTA will adopt a risk based approach in accordance with Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA2016) without the need for survey.

The Swan Coastal Plain (SCP) has six native bee species of conservation concern (DBCA 2019) ranging from Critically Endangered to Priority 3 (Table 2). Two of the native bee species (*Leioproctus contrarius* and *Leioproctus douglasiellus*) had no habitat present within the development envelope based upon their floristic associations (Invertebrate Solutions 2019, GHD 2019). Of the remaining four species with potential habitat within the Development Envelope three (*Hesperocolletes douglasi*, *Leioproctus (Glossurocolletes) bilobatus* and *Neopasiphae simplicio*) were determined to have a Low likelihood of occurrence within the Development envelope when considering the known distributions records of the species and the historical nature of many of these species' records on the SCP. Only *Hylaeus globuliferus* (Priority 3) was determined to have a Moderate likelihood of occurrence within the Proposal Development Envelope and due to the species' widespread distribution and the small amount of potential habitat to be impacted, no significant impacts to this species is anticipated. It is for these reasons above that the PTA will adopt a risk based approach in accordance with Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA2016) without the need for survey.

Table 2 Conservation significant and SRE Invertebrates potentially within the Development Envelope.

Higher Classification	Genus and Species	DBCA/ BC Status	EPBC status	SRE status	Likely habitat present within Development Envelope	Likelihood of species within Development Envelope
Gastropoda						
Pulmonata: Succineidae	<i>Succinea contenta</i>	-	-	Confirmed	Not Present	Low
Arachnida:						
Mygalomorphae:						
Barychelidae	<i>Synothele michaelsoni</i>	-	-	Likely	Present	High
Idiopidae	<i>Idiosoma sigillatum</i>	P3	-	Confirmed	Present	High
Insecta:						
Orthoptera						
	<i>Austrosaga spinifer</i>	P2	-	Likely	Present	Moderate
	<i>Kawaniphila pachomai</i>	P1	-	Widespread	Present	Moderate
	<i>Throscodectes xederoides</i>	P3	-	Likely	Not Present	Low
	<i>Throscodectes xiphos</i>	P1	-	Confirmed	Present	High
Lepidoptera	<i>Synemon gratiosa</i>	P4	-	Widespread	Present	Moderate
Hymenoptera						
	<i>Hesperocolletes douglasi</i>	Critically Endangered	Critically Endangered*	Widespread	Present	Low
	<i>Hylaeus globuliferus</i>	P3	-	Widespread	Present	Moderate
	<i>Leioproctus (Glossurocolletes) bilobatus</i>	P2	-	Confirmed	Present	Low
	<i>Leioproctus contrarius</i>	P3	-	Widespread	Not Present	Low
	<i>Leioproctus douglasiellus</i>	Endangered	Critically Endangered	Widespread	Not Present	Low
	<i>Neopasiphae simplicior</i>	Endangered	Critically Endangered	Widespread	Present	Low

*Currently nominated for Critically Endangered status

2.2.1 Gastropoda

***Succinea contenta* – Confirmed SRE species**

The land snail *Succinea contenta* occurred historically on Rottnest Island, remnant bushland in the western Perth metropolitan area and on the Darling Scarp at Red Hill near John Forrest National Park (Invertebrate Solutions 2018). It has not been collected since 1969 in its original distribution and is unlikely to persist within the SCP. There are no records of the species from within or adjacent to Development Envelope. The species has a Low probability of occurring within the Development Envelope due to the historical nature of the records on the SCP and lack of available habitat and hence no significant impacts are expected to this species as a result of the proposed development.

2.2.2 Araneae: Mygalomorphae

***Synochele michaelsoni* – Likely SRE species**

The trapdoor spider *Synochele michaelsoni* occurs on the SCP from Bibra Lake to near Hillarys Boat Harbour and on the Darling Scarp from Serpentine to north of Bindoon (Invertebrate Solutions 2018). There are no records of the species from within or adjacent to Development Envelope, with the closest record being John Forrest National Park. Many of these records are historical in nature and occur within the Perth metropolitan area. It is highly likely that much of the habitat for this species within the Perth metropolitan area has been cleared for urban development and the species is unlikely to occur through much of its historical distribution in urban areas except in remnant habitats.

Burrows of *Synochele michaelsoni* occur in a variety of habitats on the Swan Coastal Plain and the Darling Scarp including Banksia woodland and heathland on sandy soils (Raven 1994) such as within areas of Development Envelope, and the adjacent Bush Forever Site 245 (Ken Hurst Park), giving the species a High probability of occurring within Development Envelope. Considering the small amount of potential habitat (14.56 ha) and with the highest quality portion of this being immediately adjacent to Bush Forever Site 245 (Ken Hurst Park) where the species is also expected to be present, the species is not anticipated to be significantly impacted by the Thornlie-Cockburn Link Proposal.

***Idiosoma sigillatum* – Priority 3**

Idiosoma sigillatum is the dominant idiopid trapdoor spider on the Swan Coastal Plain, where it occurs from Dalyellup north to at least Ledge Point (including Rottnest Island and Garden Island) with the eastern limit of its range along the sandy foothills of the Darling Escarpment, from Boyanup north to at least Gingin (Rix *et al.* 2018). Many of these records are historical in nature and occur within the Perth metropolitan area. It is highly likely that much of the habitat for this species within the Perth metropolitan area has been cleared for urban development and the species is unlikely to occur through much of its historical distribution in urban areas except in remnant habitats (e.g. Kings Park, Bold Park, and Shenton Park bushland) (Rix *et al.* 2018).

Idiosoma sigillatum was assessed as Vulnerable according to IUCN criteria (Rix *et al.* 2017). It has a known range of 7,100 km², and an area of occupancy within that range of < 3,000 km² (Rix *et al.* 2017). It is considered to be locally extinct throughout most of its range due to extensive land clearing (Rix *et al.* 2018).

Burrows of *Idiosoma sigillatum* usually occur in Banksia woodland and heathland on sandy soils (Rix *et al.* 2018) such as within areas of Development Envelope, and the adjacent Bush Forever Site 245 (Ken Hurst Park), giving the species a High probability of occurring within Development Envelope. Considering the small amount of potential habitat (14.56 ha) and with the highest quality portion of this being immediately adjacent to Bush Forever Site 245 (Ken Hurst Park) where the species is also expected to be present, the species is not anticipated to be significantly impacted by the Thornlie-Cockburn Link Proposal.

2.2.3 Insecta: Orthoptera

***Austrosaga spinifer* – Priority 2**

Very few records exist for this spiny tree cricket, but it has been recorded from Boya on the edge of the Perth Scarp some 25 km from the Thornlie-Cockburn Link Development Envelope. The species is known to hide in shrubs and sing at night (Rent 1993). The absence of other habitat data and the distance of the closest record of this species would suggest that *A. spinifer* has Moderate likelihood of being present on site, but only within the higher quality vegetation that is limited in extent. It would also be expected that if *A. spinifer* is present within the Development Envelope, then it would also be present within the adjacent Bush Forever Site 245 (Ken Hurst Park). It is therefore anticipated that no significant impacts will occur to any *A. spinifer* that may be present from the development of the Thornlie-Cockburn Link Proposal.

***Kawaniphila pachomai* – Priority 1**

The orthopteran family Tettigoniidae are commonly known as Katydid and inhabit tree and shrubs and can be found mostly in the southern half of Australia in heath or mixed woodland and often host plant species or genus specific (Rentz 1993). The orthopteran *Kawaniphila pachomai* occurs in coastal SW Western Australia with records near Vasse and within the southern Perth metropolitan region and is listed by DBCA as a Priority 1 species in Western Australia. The species has a Moderate probability of occurring within Development Envelope but only within the higher quality vegetation that is limited in extent. It would also be expected that if *K. pachomai* is present within the Development Envelope, then it would also be present within the adjacent Bush Forever Site 245 (Ken Hurst Park). It is therefore anticipated that no significant impacts will occur to any *K. pachomai* that may be present from the development of the Thornlie-Cockburn Link Proposal.

***Throscodectes xiphos* – Priority 1**

The tree cricket *Throscodectes xiphos* is known only from its type locality in the southern Perth suburb of Jandakot where it was originally collected in the axil leaf bases of grass trees (*Xanthorrhoea preisei*). The known distribution of this species is close (5 km) to the Thornlie-Cockburn Link Development Envelope, although there are no records of the species from within or adjacent to Development Envelope. The species is currently classified by DBCA as Priority 1 as it is known only from the type locality that has now been developed. It has not been recorded from within Development Envelope, although limited (14.56 ha) un-degraded native vegetation habitat does occur (VT01). Due to the close proximity, and available habitat the species has a High likelihood of being present on site, although due to the small amount of potential habitat being cleared, combined with the immediately adjacent to Bush Forever Site 245 (Ken Hurst Park) where the species is also expected to be present, the species is not anticipated to be significantly impacted by the Thornlie-Cockburn Link Proposal.

2.2.4 Insecta: Lepidoptera

***Synemon gratiosa* – Priority 4**

Graceful Sun-moths (GSM) are diurnal, and active on warm bright sunny days with low wind. GSM are generally restricted to the SCP but has also been recorded from the Geraldton sandplains and is known from 49 locations (Bishop *et al.* 2010). Extensive survey and genetic work undertaken throughout the SCP between 2010 – 2013 eventually saw their removal from the previous Wildlife Conservation Act Schedule 1 category and the EPBC fauna list, however due to their limited distribution, small populations and rarity in nature the GSM is listed on the DBCA Priority fauna listing (Priority 4).

Limited habitat for the moth is known to occur within the Thornlie-Cockburn Link Development Envelope in the form of *Lomandra hermaphrodita* (GHD 2019) however, due to the natural rarity of the species in nature and its patchy distribution the species is considered to have only a Moderate Likelihood of occurrence within the Development Envelope. Considering the small amount of potential habitat (14.56 ha) and with the highest quality portion of this being immediately adjacent to Bush Forever Site 245 (Ken Hurst Park) where the species would also be expected to be present, the species is not anticipated to be significantly impacted by the Thornlie-Cockburn Link Proposal.

2.2.5 Insecta: Hymenoptera

***Hesperocolletes douglasi* – Critically Endangered/Critically Endangered**

This enigmatic native bee was previously known only from Rottnest Island where it was presumed extinct until 2015 when an extant specimen was recorded from near Pinjar on the northern SCP during a general insect research project (Houston 2018, WA Government, 2018). Very little is known of this species and floristic associations are still being determined with the currently known list including *Philotheca spicata*, *Patersonia occidentalis*, two species of *Stylidium*, a species of *Scaevola* and species from Fabaceae and Myrtaceae and hence whilst it is difficult to completely exclude the species as being present on the site, it would be anticipated that due to the small area of un-degraded native vegetation to be cleared that the species would have a Low likelihood of occurring within the Thornlie-Cockburn Link Proposal Development Envelope. It is also likely that any potential habitat on the site that could be used by *Hesperocolletes douglasi* would also be present and in better condition in the adjacent Bush Forever Site 245 (Ken Hurst Park).

***Hylaeus globuliferus* – Priority 3**

This native bee has distribution in Western Australia from north of Eneabba, through the southern Wheatbelt and the SCP, and east along the south coast to the Fitzgerald National Park (ALA 2018). All available records from the SCP are historical in nature and its current status in the Perth metropolitan area is unknown. *Hylaeus globuliferus* is known to be associated with *Adenanthos cygnorum* and *Banksia attenuata* amongst other native plants (Houston 2018) that are both present within the site (GHD 2019). It is therefore Moderately likely to occur on the site due to the presence of its associated plants, however, due to the absence of any recent records within the Thornlie-Cockburn Link Proposal Development Envelope it is considered that the implementation of the proposal will not significantly impact upon the species.

***Leioproctus (Glossurocolletes) bilobatus* – Priority 1**

The bee *Leioproctus (Glossurocolletes) bilobatus*, is associated with Jarrah/Wandoo Forest nominally to the east of the Swan Coastal Plain (Houston 2018), and the species has a distribution from as far east as Christmas Tree Well off Brookton Highway and on the South Coast within the Stirling Ranges (Phoenix 2010). *Leioproctus (Glossurocolletes) bilobatus* has so far been collected solely from the yellow flowering pea, *Gompholobium aristatum* which does not occur within the Thornlie-Cockburn Link Proposal Development Envelope. It is therefore a Low probability that *Leioproctus (Glossurocolletes) bilobatus* is present within the Thornlie-Cockburn Link Proposal Development Envelope and therefore no significant impacts are anticipated to occur to this species.

***Leioproctus contrarius* – Priority 3**

No habitat for the native bee *Leioproctus contrarius* is present (*Scaevola sp repens* var. *repens* and *Lechenaultia* spp.) within the Thornlie-Cockburn Link Proposal Development Envelope (GHD 2019 Houston 2000). It is therefore a Low probability that *Leioproctus contrarius* is present within the Thornlie-Cockburn Link Proposal Development Envelope and therefore no significant impacts are anticipated to occur to this species.

***Leioproctus douglasiellus* – Endangered/Critically Endangered**

The native bee species *Leioproctus douglasiellus*, is known from the SCP where it has been recorded from Kenwick wetlands, Cannington and Forrestdale Lake and near Lithgow in the Blue Mountains of NSW (ALA 2019). The bee is associated with *Goodenia filiformis* and *Anthotium junctiforme* (Cardno 2005, Houston 2000, Houston 2018). These species were not recorded within the Thornlie-Cockburn Link Proposal Development Envelope (GHD 2019). It is therefore a Low probability that *Leioproctus douglasiellus* is present within the Thornlie-Cockburn Link Proposal Development Envelope and therefore no significant impacts are anticipated to occur to this species.

***Neopasiphae simplicior* – Endangered/Critically Endangered**

This native bee has distribution in Western Australia from north of Geraldton, through the coastal fringe and along the southern coast to Cape Arid National Park (ALA 2018). Most available records from the SCP are historical in nature and its current status in the Perth metropolitan area is unknown. This species along with others in the genus are known to use annual plants such as daisies (Asteraceae and Goodeniaceae, Houston 2018) that occur within the Thornlie-Cockburn Link Proposal Development Envelope (GHD 2019). Due to the absence of any recent records within the Development Envelope it is, however, despite the available habitat considered to have a Low likelihood of occurrence and it is considered that the Thornlie-Cockburn Link Proposal will not significantly impact upon the species.

3 SRE habitat preliminary impact assessment

The potential impacts to SRE and Conservation Significant invertebrate fauna within the Thornlie-Cockburn Link Proposal Development Envelope are summarised in Table 3 and Table 4. The assessment of the impact to SRE and Conservation Significant invertebrate fauna at both the local and regional (SCP) scale from each disturbance mechanism takes into account both the likelihood of the impact occurring, its duration and severity, the potential consequence to SRE and Conservation Significant invertebrate fauna and the likelihood of SRE fauna being present. Further detail on methods can be found in Appendix 1.

The only direct impact to SRE fauna is from native vegetation clearing within Development Envelope that will directly remove habitat used by SRE species (Table 3). Given the small size of intact vegetation within the Development Envelope and that the majority of vegetation is degraded or offers no habitat for SRE or Conservation significant invertebrates, this direct impact is considered to be Low and it is considered unlikely that the Proposal would result in local extinction of any SRE or Conservation significant species.

Table 3 Risk of direct impact to SRE and Conservation Significant invertebrates from the Thornlie-Cockburn Link Proposal

Direct disturbance mechanism	Likelihood of impact occurring	Potential of Impact to SRE Fauna locally	Potential of Impact to SRE Fauna Regionally (SCP)
Vegetation clearing directly removing and/or disturbing SRE habitat	High	Low	Low

The indirect impact of the clearing of native vegetation causing fragmentation of the remaining vegetation may lead to the restriction of genetic flow for SRE species that have limited dispersal capabilities. As the majority of the vegetation that is usable by SRE invertebrates for habitat that is proposed to be cleared is already on the edge of continuous vegetation tracts such as Bush Forever Site 245 (Ken Hurst Park) and Bush Forever Site 388 (Jandakot Airport), this indirect impact is Low. The incursion of weeds both during construction and following construction is an important potential indirect impact to Development Envelope as it has the potential to degrade the adjacent high quality bushland within both Bush Forever sites 245 and 388. Increased local weed incursion into native bushland can have a significant impact upon SRE and Conservation Significant invertebrate species that rely on sometimes small microhabitats within the landscape. This has the potential to cause a Moderate impact to SRE fauna and is considered to be the most significant indirect impact to SRE fauna. This impact can be managed through management and mitigation measures including general ongoing weed control.

If not managed appropriately, increasing sedimentation and alteration of surface hydrology has the potential to affect SRE fauna such as mygalomorph spiders that live in burrows at ground level. Sedimentation can be managed by appropriate stormwater runoff design and during construction via management and mitigation measures as outlined within the referral information (Aurora 2018).

Contamination of surface and groundwater during construction and operations may also impact significantly upon SRE habitat, but risks of contamination can be minimised by employing management and mitigation measures to minimise and prevent contamination. The potential for contamination during construction is limited to isolated areas of chemical storage and small quantities of hydrocarbons where machinery or generators are working. Risks will be minimised by measures included in a CEMP. The risk of contamination during operations is minimal as the passenger railway runs off overhead electrified wires rather than stored fuel on the trains themselves. The trains contain only small quantities of transmission oil with minimal risk of contamination impacts. Where management measures are implemented, the risk of hydrocarbon contamination to SRE species and habitat is anticipated to be Low, however, should a major spill occur and not adequately contained and remediated, then the impacts would be significant.

Vibration and noise from the construction and ongoing operation of the rail line is expected to be minimal, especially beyond the immediate vicinity of the rail line itself. These impacts are considered to be Low.

The majority of anticipated impacts (Table 3 and Table 4) are Low or able to be managed through standard construction management and mitigation measures.

Table 4 Risk of indirect impact to SRE and Conservation Significant invertebrates from the Thornlie-Cockburn Link Proposal

Indirect disturbance mechanism	Likelihood of impact occurring	Potential of Impact to SRE Fauna locally	Potential of Impact to SRE Fauna Regionally (SCP)
Habitat fragmentation and genetic isolation due to vegetation clearing and construction works	Low	Low	Low
Weed incursion during construction works	Moderate	Moderate	Low
Increased sedimentation during construction works.	Low	Moderate	Low
Alteration of surface hydrology during construction works	Low	Low	Low
Hydrocarbon spills during construction and/or operations	Very Low	Moderate	Low
Vibration disturbance from operational activities	Low	Low	Low
Vibration disturbance from construction activities	Low	Low	Low
Noise during construction works	Low	Low	Low
Noise during operations	Low	Low	Low

At a regional scale across the SCP the direct and indirect impacts of the Thornlie-Cockburn Link Proposal are generally considered to be Low due to the very small extent of the native vegetation usable by SRE invertebrates. It is also highly likely that any SRE or Conservation Significant invertebrates that inhabit the Development Envelope are also found in the nearly adjacent Bush Forever Sites 245 and 388 (Ken Hurst Park and Jandakot Airport). Fragmentation is substantially

mitigated as the clearing is primarily on the edge of existing habitat and not dividing any high quality habitat such as in Bush Forever Sites 245 and 388. Other anticipated impacts including altering local hydrology are considered to be insignificant in the scale of the southern SCP.

Cumulative impacts on the SCP will be Low, with the primary cumulative impact from the Thornlie-Cockburn Link Proposal being native vegetation clearing. It is anticipated that clearing of the Development Envelope will not add significantly to the cumulative impacts to SRE fauna in the local area, especially since none of the habitats identified would provide habitat isolates that would be likely to contain SRE taxa within the limited extent of Development Envelope.

4 Summary and Conclusions

The potential SRE habitats located within the Thornlie-Cockburn Link Proposal have a Low to Moderate likelihood of containing SRE or Conservation Significant invertebrate species that are restricted to the Development Envelope. No high value SRE habitat is present within the Thornlie-Cockburn Link Development Envelope, and 6.53 ha of Moderate value SRE habitat is present although some of this habitat is in a degraded condition thus reducing its habitat value. The remainder of the Development Envelope is considered to be of Low or Nil habitat value for SRE and Conservation Significant invertebrates. This assessment is based upon the absence of any dramatic habitat isolates, such as deep moist gullies or large mountains that would be likely to contain SRE taxa within the limited extent of the Thornlie-Cockburn Link Development Envelope. Furthermore, all the vegetation units are laterally continuous within the region and not limited to the Thornlie-Cockburn Link Development Envelope. The vegetation condition is largely degraded to completely degraded and offers little habitat for SRE and Conservation Significant invertebrates except for some small patches of Banksia Woodland and Melaleuca woodland/dampland, which are not considered to be significant at the regional scale of the southern SCP.

Within the proposal's Development Envelope, there are 10 SRE/Conservation Significant invertebrate species that have habitat present, and four with no habitat present based upon desktop resources only. Of the 10 species with habitat present within the Development Envelope, three species have a High likelihood of occurrence (two trapdoor spiders and a tree cricket), four have Moderate likelihood of occurrence (two tree crickets, Graceful sun-moth and a bee) and three have a Low likelihood of occurrence (three bees) within the Development Envelope.

The only direct impact to SRE fauna is from vegetation clearing within the Development Envelope that will directly remove habitat used by SRE species. Given the small size of intact vegetation within the Development Envelope and that the majority of vegetation is degraded or offers no habitat for SRE or Conservation significant invertebrates this direct impact is considered to be Low and it is considered unlikely that the Proposal would result in local extinction of any SRE or Conservation significant species.

The indirect impact of the clearing of native vegetation causing fragmentation of the remaining vegetation may lead to the restriction of genetic flow for SRE species that have limited dispersal capabilities. As the majority of the vegetation that is usable by SRE invertebrates for habitat that is proposed to be cleared is already on the edge of continuous vegetation tracts such as Bush Forever Site 245 (Ken Hurst Park) and Bush Forever Site 388 (Jandakot Airport), this indirect impact is Low. Increased local weed incursion into native bushland can have a significant impact upon SRE and Conservation Significant invertebrate species that rely on sometimes small microhabitats within the landscape. This has the potential to cause a Moderate impact to SRE fauna and is considered to be the most significant indirect impact to SRE fauna. This impact can be managed through management and mitigation measures including general ongoing weed control.

The majority of anticipated direct and indirect impacts to SRE and Conservation Significant invertebrate species from the Thornlie-Cockburn Link Proposal are Low or able to be managed through standard construction management and mitigation measures.

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Appendix 1

Likelihood of SRE invertebrate occurrence

The likelihood of SRE invertebrate species occurring in the site was assessed using a combination of regional and local botanical and landform information and database searches including:

- Analysis of published and unpublished reports concerning SRE invertebrate from the region.
- Botanical and vegetation mapping and other information available for the site.
- Results of a Protected Matters Search from the Federal Government's Department of the Environment and Energy (DEE) website.
- Records of fauna held by the WAM.

When considering the likelihood of SRE and Conservation Significant invertebrates at the local scale both the Bush Forever Site 245 (Ken Hurst Park) and Site 388 (Jandakot Airport) were specifically investigated, whilst assessments at the regional scale included the entire Swan Coastal Plain.

Based on the analysis of all available information the site was assigned a level of likelihood to support SRE invertebrates of either 'Very Low', 'Low', 'Moderate', 'High', or 'Definite'.

Table 5 SRE species likelihood of occurrence definitions

SRE Species Likelihood of occurrence	Definition
Definite	The species is confirmed to occur within the site.
High	Habitat for the species is known to occur within the site and known records of the species are within 20 km.
Moderate	Habitat for the species is known to occur within the site and known records of the species are within 50 km.
Low	The species has been recorded from within 50 km, however, no or limited habitat is present for the species within the site and/or distributional records are historical in nature.
Very low	No habitat exists for the species within the site and no records of the species are within 50 km or the distribution of the species is known well enough to exclude its presence within the site.

Short Range Endemic Status

The allocation of short range endemism status can be difficult due to the often incomplete taxonomic framework of many invertebrate groups and the often frequent need for substantial revision to enable accurate identification. Short Range Endemic status is assigned using the categories described in Table 6, based upon the available information from the WAM database and discussion with appropriate taxonomic authorities for various invertebrate groups. Insufficient

information exists for many invertebrate species due to specimens being juvenile, the wrong sex to allow identification, damaged, or inadequate taxonomic frameworks, precluding the assignment of SRE status.

Table 6 Short Range Endemic Status of Species

SRE Status	Definition
Confirmed	A confirmed SRE species. A known distribution of < 10,000 km ² (after Harvey 2002). Taxonomy of the group is well known. The group is well represented in collections, or via comprehensive sampling.
Likely	Likely to be a SRE species based upon knowledge of the family/genus, where other closely related species show evidence of short range endemism. Where habitats containing the specimens show discontinuity within the landscape.
Possible	Based upon existing knowledge of the genus / family there is a possibility that the species may have a restricted range. Where habitats containing the specimens may show discontinuity within the landscape. Potential SRE species may be assigned one of the sub categories below: <ul style="list-style-type: none"> A. Data deficient i.e. new species, lack of distribution, taxonomic or collecting knowledge, juvenile specimens, wrong sex for identification B. Habitat indicators C. Morphology indicators D. Molecular evidence E. Research and expertise of WAM staff/taxonomic specialists
Widespread	Not a SRE, a wide ranging distribution of > 10,000 km ²

Potential Impacts to SRE invertebrates

The potential impacts of development on invertebrates may be categorised as:

- Direct impacts; and
- Indirect impacts.

Direct impacts are the obvious and unavoidable destruction or degradation of habitat, generally native vegetation that occurs due to clearing and earthworks (e.g. infrastructure areas etc.).

Indirect impacts are generally gradational, and more difficult to predict and manage because they may occur at moderate to large distances from the project footprint. These impacts may be expressed some time after development has begun.

The zone of influence for indirect impacts may be considerably larger than areas of direct impact. Potential indirect impacts of development include:

- Risk of extinction from reduction and/or fragmentation in habitat;
- Dust deposition;
- Alteration of surface hydrology regimes, sedimentation, and water quality (e.g. under and proximal to roads and infrastructure);
- Surface water contamination from plant equipment and infrastructure; and

- Vibration disturbance from operational activities.

The Thornlie-Cockburn Link Proposal contained within the EIA documentation (Aurora Environmental 2018) were reviewed to assess the potential severity of impact to potential SRE and Conservation Significant invertebrate habitats. In evaluating the relevance of these factors to the Project, consideration was given to the magnitude, duration and spatial extent of the impacts, where known. This assessment has taken the approach of considering these broad categories of potential impacts and evaluating their occurrence and relative severity. The impacts were then assigned a level of either 'Low', 'Moderate', or 'High' according to their potential degree to adversely affect the EPA's objective to maintain representation, diversity, viability and ecological function at the species, population and assemblage level for SRE fauna.

Where an impact is designated as 'Low' no further consideration to this factor is required if all assumptions made throughout this report are correct.

Appendix 2

CONSERVATION CODES

For Western Australian Flora and Fauna

(last updated 3 January 2019)

Threatened, Extinct and Specially Protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened species	
<p>Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the Biodiversity Conservation Act 2016 (BC Act).</p> <p>Threatened fauna is that subset of ‘Specially Protected Fauna’ listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna.</p> <p>Threatened flora is that subset of ‘Rare Flora’ listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora.</p> <p>The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.</p>	

CR Critically endangered species

Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”.

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.

Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.

EN Endangered species

Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”.

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.

Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.

VU Vulnerable species

Threatened species considered to be “facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines”.

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.

Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

Extinct Species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for extinct fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for extinct flora.

EW Extinct in the wild

Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

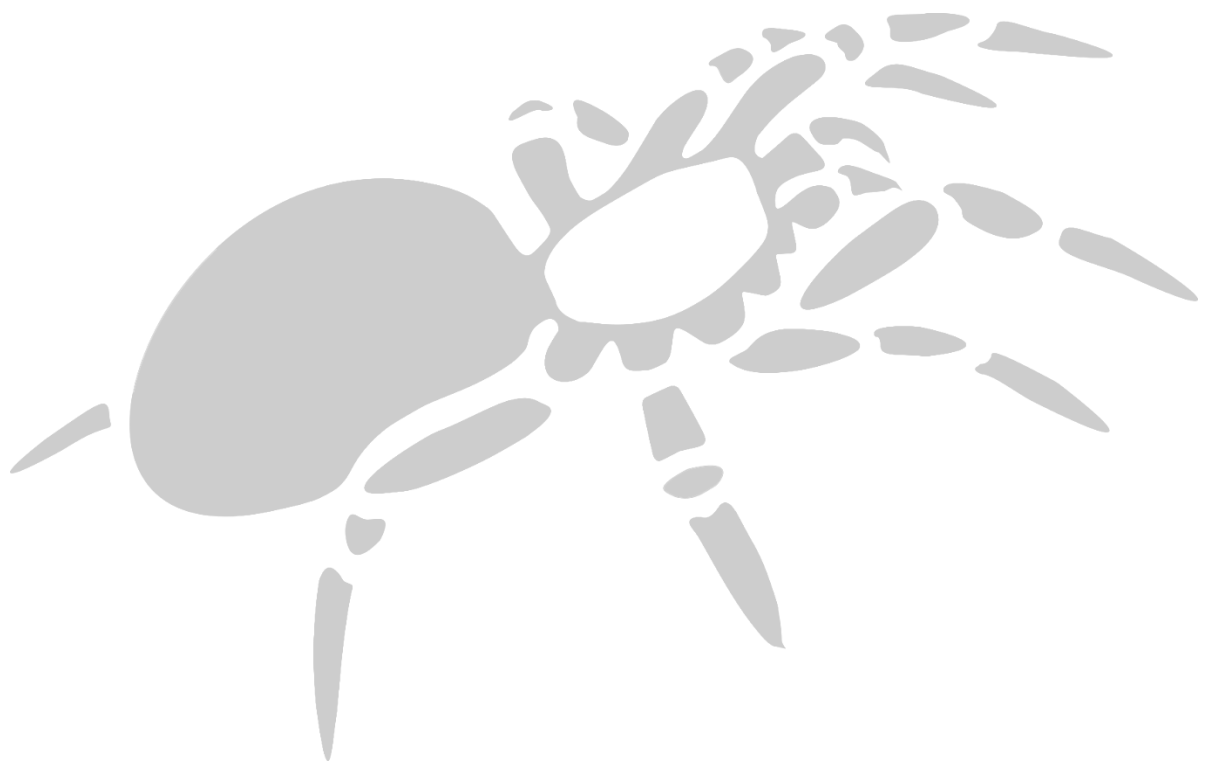
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

- (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.
- (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.
- (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

1 The definition of flora includes algae, fungi and lichens

2 Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).



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