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Lake MacLeod Solar Salt Project – Short - Range Endemic (SRE) Invertebrate Desktop Assessment

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Lake MacLeod Pty Ltd

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Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands



Lake MacLeod Solar Salt Project – Short - Range Endemic (SRE) Invertebrate Desktop Assessment

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EXECUTIVE SUMMARY

Lake MacLeod Pty Ltd (Lake MacLeod) is undertaking environmental investigations to support an application for a native vegetation clearing permit (NVCP) at its Lake MacLeod Solar Salt Project. Located on the northwest coast of Western Australia 50 km North of Carnarvon, the Lake MacLeod operation comprises of both salt and gypsum operations. Salt production commenced at Lake MacLeod in the 1960's with continuous operation to the present under several project owners.

The proposed clearing areas include borrow pits areas, one water dam, and smaller road maintenance areas. Together these areas cover an area of 397.24 ha and are hereafter referred to as the Project. The borrow pit areas will be used for a combination of expansion construction material and routine road maintenance over the life of the operation. The water dam will be used to supply additional water to the operation, supporting the increase in production.

The clearing of native vegetation and removal of surface soils within the Project have the potential to impact terrestrial short-range endemic (SRE) invertebrate fauna. Bennelongia Environmental Consultants were commissioned by Lake MacLeod to conduct a desktop review in order to increase SRE invertebrate knowledge within the Project and surrounding areas, support Environmental Approvals, and direct further studies if required.

The desktop assessment combined three sources of information: records of occurrence of species from SRE Groups provided by the Western Australia Museum (WAM); records of occurrence of species from SRE Groups stored in Bennelongia's database; and publicly available information such as published papers or scientific reports accessible via online portals (such as the Atlas of Living Australia and the Dandjoo Biodiversity Data Repository). Previous terrestrial fauna desktop study and field survey conducted within and around the Project were also reviewed. Database searches covered a rectangular area of 10,000 km² around the Project Areas (top left coordinates: 23.747°S, 113.369°E; bottom right coordinates: 24.966°S, 114.116°E). Only described species were categorised according to the WAM's SRE classification scheme, which utilised a combination of information regarding the taxon's known distribution, habitat preferences and extent, and biology.

The desktop review returned a total of 77 identifiable species (undescribed and described) in the search area, with 16 of these being collected within the Project areas, suggesting a moderately diverse community of SRE invertebrates exists at the Project. There were 37 described species of which 27 were classified as Widespread fauna and hence not of conservation concern. Two additional species were categorised as Likely Potential SREs, and eight species were categorised as Unlikely Potential SREs.

Given the relatively small area expected to be disturbed in relation to ranges of true SRE species (~ 400 ha), no significant impacts over the regional habitats are expected as a result of the Project development. However, as previous surveys have identified, the area appears to provide suitable habitats for invertebrate species belonging to SRE Groups. The presence of species known only from the search area, species and ecological communities listed as Priority 3, and representatives of known SRE genera in and around the Project highlight the potential uniqueness of the area for SRE invertebrates.

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1. INTRODUCTION

Lake MacLeod is undertaking environmental investigations to support an application for a native vegetation clearing permit (NVCP) at its Lake MacLeod Solar Salt Project. Located on the northwest coast of Western Australia 50 km North of Carnarvon (Figure 1), the Lake MacLeod operation comprises of both salt and gypsum operations. Salt production commenced at Lake MacLeod in the 1960's with continuous operation to the present under several project owners.

The proposed clearing areas include borrow pits areas, one water dam, and smaller road maintenance areas. Together these areas cover an area of 397.24 ha and are hereafter referred to as the Project (Figure 2). The borrow pit areas will be used for a combination of expansion construction material and routine road maintenance over the life of the operation. The water dam will be used to supply additional water to the operation, supporting the increase in production.

The clearing of native vegetation and removal of surface soils within the Project have the potential to impact terrestrial short-range endemic (SRE) invertebrate fauna. Bennelongia Environmental Consultants (Bennelongia) were commissioned by Lake MacLeod to conduct a desktop review in order to increase SRE invertebrate knowledge within the Project and surrounding areas, support Environmental Approvals, and direct further studies if required.

Bennelongia reviewed available information on habitat and previous biological records to appraise the likelihood of SRE species occurring within and in the vicinity of the Project. The distribution of each species returned is assessed below and occurrences of confirmed or potential SREs and conservation listed terrestrial invertebrate species (including species from non-SRE groups) in the vicinity of the Project are highlighted and discussed in detail.

2. SRE FRAMEWORK

2.1. Short-Range Endemic Invertebrates

In addition to having ranges notionally less than 10,000 km², SRE invertebrate species usually have patchy distributions within their range, slow growth, low fecundity, and poor dispersal capabilities. Guidelines for the consideration and assessment of SRE invertebrates in Western Australia are provided in the *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2016a) and *Technical Guidance: Sampling of short range endemic invertebrate fauna* (EPA 2016b). Assessment focusses on SRE Groups, which are higher-level taxonomic groupings known to contain moderate to high proportions of SRE species. SRE Groups include land snails (Gastropoda), millipedes (Diplopoda), centipedes (Chilopoda), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), spiders (Araneae; mainly trapdoor spiders, Mygalomorphae), slaters (Isopoda), and in mesic landscapes velvet worms (Onychophora) and earthworms (Oligochaeta).

Not all species in SRE Groups have restricted ranges; indeed, several species in a given SRE Group might in fact be widespread. Determining whether a species belonging to an SRE Group is in fact an SRE is therefore often difficult and assessment is on a case-by-case basis. One approach is to assume that the distribution of a species reflects the extent of its preferred or obligate habitat(s), and that species found only in restricted or patchy habitats have smaller ranges than those collected from extensive or common habitats. However, in cases where short range endemism is driven by life history characteristics, a species may be a true SRE but inhabit a widespread, apparently well-connected habitat (Harvey 2002; Harvey *et al.* 2015b; Harvey *et al.* 2011; Rix *et al.* 2015). Therefore, several factors are considered in conjunction when evaluating the SRE status of a species and the likelihood of threat to that species. These factors include the known range of the species; habitat(s) at the collection site(s) and the spatial extent and connectivity of these habitats; and the distribution patterns of phylogenetically related surrogate species (ideally members of the same genus).

In order to synthesise investigations of these factors in the context of determining SRE status, this report follows the Western Australia Museum's (WAM; Appendix 1) classification system for SREs in recognising three categories:

1. **Confirmed SRE** species have a known distribution range smaller than 10,000 km². The taxonomy is well known, and the group well represented in collections and/or via comprehensive sampling.
2. **Potential SRE** species belong to a group with gaps in our knowledge of its distribution, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is poorly understood due to insufficient sampling.
3. **Widespread (not SRE)** species have a known distribution range larger than 10,000 km². The taxonomy is well known, and the group is well represented in collections via comprehensive sampling.

In many surveys, most species fit the **Potential SRE** category, but the likelihood of species within the category actually being SREs varies substantially. In an attempt to increase the accuracy of categorisation, for the purposes of this report the Potential SRE category is further sub-divided into three categories:

- A. **Data Deficient Potential SRE**, indicating that insufficient data are available to determine SRE status. Insufficiency of data may be caused either by a lack of geographic or taxonomic information, or because the individuals sampled are not identifiable to species level (e.g. nondiagnostic sex, juvenile, damaged). This category is applied only to those species that belong to a known SRE Group, rather than being applied to any undescribed species in the records.
- B. **Unlikely Potential SRE** species status is applied in one of two cases. First, the species belongs to an SRE Group but has been collected from many sites and/or multiple habitats. Second, the species belongs to a smaller taxonomic group within the SRE Group that tends not to contain SREs.
- C. **Likely Potential SRE** species are from taxonomic groups in which SREs are likely, and when specimens have been collected from one or very few sites and/or habitats.

In the context of these categories, identifying a species as a Potential or Confirmed SRE is often only the first step in determining the impacts of mining activities on that species. Even a Confirmed SRE species may be locally widespread around a Project Area and therefore at minimal risk of disturbance if managed properly. The actual level of threat to an SRE species often depends on its distribution relative to the development footprint rather than its SRE status alone. Determining the likely level of threat to a species therefore requires further consideration of the extent of the species' preferred habitat, both within and beyond the area of activity.

2.2. Conservation Legislation

The *Biodiversity Conservation Act 2016* (BC Act) in Western Australia deals with the protection, conservation, and sustainable use of the state's biodiversity, and provides general protection for all native species. Some species are given special protection under the BC Act, primarily because they are rare, and are referred to as Threatened species. Species may also be recognised and protected as Threatened at the national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). There is a general concordance of species listed under the two acts, but the BC Act has greater invertebrate coverage. Additionally, the Department of Biodiversity, Conservation and Attractions (DBCA) lists some Priority species for conservation. Species are typically listed as Priority primarily when they are considered potentially under threat but there is insufficient evidence to support listing as Threatened. Priority species listed by DBCA are still recognised but do not receive full protection as those under either the BC Act or EPBC Act.

Information available from the BC and EPBC Acts, as well as from the DBCA's list of Priority species, is often used to complement a species' SRE assessment. Additionally, when a species listed in these sources is found in a Project Area, the potential impact of development on that species requires additional consideration of that species' taxonomy, distribution, and habitat requirements.








Legend	
	Towns
	Project location
	Freeways & Highways
	Lake Macleod
	Main Roads

Figure 1. Location of the Lake Macleod Solar Salt Project





 GDA2020 MGA Zone 49

 Author: vmarques

 Date: 12/08/2025



Legend		Project Areas	
●	Towns	■	Borrow Pit
■	Project location	■	Water Dam
▨	Lake Macleod	■	Road Maintenance
■	Tenements		

Figure 2. Project Areas and proposed activities

3. ENVIRONMENT

3.1. Regional Setting

According to the Interim Biogeographic Regionalisation of Australia (IBRA), the Project is located within the Wooramel (CAR2) Subregion of the Carnarvon Bioregion (Figure 3). The Wooramel Subregion spans the southern and central parts of the Carnarvon Basin, and it is characterised by alluvial plains associated with downstream sections and deltas of Gascoyne, Minilya and Wooramel rivers. Wooramel landforms range from aeolian red sand dunes and Permian sediments to red sand plains overlying limestone plateaux (CALM 2001). The subregion has a seasonal arid climate with annual temperatures ranging between 17.2-27.4 °C and mean annual rainfall of 220.5 mm (BOM 2025). Historically, the rainfall is primarily experienced in the winter months between May and July, with a smaller peak in February/March. This climate supports acacia shrublands (Mulga, Bowgada and *A. coriacea*) over bunch grasses on red sandy ridges and plains, mangroves confined to small areas around Lake MacLeod and near Carnarvon, and saline alluvial plains with samphire and saltbush low shrublands in near-coastal areas (CALM 2001).

3.2. Vegetation

According to pre-European vegetation mapped by Beard (1975), the Project sits within three vegetation system associations (Table 1). Veg Assoc 329 is characterised by “shrublands; dwarf waterwood (*Acacia coriacea*) shrubs on recent dunes” and extends to south and north of the Project on coast dunes (Figure 3). Veg Assoc 95 is characterised by “hummock grasslands, shrub steppe; acacia & grevillea over *Triodia basedowii*”. This vegetation type occurs in the central part of the Project and is locally widespread to the north (Figure 3). The eastern part of the Project, adjacent to the Lake MacLeod, intersects a patch of Veg Assoc 328 which comprises “succulent steppe with scrub; waterwood & *Acacia sclerosperma* over saltbush & samphire”.

Table 1. Vegetation system associations occurring at the Project (see Figure 3).

Veg Assoc	Description	Total continuous area (ha)	Area within Project (ha)
Coastal Dunes 95	Hummock grasslands, shrub steppe; acacia & grevillea over <i>Triodia basedowii</i>	90,238.87	138.83
Lake Macleod 328	Succulent steppe with scrub; waterwood & <i>Acacia sclerosperma</i> over saltbush & samphire	7,216.98	248.86
Coastal Dunes 329	Shrublands; dwarf waterwood (<i>Acacia coriacea</i>) shrubs on recent dunes	27,404.69	9.55

3.3. Land Systems and Geology

Landscape mapping suggests that five land systems intersect the Project (Table 2; Figure 4A). Cardabia Land Systems is the most widespread system in the area, and it covers the central part of the Project between the coastal dunes and Lake MacLeod. This land system is characterised by alluvial and sandy plains supporting soft spinifex grasslands. Warroora and MacLeod Land Systems are adjacent to Lake MacLeod and characterised by alluvial plains supporting halophytic shrublands. The remaining two land systems intersect small areas of the Project. Brown Land System comprise sandplains and occasional dunes supporting grassy acacia shrublands to the south; while the Coast Land System consists of coastal plains, beaches, dunes, mudflats and cliffs supporting various coastal vegetation to the west. All five systems intersecting the Project are suitability for species from SRE Groups.

Surface geology is particularly important for burrowing animals such as urodacid scorpions and mygalomorph spiders (Koch 1978; Rix *et al.* 2018) as it has the potential to influence these animals’ ability to construct their respective burrows (Koch 1978; Shorthouse and Marples 1980). Scarce geological units with patchy distributions are possibly the most likely geologies to delimit species distributions based on burrow requirements. Likewise, land snails are usually most common in geologies

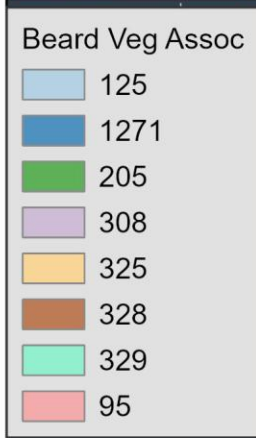
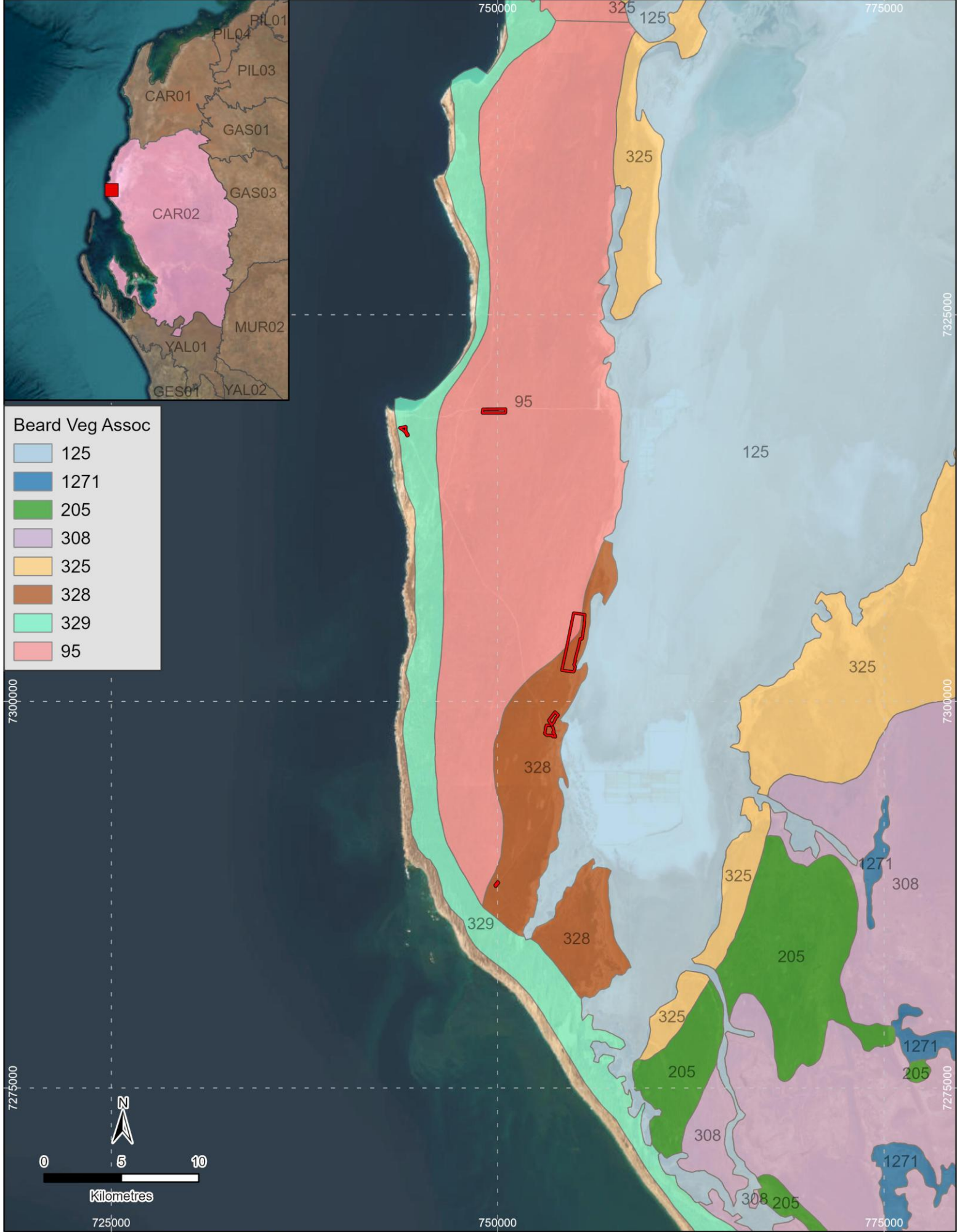


Figure 3. IBRA subregion and vegetation system associations around the Project

containing calcite, which is generally common towards the coastline, and their distribution might be limited by local landscape features. Regolith in the Project area is dominated by exposed rock of saprolite and saprock, as well as mainly eolian sandplain, including some residual deposits (Figure 4B). These geologies are abundant throughout the area and are not restricted to the Project. The northern part of the Project however intersects a relatively small calcrete deposit, which has a patchy distribution around the Project (Figure 4B).

Table 2. Soil landscape systems within the Project (see Figure 4).

Soil Landscape Systems	Description	Land Type	Total continuous area (ha)	Area within Project (ha)
Cardabia Land System	Undulating sandy plains with linear dunes, minor limestone plains and low rises, supporting mainly soft spinifex hummock grasslands with scattered acacias and other shrubs.	Alluvial and sandy plains; Soft spinifex grasslands	55,243.92	186.01
Brown Land System	Sandy plains with sparse longitudinal dunes, supporting tall acacia shrublands.	Sandplains and occasional dunes; Grassy acacia shrublands	3,461.11	2.34
Warroora Land System	Flat to gently sloping saline alluvial plains, with minor areas of sand and limestone, supporting tall acacia shrublands and low shrublands of saltbush, bluebush and samphire.	Alluvial plains; Halophytic shrublands	2,526.64	190.61
Coast Land System	Large coastal dunes (some unvegetated) with narrow swales, limestone plains, wave-cut platforms and beaches, supporting diverse tall and low shrublands.	Coastal plains, beaches, dunes, mudflats and cliffs; Various coastal vegetation	1,340.53	7.21
MacLeod Land System	Broad saline plains, with sandy banks and low rises above saline slopes and bare mudflats; bare surfaces and low shrublands of samphire and saltbush.	Alluvial plains; Halophytic shrublands	9,302.21	11.06

4. METHODS

The desktop assessment combined three sources of information: records of occurrence of species from SRE Groups provided by the Western Australia Museum (WAM); records of occurrence of species from SRE Groups stored in Bennelongia’s database; and publicly available information such as published papers or scientific reports accessible via online portals (such as the Atlas of Living Australia and the Dandjoo Biodiversity Data Repository). A previous terrestrial fauna desktop study and a field survey conducted within and around the Project were also reviewed (Outback Ecology 2009, 2011).

Database searches covered a rectangular area of 10,000 km² around the Project Areas (top left coordinates: 23.747°S, 113.369°E; bottom right coordinates: 24.966°S, 114.116°E). The desktop search does not have the standard square shape of 100 x 100 km given the coastal location of the Lake MacLeod operation and because similar habitat is more likely to occur to the north and south along the coastline than further inland in an easterly direction. Database searches were combined and filtered so that only species belonging to SRE Groups were retained. Since taxonomic uncertainty is considered a limitation for range assessments, undescribed species have not been assessed in detail. As a result, only described species were categorised according to the WAM’s SRE classification scheme (Section 2.1). The SRE categorisation utilised a combination of information regarding the taxon’s known distribution, habitat preferences and extent, and biology. In cases where a record was not classified to the species level, it was not counted as a unique species unless it was the only member of its group among the results (i.e. the only member of a genus, order, family, etc.). Records were also mapped and ArcGIS Pro v2.9.5 was used for all spatial data analyses.

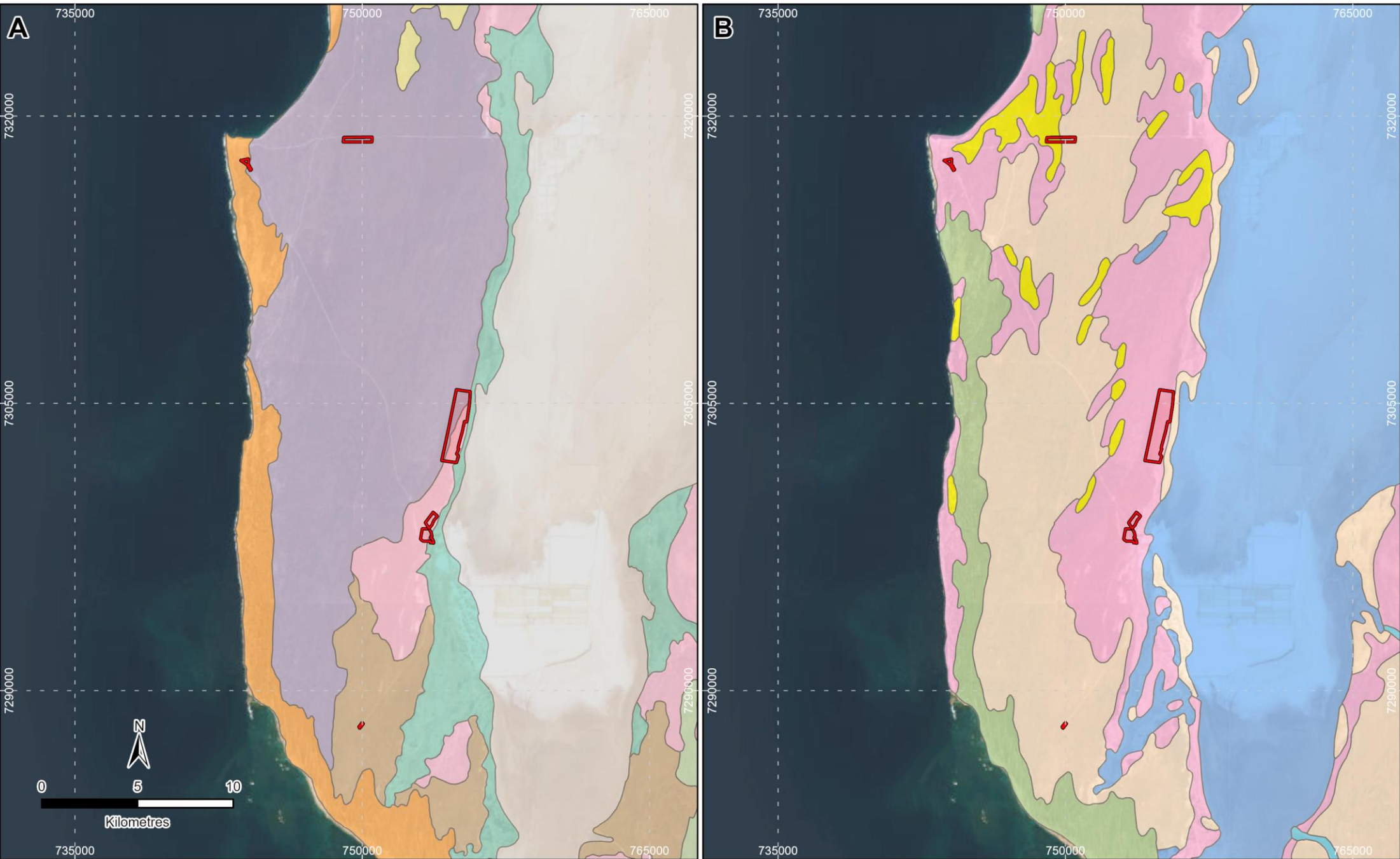


Figure 4. Soil-landscape systems (A) and regolith (B) occurring around the Project

5. RESULTS AND DISCUSSION

5.1. Listed Terrestrial Invertebrate Species, TECs and PECs

The spider species *Idiosoma incomptum*, also known as the Carnarvon shield-backed trapdoor spider, is part of the *nigrum*-group which includes three threatened species that are listed as endangered under the BC Act 2016, and this species is listed as Priority 3 by the Department of Biodiversity, Conservation and Attractions (DBCA). *Idiosoma incomptum* is considered a poorly-known species, has been recorded from several locations, and does not appear to be under imminent threat. The known extent of occurrence of *Idiosoma incomptum* is nearly 6,500 km², but the paucity of records might indicate the species is likely to have a wider distribution in the Midwest (Rix *et al.* 2018) and certainly has a range that extends well beyond the Project area.

In addition, two Priority 3 (iii) ecological communities associated with local land systems occur within the search area. The search area intersects the western end the Barrabiddy Land System community, which is approximately 65 km northeast of the Project Areas. This community is defined as "Flood plains and broad drainage zones with shallow channelling, supporting tall acacia shrublands with some saltbush and tussock grasses. Bluebush/salt bush shrublands largely lost". The Lyell Land System community, however, is located approximately 15 km southeast of the Project, on the eastern side of the Lake MacLeod. This community is defined as "Sandplains with reticulate dunes and saline interdunal plains supporting tall and low acacia shrublands and saltbush".

5.2. SRE Group Taxa in the Search Area

The desktop assessment returned at least 77 species belonging to SRE Groups previously collected from within the search area (Table 3; Figure 5). These include trapdoor spiders (34 species), snails (17 species), scorpions (12 species), pseudoscorpions (4 species), centipedes (4 species), millipedes (3 species), and terrestrial slaters (3 species).

Of the 37 described species, 27 species are categorised here as Widespread, while 10 species are currently considered Potential SREs. These include eight Unlikely Potential SRE species and two Likely Potential SRE species. Note in this context that the distribution of the remaining taxa was not assessed further due to substantial taxonomy uncertainty (e.g. unclear species status and unresolved taxonomy). Of the 77 taxa returned in total, 16 species have been found within the Project and further discussion on these species is provided below. In addition, 26 taxa were excluded from the species count because they are unspecific and likely belong to species found in the search area (e.g. Anamidae sp. might represent one of the 10 species within the family; *Gastrocopta cf. margaretae* is likely to be *Gastrocopta margaretae*). All taxa of SRE Groups returned and the closest record in relation to the Project are shown in Table 3.

Land Snails (Gastropoda)

Seventeen species of land snails were recovered from the search area (Table 3). These include species of genera *Bothriembryon* and *Rhagada*, both known to have many endemic species with small ranges (Johnson *et al.* 2004; Johnson *et al.* 2012; Johnson *et al.* 2016; Whisson 2019). Of the 14 described species, ten are considered Widespread based on their known distributions, while the remaining four species are considered Unlikely Potential SREs given they seem to have been found in more than four habitat types. The only Potential SRE species found within the Project is *Rhagada torulus*, which is locally widespread to the north toward Cape Range, with records not only from Bernier and Dorre Islands, but also from the Denham Peninsula (Atlas of Living Australia). Within the Project, a total of eight species of land snails have been recorded (Table 3).

Table 3. SRE Group taxa found within the desktop search area.

Grey shading denotes taxa that might represent other species found in the area. Orange shading denotes species historically collected from within the Project. Blue shading denotes species listed as priority.

Higher Level ID	Lowest Identification	Closest record to Project (km)	SRE Status
Land snails			
Planorbidae	<i>Leichhardtia</i> sp.	56.66	
Stylommatophora			
Bothriembryontidae	<i>Bothriembryon</i> sp.	5.30	
	<i>Bothriembryon (Bothriembryon) costulata</i>	2.60	Widespread
	<i>Bothriembryon (Bothriembryon) onslowi</i>	0.00	Widespread
Camaenidae	Camaenidae sp.	43.36	
	<i>Plectorhagada carcharias</i>	0.00	Widespread
	<i>Plectorhagada plectilis</i>	1.26	Widespread
	<i>Plectorhagada scolythra</i>	8.65	Unlikely Potential SRE
	<i>Quistrachia</i> sp.	46.23	
	<i>Quistrachia warroorana</i>	20.05	Unlikely Potential SRE
	<i>Rhagada</i> sp.	3.93	
	<i>Rhagada cf. torulus</i>	0.60	
	<i>Rhagada torulus</i>	0.00	Unlikely Potential SRE
	<i>Rhagada torulus/globosa?</i>	24.37	
	<i>Strepsitaurus cardabius</i>	45.27	Unlikely Potential SRE
Gastrocoptidae	<i>Gastrocopta cf. margaretae</i>	0.03	
	<i>Gastrocopta margaretae</i>	0.00	Widespread
	<i>Gastrocopta cf. mussoni</i>	0.00	Widespread
Punctidae	Punctidae sp.	5.66	
Pupillidae	<i>Pupoides</i> sp.	5.66	
	<i>Pupoides adelaidae</i>	0.00	Widespread
	<i>Pupoides cf. adelaidae</i>	0.00	
	<i>Pupoides cf. beltianus</i>	0.00	Widespread
	<i>Pupoides contrarius</i>	2.55	Widespread
	<i>Pupoides cf. myoporinae</i>	0.00	
	<i>Pupoides myoporinae</i>	0.00	Widespread
Succineidae	Succineidae sp.	46.62	
	<i>Succinea</i> sp.	5.13	
Scorpions			
Buthidae	Buthidae sp.	0.00	
	<i>Hemilychas alexandrinus</i>	46.76	Widespread
	<i>Isometroides</i> sp.	0.00	
	<i>Isometroides</i> `midwest`	0.00	
	<i>Isometroides</i> `vescus spp. group`	0.00	
	<i>Isometroides</i> `vescus`	46.94	
	<i>Lychas</i> sp.	0.00	
	<i>Lychas</i> `eddiei`	0.00	
	<i>Lychas</i> `macleod 1`	1.41	
	<i>Lychas</i> `prendinii`	15.78	
	<i>Lychas</i> `SCO039` (annulatus complex)	76.70	
	<i>Lychas</i> `splendens`	5.14	
Urodacidae	<i>Urodacus</i> sp.	44.51	
	<i>Urodacus</i> `armatus`	25.67	
	<i>Urodacus hartmeyeri</i>	0.00	Widespread
	<i>Urodacus hoplurus</i>	20.06	Widespread
Pseudoscorpions			
Garypidae	<i>Synsphyronus callus</i>	5.30	Widespread
Olpiidae	Olpiidae sp.	80.87	
	<i>Austrohorus</i> `BPS446`	77.93	
	<i>Beierolpium</i> sp.	77.93	
	<i>Beierolpium</i> 8/4 `BPS441`	76.25	
	<i>Indolpium</i> `BPS445`	76.25	
Spiders			
Actinopodidae	<i>Missulena</i> sp.	0.00	
	<i>Missulena</i> `MYG048`	0.16	
	<i>Missulena</i> `MYG049`	20.04	

Higher Level ID	Lowest Identification	Closest record to Project (km)	SRE Status
	<i>Missulena davidi</i>	46.23	Widespread
	<i>Missulena hoggi</i>	46.94	Widespread
	<i>Missulena mainae</i>	3.35	Unlikely Potential SRE
	<i>Missulena occatoria</i>	46.06	Widespread
	<i>Missulena terra</i>	3.74	Unlikely Potential SRE
Anamidae	Anamidae sp.	16.94	
	`MYGAAB` `MYG482`	20.04	
	<i>Aname</i> sp.	0.00	
	<i>Aname</i> `BMYG203`	61.03	
	<i>Aname</i> `mainae`	45.49	
	<i>Aname</i> `MYG437`	78.90	
	<i>Aname</i> `MYG566`	44.74	
	<i>Aname</i> `MYG739`	16.93	
	<i>Hesperonatalius langlandsi</i>	6.45	Likely Potential SRE
	<i>Hesperonatalius maxwelli</i>	6.42	Likely Potential SRE
	<i>Kwonkan</i> sp.	2.50	
	<i>Kwonkan</i> `BMYG204`	77.93	
	<i>Proshermacha</i> `tepperi`	46.23	
Barychelidae	<i>Aureocrypta lugubris</i>	20.02	Widespread
	<i>Idiommatata</i> `MYG778`	46.27	
Euagridae	<i>Cethegus</i> sp.	2.55	
Halonoproctidae	<i>Conothele</i> `MYG563`	16.95	
	<i>Conothele</i> `MYG580`	3.32	
	<i>Conothele</i> `MYG581`	3.69	
Idiopidae	<i>Bungulla bertmaini</i>	3.74	Widespread
	<i>Bungulla quobba</i>	0.00	Unlikely Potential SRE
	<i>Euoplos</i> `MYG078`	20.04	
	<i>Euoplos</i> `MYG874`	15.78	
	<i>Gaius tealei</i>	79.40	Widespread
	<i>Gaius villosus</i>	23.83	Widespread
	<i>Idiosoma</i> sp.	44.51	
	<i>Idiosoma</i> `MYG129`	0.00	
	<i>Idiosoma incomptum</i>	15.78	Unlikely Potential SRE
	<i>Eucyrtops</i> sp.	43.87	
Theraphosidae	`Selenotholus?` `sp.? (fragments)`	38.52	
	<i>Selenocosmia</i> `wacarina`	46.94	
Slaters			
Isopoda	<i>Isopoda</i> sp.	44.29	
Armadillidae	<i>Buddelundia</i> sp.	79.40	
	<i>Buddelundia</i> `BIS483`	80.23	
	<i>Buddelundia bipartita</i>	0.00	Widespread
Paraplatyarthridae	<i>Paraplatyarthrus</i> `BIS485`	76.25	
Centipedes			
Scolopendromorpha			
Scolopendridae	<i>Cormocephalus strigosus</i>	23.83	Widespread
	<i>Ethmostigmus curtipes</i>	0.00	Widespread
	<i>Scolopendra</i> sp.	80.87	
	<i>Scolopendra morsitans</i>	52.14	Widespread
Scutigermorpha			
Scutigeridae	<i>Thereuopoda</i> sp.	5.14	
Millipedes			
Polydesmida			
Paradoxosomatidae	<i>Antichiropus</i> `DIP165, WSI`	44.73	
	<i>Oxidus gracilis</i>	46.23	Widespread
Polyxenida	<i>Polyxenida</i> sp.	0.00	
Polyxenidae	<i>Unixenus mjoebergi</i>	3.74	Widespread

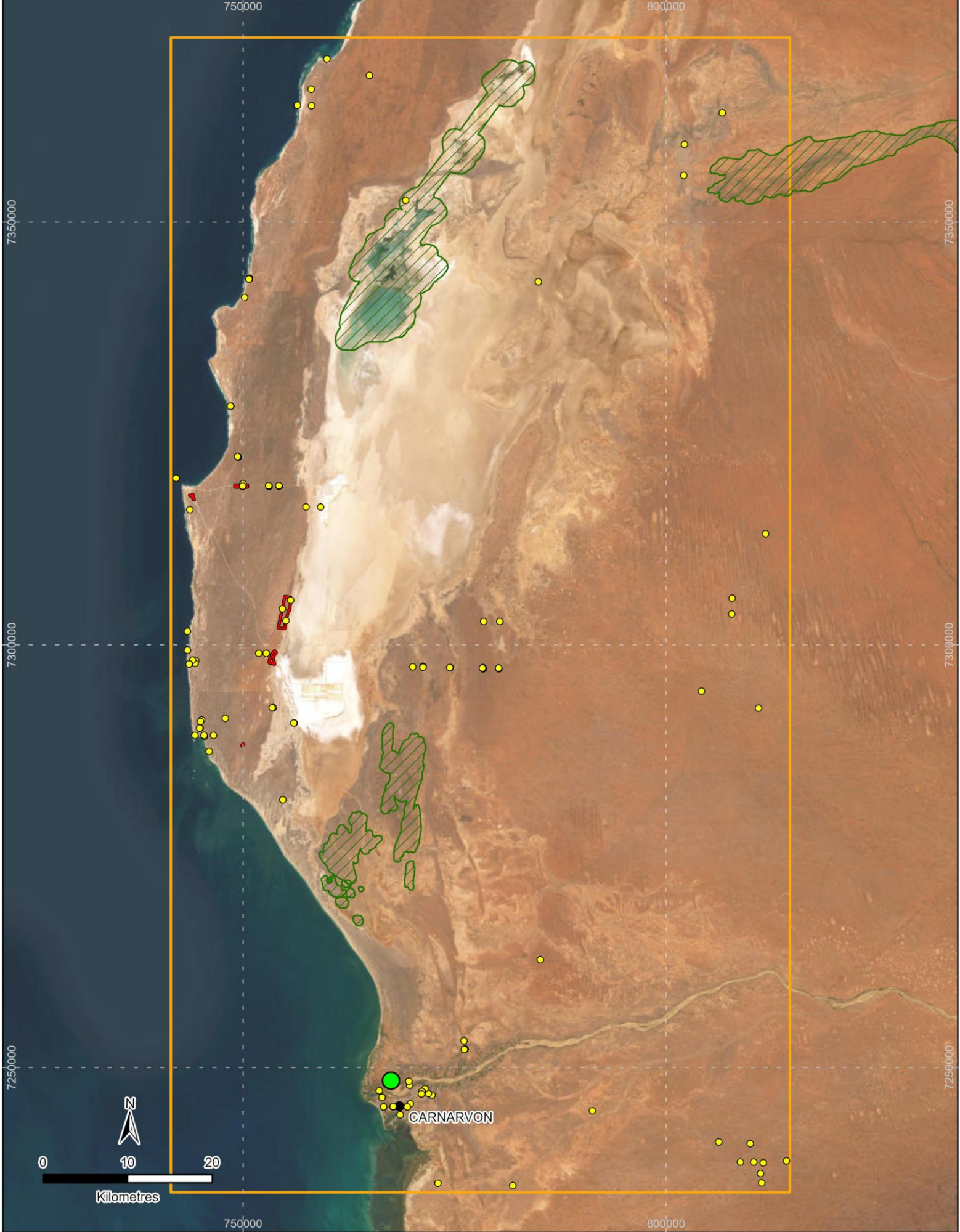


Figure 5. Locations of SRE Group records in the desktop search area

Pseudoscorpions (Pseudoscorpiones)

Epigeal pseudoscorpion species can have widespread distributions (Harvey 2002) but there is increasing molecular evidence for small species ranges in the families Chthoniidae (genera *Lagynochthonius* and *Tyrannochthonius*), Garypidae (genus *Synsphyronus*) and the Olpiidae (genus *Austrohorus*). Notably, some species of *Synsphyronus* are restricted to specialist habitats including granite outcrops and have limited distributions (Harvey 2010, 2012; Harvey 2018; Harvey *et al.* 2015a). Phoresy (dispersal by means of attachment to a host organism) has been documented for many families of pseudoscorpions (Jhasser Martínez *et al.* 2018; Lira and Tizo-Pedroso 2017; Muchmore 1972), which might allow movement outside of restricted habitats. However, pseudoscorpion taxonomy is poorly resolved, largely due to high diversity, and thus accurate range determination can be difficult.

The desktop search returned at least 4 species of pseudoscorpions as occurring in the search area, and none within the Project (Table 3). The only described species, *Synsphyronus callus*, is considered to be Widespread in Western Australia. No pseudoscorpions have been found within the Project to date, although habitat mapping suggests that they will occur.

Scorpions (Scorpiones)

The desktop search detected at least 12 species of scorpion from two families in the search area (Table 3). Of these, four species have been recorded within the Project, including the burrowing species *Urodacus hartmeyer*. Although some species of *Urodacus* are known to have restricted distributions, this species has been recorded along the Western Australian coast from Geraldton in the South to Cape Range in the North (ALA). As a result, *Urodacus hartmeyer* is considered Widespread, along with two other described species of scorpion found in the search area. A total of four species of scorpions (*U. hartmeyer*, and three undescribed species) have been found within the Project (Table 3).

Mygalomorph (trapdoor) spiders (Mygalomorphae)

Mygalomorph (trapdoor) spiders is arguably the most diverse group of SRE invertebrates, with at least 35 species of seven families occurring in the search area around the Project. Of the 13 described species, seven species are known to be Widespread, four are Unlikely Potential SREs, and two are Likely Potential SRE (Table 3).

Unlikely Potential SREs include species from genera that only have a few potential SRE species (e.g. genus *Missulena*: species *Missulena mainae* and *Missulena terra*), species recorded from locally widespread habitat (*Bungulla quobba*; found in the Project), and species collected from different habitats (*Idiosoma incomptum*; Priority 3 species discussed above).

The two Likely Potential SRE mygalomorph spiders are the anamids *Hesperonatalius langlandsi* and *Hesperonatalius maxwelli*, previously reported as *Aname* 'MYG215' and *A.* 'MYG214' (Outback Ecology 2011). These are the only described species from the *Hesperonatalius* (Castalanelli *et al.* 2017) and are known from only one and two locations, respectively. Both species have been collected from samphire flats at the edge of Lake MacLeod or in white coastal dunes nearby.

The species *Bungulla quobba* and *Idiosoma* 'MYG129' are the only species found in the Project; but the presence of high-level identifications of *Missulena* and *Aname* suggests a higher diversity is likely in and around the Project (Table 3).

Terrestrial slaters (Isopoda)

In Australia, the order Isopoda contains a largely undescribed and diverse group of terrestrial epigeal crustaceans (suborder Oniscidae) that, due to poor dispersal capabilities and specific habitat preferences, are often SREs (Judd 2004; Judd and Horwitz 2003; Judd and Tati 2011). The desktop search recorded three species of slater in the search area (Table 3). Previously identified as *Buddelundia* sp. 24, *Buddelundia bipartite* is the only described species in the search area, and although it has been found in the Project, it is considered a Widespread species given its wide distribution (ALA).

Centipedes (Chilopoda)

Four morphospecies of centipede were recovered in the search area (Table 3). The only species occurring in the Project is *Ethmostigmus curtipes* which, along with two other described species, has a wide distribution and it is categorised as Widespread. We note in this context though that there is increasing molecular evidence for cryptic speciation in many of the presently recognised morphospecies of centipedes.

Millipedes (Diplopoda)

At least three species of millipedes have been collected in the desktop search area (Table 3) and two of these are Widespread described species, including the introduced *Oxidus gracilis*. One species belongs to the genus *Antichiropus*; a genus which predominantly comprises Confirmed SRE species and is one of the SRE “flagship” groups. However, the closest record of *Antichiropus* ‘DIP165, WSI’ has been collected approximately 45 km south of the Project near Carnarvon. The only species of millipede found in the Project is the high-level identification *Polyxenida* sp. and these are widespread millipedes.

5.3. Habitat Assessment

Habitats which typically support SRE invertebrates are relictual mesic environments or those that are isolated within the landscape, such as creek lines, drainages or rocky outcrops. Vegetation, landscape and geology mapping (see section 3) indicate all units found within the Project extend well beyond its boundaries, suggesting that habitats that might be deemed prospective for SREs are likely to be locally widespread. Nevertheless, surficial calcrete deposits in and around the northern end of the Project are more likely to harbour suitable habitat for SREs due to a local patchy distribution (Figure 4B). This seems to align with previous SRE investigations conducted by Outback Ecology (2011). Of the 11 broad fauna habitats near the current Project, four were considered moderately isolated and these are: salt lake, saltland scrub, low coastal shrubland/heath and calcrete ledge. Of these, only a calcrete ledge was categorised as a moderately sheltered habitat with moderate potential to support SRE species (Outback Ecology 2011).

6. SUMMARY AND CONCLUSION

The desktop assessment suggests a moderately diverse community of SRE invertebrates exists in the Project area. A total of 77 identifiable species were recovered in the search area around the Project, with 16 of these being collected within the Project areas. Although no Confirmed SRE species were recovered, of the 37 described species, 27 species are considered Widespread, two species were categorised as Likely Potential SREs, and eight species were categorised as Unlikely Potential SREs.

Given the relatively small area expected to be disturbed in relation to ranges of true SRE species (~ 400 ha), no significant impacts over the regional habitats are expected as a result of the Project development. However, as previous surveys have identified, the area provides suitable habitats for invertebrate species belonging to SRE Groups, with some areas being considered moderately isolated with moderate potential to support SRE species. The presence of species known only from the search area, species and ecological communities listed as Priority 3, and representatives of known SRE genera in and around the Project highlight the potential uniqueness of the area for SRE invertebrates.

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8. APPENDICES

APPENDIX 1 – WESTERN AUSTRALIAN MUSEUM SRE CLASSIFICATION SYSTEM

Confirmed SREs are species with a well understood taxonomy, those that are well represented in collections, or species that come from areas that have been well sampled and have a known distribution range <10,000 km².

Potential SREs are species that belong to genus or other taxonomic grouping for which there are gaps in our knowledge, either because the taxon is not well represented in collections, taxonomic knowledge is incomplete, or species distributions are imperfectly understood because sampling has been patchy.

Widespread (not SRE) species have a known distribution range >10,000 km². The taxonomy of the species is well understood and it is well represented in collections.

The WAM uses five further sub-categories if a species is determined to be a “Potential SRE”. These relate to the reasons for treating a species as a Potential SRE:

1. **Data deficient:** This is a precautionary sub-category because there are insufficient data available to determine SRE status in a species belonging to SRE Groups, either because there is a lack of geographic and taxonomic information, or because the individuals sampled cannot be identified to species level (e.g. wrong sex, juvenile, damaged);
2. **Habitat Indicators:** Here and in the following sub-categories, there is some evidence available from which the likely SRE status of the species may be inferred. For example, habitat indicators may suggest a species is likely to be an SRE because of its association with a particular habitat.
3. **Morphological Indicators:** The likely SRE status of a species may be determined through its morphological characteristics, e.g. a flattened body for rock-dwelling species.
4. **Molecular Evidence:** DNA sequence data reveal patterns congruent with the species being an SRE. This category is also used for species-complexes with a high degree of morphologically cryptic species, e.g. centipedes.
5. **Research & Expertise:** Available research data and/or WAM expertise may provide the basis for considering a species likely to be an SRE.