Metals X Limited

Wingellina Nickel Project

Subterranean Fauna Assessment

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Subterranean Fauna Assessment

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Executive Summary

Metals X Limited (Metals X) commissioned Outback Ecology to undertake a subterranean fauna assessment for the proposed Wingellina Nickel Project (the Project). The Project is located approximately 1,400 kilometres (km) north-east of Perth and 8 km south-west of the Surveyor General's Corner, which marks the intersection of the Northern Territory, South Australian and Western Australian borders.

The overarching objective of the subterranean fauna assessment was to gather sufficient information to assess if the extraction of groundwater and/or removal of potential habitat during the development and operation of the Project will place subterranean fauna within the area at risk. The specific objectives of the assessment were to:

- identify the significance of the proposed study areas as subterranean fauna habitat;
- assess the conservation significance of any subterranean fauna, and
- provide a risk assessment.

The assessment involved a comprehensive desktop study, searches of relevant databases, and subterranean fauna surveys of four Project areas:

- Wingellina Pit – stygofauna pilot survey;
- Wingellina TSF – stygofauna and troglofauna pilot surveys;
- Pipalyatjara calcrete (South Australia) – stygofauna pilot survey and troglofauna baseline survey; and
- Area 3, the Wedge and Yapan (South Australia) – stygofauna and troglofauna baseline surveys.

The surveys within the South Australian Project area were undertaken to enhance the regional context for the assessment.

A total of 132 stygofauna net samples and 91 troglofauna trap samples were taken between April 2008 and March 2011. This yielded 5,970 invertebrates, of which 5,959 (99.8 %) were considered to be surface aquatic or terrestrial invertebrates (non-stygofauna and non-troglofauna). These invertebrates were well-distributed across the survey holes, with the highest diversity and abundance occurring at the Pipalyatjara calcrete deposit.

Only two obligate subterranean species were collected during the assessment:

- one stygofauna species, *Dussartcyclops* sp. TK1 (Copepoda), was collected from a single hole in the Pipalyatjara calcrete deposit; and
- one troglofauna species, *Tyrannochthonius* sp. OES6 (Pseudoscorpionida), was collected in a net scrape sample, also from Pipalyatjara calcrete deposit.

Both of the obligate subterranean species recorded appear to be uncommon, with very few specimens collected. As these species were only recorded in the calcrete habitat in South Australia, no further assessment is currently required from a legislative perspective. However, being new to science both species can be considered of scientific importance.

No obligate subterranean fauna were recorded from the Wingellina Pit or the Wingellina TSF. Consequently, the proposed mining activities at Wingellina pose no risk to subterranean fauna. There were also no obligate subterranean fauna recorded from Area 3, the Wedge and Yapan Project areas in South Australia.

The subterranean fauna of the central arid zone is poorly known compared to other regions such as the Pilbara and the Yilgarn. The survey results presented in this report represent the most comprehensive assessment of subterranean fauna in the area undertaken to date. The findings have demonstrated a very low diversity and abundance of subterranean fauna species associated with habitats in the Wingellina region.

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1. INTRODUCTION

1.1. Project Background

Metals X Limited (Metals X) commissioned Outback Ecology to undertake a subterranean fauna (stygofauna and troglofauna) assessment of the proposed Wingellina Nickel Project (the Project), located within Ngaanyatjarra lands on Aboriginal Reserve 17614. The Project is situated along the Gunbarrel Highway approximately 1,400 kilometres (km) north-east of Perth and 8 km south-west of the Surveyor General's Corner that marks the intersection of the Northern Territory, South Australian and Western Australian borders (**Figure 1**). The Wingellina nickel deposit has formed within the North Hinckley Range, adjacent to the Wingellina Hills that occur to the north of the Musgrave Ranges.

Extraction of the Wingellina deposit will involve open pit mining of the nickeliferous limonite ore, with on-site processing to produce an intermediate mixed nickel-cobalt hydroxide product. Production of 40,000 tonnes (t) of nickel and 3,000 t of cobalt metal in concentrate per annum is expected for about 40 years. Approximately 11 gigalitres (GL) per year of water will be required for the Project's construction and mining operations. Potential water supply options for the Project are currently being investigated.

The Project includes two components (**Table 1**) that have the potential to impact on subterranean fauna or habitat:

- *Wingellina Pit*. Centrally located within exploration tenement E69/535 in Western Australia (**Figure 1**). The proposed activities at Wingellina Pit will involve open pit mining of ore and waste, including pit dewatering, from up to 20 proposed pits situated over a 10 km strike length.
- *Wingellina Tailings Storage Facility (TSF)*. Situated approximately 500 m to the north-east of the Wingellina Pit, the proposed TSF will have a final footprint of approximately 830 ha.

The Project includes additional components in South Australia (**Table 1**). Although legislative approval specific to subterranean fauna is not required for these components, they have been included in this assessment to provide regional context:

- *Pipalyatjara Calcrete Deposit*. Located 30 km east of Wingellina Pit on tenement E3555 in South Australia. The proposed activities at Pipalyatjara will involve extractive quarrying above the groundwater table of a calcrete deposit to provide a local source of limestone to act as neutralising agent required for nickel processing.
- *Area 3, the Wedge and Yapan*. Potential nickel resource areas to the north-east of Wingellina (in South Australia) are currently being explored.

A potential groundwater source has been identified in the Officer Basin, nearly 100 km south-west of Wingellina on tenement L69/12 in Western Australia. However, the feasibility of this water resource is still being investigated, and the subterranean fauna has not yet been assessed.

Table 1: Project components and the subterranean fauna assessment requirements

Area	Tenement	State	Activity	Potential Impact on Subterranean Fauna
Wingellina Pit	E69/535	WA	Open pit nickel mining	physical removal of habitat, groundwater drawdown
Wingellina TSF	E69/535	WA	Tailings storage facility	surface disturbance, alteration of resource flow, contamination
Pipalyatjara Calcrete	E3555	SA	Suitable source of limestone	physical removal of habitat (above groundwater level)
Area 3, The Wedge & Yapan	E3555	SA	Additional resource exploration	n/a
Officer Basin	*L69/12*	*WA*	*Potential water supply borefield (under consideration)*	*(groundwater drawdown)*

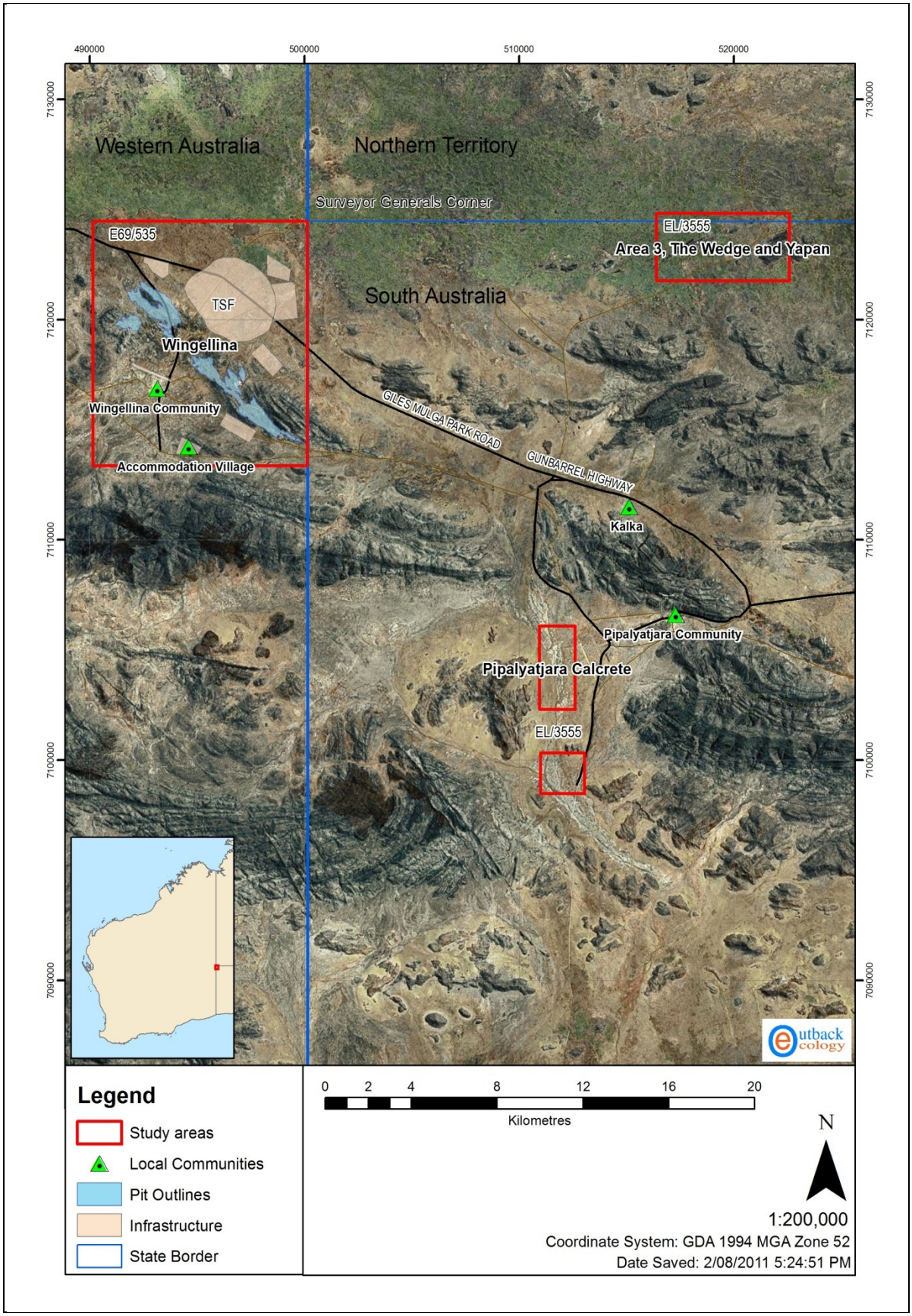

Figure 1: Location of the proposed Wingellina Nickel Project components

1.2. Objectives and Scope

The overarching objective of this assessment is to assess the subterranean fauna values of the region, to determine if the removal of potential habitat and groundwater drawdown will place any stygofauna or troglofauna within the Wingellina mine site area at risk. The report is limited to the Wingellina Pit, Wingellina TSF, Pipalyatjara Calcrete deposit, and Area 3, the Wedge and Yapan areas. Specific objectives of the assessment were to:

- evaluate the potential of habitat within the proposed mining areas to support subterranean fauna;
- establish the conservation significance of any subterranean fauna assemblage or species; and
- identify any potential risks to obligate subterranean fauna from the proposed mining activities.

The scope of this assessment encompassed a literature review, database search and subterranean fauna surveys of of four Project areas:

- Wingellina Pit – Stygofauna Pilot Survey;
- Wingellina TSF – Stygofauna and Troglofauna Pilot Surveys;
- Pipalyatjara calcrete – Stygofauna Pilot Survey and Troglofauna Baseline Survey; and
- Area 3, the Wedge and Yapan – Stygofauna and Troglofauna Baseline Surveys.

2. EXISTING ENVIRONMENT

2.1. Biogeographic Region

As defined by the Interim Biogeographic Regionalisation for Australia (IBRA), the Project area is located in the Mann-Musgrave Block sub-region of the Central Ranges IBRA Bioregion (CR1). This region is dominated by volcanic and quartzite ranges and derived soil plains, interspersed with red Quaternary sand plains (Graham and Cowan 2001). The ranges support mixed *Acacia* scrub or *Callitris* woodlands over hummock grasses, and are often fringed by low open Ironwood and Corkwood woodlands, while the sand plains support low open woodlands of Desert Oak or Mulga (Graham and Cowan 2001).

2.2. Climate

The climate of the Central Ranges is characterised as a true arid desert, with hot summers and mild winters (**Figure 2**). Although occasional rainfall records have been registered for Pipalyatjara station since 2004, the nearest registered meteorological station with long-term records is Giles Meteorological Office, located approximately 130 km to the north-west of the Project area. Mean maximum temperatures above 30 ℃ extend across six months of the year, and mean annual rainfall is 283 mm, most of which falls during the warmer months.

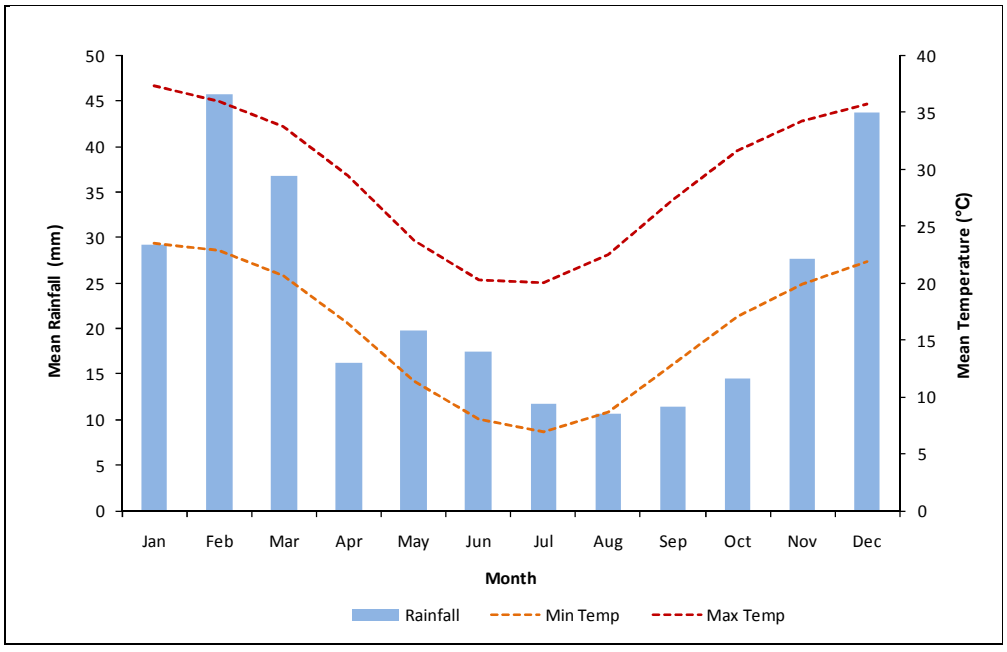

Figure 2: Average monthly rainfall and temperatures recorded for the Giles Meteorological Office, 1956-2010 (Bureau of Meteorology 2011)

2.3. Land Tenure and Land Use

Land use across the Central Ranges bioregion is almost entirely Aboriginal Reserve (Graham and Cowan 2001) and all of the Project tenements lie within Aboriginal Lands. The regional district

population consists predominately of Ngaanyatjarra people and is concentrated at Warburton on the Great Central Road. The physical land use surrounding the Project area is generally limited to hunting native and feral animals, gathering bush tucker and cultural ceremonies (Outback Ecology 2011b). The Ngaanyatjarra Council and the Traditional Owners have identified sites of heritage significance within the Project area that are excluded from development. The mine plan has been developed to avoid these exclusion zones and access is prohibited.

An excellent working relationship has been built with the local Ngaanyatjarra people during the exploration and feasibility phases of the Project. A coordination committee comprising senior Traditional Owners was established to ensure community participation in the development of the Project. The relationship was formalised in June 2010 when Metals X signed a mining agreement with the Traditional Owners and granted Native Title holders (Outback Ecology 2011b). The agreement provides consent for the grant of a mining lease and subsequent mining operations.

A small amount of mining exploration had previously been undertaken within exploration tenement E69/535 between 2001 and 2004, by Acclaim Exploration NL. A small decommissioned mine for chrysoprase (a semi-precious gemstone) is located to the east of the township and the land immediately surrounding the old workings is heavily disturbed (Outback Ecology 2011b). Another small area outside of the Wingellina township and rubbish tip has also been disturbed in recent years. A number of large fires have affected the Project area over the past decade, with the fire regime predicted to continue until resources for effective fire management and control become regionally available (Outback Ecology 2011b).

The South Australian title is entirely within the freehold Anangu Pitjantjatjara Lands. Exploration on the South Australian land is carried out pursuant to an Exploration Deed between Austral Nickel Pty Ltd, a wholly-owned subsidiary of Metals X Limited, and Anangu Pitjantjatjara Yankunytjatjara.

2.4. Geology

The ranges of the Musgrave Block are composed of Middle Proterozoic igneous and metamorphic rocks, primarily gneiss, granite and gabbro. The Wingellina Intrusion is a layered gabbro and ultramafic igneous body (Outback Ecology 2011b). Surface geology consists of Aeolian sands, magnesite, calcium carbonate and dolomite. At greater depths soils are consolidated, becoming more compact. Possible crevices and fissures are likely to occur in the top 10 metres (m), predominantly within the top 3 m, but not at great frequency. At greater depths, some shears and pores may be found ranging from approximately 5 to 10 millimetres (mm).

Overall, the geology present in the Wingellina Pit area is not considered prospective for subterranean fauna. Calcrete geologies are known to provide favourable habitats for stygofauna and troglofauna (Environmental Protection Authority 2003, 2007, Humphreys 2001, Outback Ecology 2011a). The

calcrete geology at Pipalyatjara is therefore considered to be the most prospective habitat for subterranean fauna in the overall Project area.

2.5. Drainage

The Project area is situated in the northern part of the internally-draining Warburton drainage basin (Rockwater Pty Ltd 2010). The Warburton basin extends across the southern Gibson Desert and northern Great Victoria Desert with an overall area of 340,000 km^2. Because of the aridity of the region, surface water flows only occur after particularly heavy rainfall events and are limited to rocky ranges that generate run-off.

Rockwater Pty Ltd (2010) identified three sub-catchments that have the potential to impact the Wingellina Pit and Wingellina TSF areas. These sub-catchments are defined by the Hinckley Range, Wingellina Hills and a small range of hills running in a north-west direction. The Wingellina Hills coincide with the nickel deposit and extend in a north-west direction, with small drainage lines heading to the south-west and north-east towards the Wingellina TSF. The Hinckley Range is situated to the south-west of this and features numerous small, drainage lines that head in a northerly direction towards the Wingellina Pit and Wingellina TSF.

To the east of the Wingellina TSF the drainage patterns are not well defined because of the lower topographic relief. In this part of the Project area, there appears to be a drainage line heading in a northerly direction (Rockwater Pty Ltd 2010). To the immediate south of this, ephemeral flows are likely to head in a south-easterly direction into South Australia, where they ultimately lead to Pidingadinga Creek. The Pipalyatjara calcrete deposits are situated along this drainage line in the upper reaches of Pidingadinga Creek, which heads due south and then south-east before merging with Gum Creek. The Area 3, the Wedge and Yapan nickel deposits are situated to the north of an east to west trending range, with small drainage lines on the northern face.

2.6. Hydrogeology

Hydrogeological information on the Musgrave Province is limited. The aquifers present are shallow, unconsolidated, sedimentary aquifers or fractured rock aquifers, and are generally small and low yielding (Department of Sustainability Environment Water Population and Communities 2007). Many contain old (10,000 years) waters that are no longer recharged. Groundwater recharge of aquifers occurs mainly due to rainfall infiltration near the Musgrave Ranges, but in other areas there is minimal direct recharge (Magee 2009). Across much of the Musgrave and Officer Basins, groundwater is instead likely sourced from down-valley through-flow from an origin in the ranges, and via leakage from sub-artesian groundwater in underlying formations (Magee 2009).

3. SUBTERRANEAN FAUNA

3.1. Background

3.1.1. Stygofauna

Stygofauna (groundwater fauna) are predominantly comprised of invertebrates, particularly crustaceans. Other invertebrate stygofauna groups can include gastropods, insects, water mites and worms. Stygofauna can be further classified according to their level of dependency on the subterranean environment:

- *stygoxenes* are animals that enter groundwaters passively or accidentally;
- *stygophiles* inhabit groundwaters on a permanent or temporary basis; and
- *stygobites* are obligate groundwater dwellers (and the focus of this stygofauna assessment).

Stygobites are restricted to their subterranean environment and can be distinguished from surface dwelling animals ecologically and genetically (Cooper *et al.* 2002, Danielopol and Pospisil 2000). They also display morphological characteristics typical of a subterranean existence, such as a reduction or absence of pigmentation, absence or reduction of eyes, and the presence of extended locomotory and sensory appendages (Humphreys 2008).

Stygofauna occur in various types of aquifers that exhibit voids of a suitable size for biological requirements (Humphreys 2008). In Australia, research efforts and improved sampling techniques have revealed a rich stygal community. Although previously thought to be restricted to karst landscapes, stygofauna have now been found in alluvial sediments, fractured rock aquifers, pisolites and thin regoliths (Guzik *et al.* 2011; Humphreys 2006, 2008; Outback Ecology 2011a; Subterranean Ecology 2008a). In Western Australia, studies have shown that the calcretes and alluvial aquifers of the arid and semi-arid zones contain rich stygofauna communities, with the Pilbara and to a lesser extent the Yilgarn, standing out as global hotspots for stygofauna diversity (Environmental Protection Authority 2007).

3.1.2. Troglofauna

Troglofauna (terrestrial subterranean fauna) are often relictual forms related to surface-dwelling (epigean) groups, and can be recognised by characteristics associated with a subterranean existence (Humphreys 2000). Similar to stygofauna, troglofauna can be further divided into:

- *trogloxenes* are animals that enter subsurface terrestrial habitats passively or incidentally;
- *troglophiles* carry out part of their lifecycle underground, but are also able to survive in epigean habitats; and
- *troglobites* are obligate subterranean inhabitants (and the focus of this troglofauna assessment).

Because they are restricted to subterranean environments, troglobites generally lack pigmentation, are blind or have reduced eyes, have elongated limbs, and may possess enhanced non-visual

sensory adaptations (Culver *et al.* 1995). Troglofauna are found worldwide and have until recently been classified as cave or well-dwelling organisms (Culver and Sket 2000). Significant areas for troglofauna in Western Australia are the Cape Range and Barrow Island karst cave systems, where large and diverse communities have been discovered in extensive cave systems (Hamilton-Smith and Eberhard 2000). However, the discovery of diverse troglofauna communities in subsurface rock fractures in non-karst areas in the 1980's prompted broader consideration of potential habitat (Juberthie 2000). Recent surveys have identified troglofauna from non-karstic geologies such as vuggy pisolite ore beds in the Pilbara region, and calcrete and metamorphic mafic rocks in the Yilgarn (Barranco and Harvey 2008; Bennelongia 2009; Outback Ecology 2011a; Subterranean Ecology 2008b).

Troglofauna are defined in the Western Australian Environmental Protection Authority (EPA) Guidance Statement 54a (2007) as "air-breathing subterranean animals found in caves or voids" and are considered to represent short range endemic species (SRE's). Short range endemic species are defined as species that have geographically restricted ranges of less than 10,000 km^2 and are considered more vulnerable to extinction because of their limited distribution range (Harvey *et al.* 2011, Harvey 2002).

3.2. Risks and Relevant Legislation

Subterranean fauna are protected under State and Federal legislation, governed by three acts:

- *Wildlife Conservation Act 1950 (Western Australia)*;
- *Environmental Protection Act 1986 (Western Australia)*; and
- *Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (Commonwealth)*.

The Department of Environment (DEC) is responsible for administering the *Wildlife Conservation Act 1950*, and maintains a list of rare or threatened species of subterranean fauna, or those with high conservation value. The DEC also recognises four categories of threatened ecological communities (TECs), as well as priority ecological communities (PECs) that are possibly threatened and/or have not yet been adequately defined (Department of Environment and Conservation 2007).

Threatened species and ecological communities that occur in Western Australia may also be listed as nationally threatened under the federal *EPBC Act 1999* (Department of Sustainability Environment Water Population and Communities 2010). These state and federal lists are maintained by the DEC and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) and provide important information on significant stygofauna and troglofauna communities that may be at risk from proposed mining activities.

With this legislation in mind, the EPA has developed two key documents to guide the assessment process for activities that could potentially impact on subterranean fauna or habitat:

- *Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves During Environmental Impact Assessment in Western Australia* (2003); and
- *Guidance Statement No. 54a Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (Technical Appendix to Guidance Statement 54)* (2007).

These documents provide advice to proponents and the public on the EPA's minimum requirements for environmental impact assessment (EIA) and management of subterranean fauna. In relation to mining, potential threats to subterranean ecosystems that may support stygofauna and/or troglofauna communities include:

- lowering the water table, which may dry out subterranean habitats;
- altering the water quality, which may exceed species tolerance limits; and
- direct removal of, or disturbance to, physical habitats (Environmental Protection Authority 2003).

In accordance with these Guidance Statements, there are two components of the Project that require a subterranean fauna assessment:

- *Wingellina Pit.* Mining will involve the physical removal of waste and ore material and the lowering of groundwater levels through mine pit dewatering.
- *Wingellina TSF*. As a physical structure, the TSF may influence the flow of water and resources into the subterranean habitat in the immediate area. The TSF could potentially also impact on the subterranean habitat during construction (e.g. disturbance of surface material), or in the event of failure (e.g. contamination).

These mining activities represent potential threats to subterranean fauna, and a subterranean fauna assessment is therefore required to determine if any significant species or communities occur in the area.

Metals X is also considering mining the Pipalyatjara calcrete resource in South Australia to provide a neutralizing agent required in the nickel processing. This could potentially impact on subterranean fauna through habitat disturbance, although the quarrying activities will not extend to below the water table. If this option is pursued, approval to mine the calcrete will be sought from the South Australian Department of Primary Industries and Resources (PIRSA) in accordance with the *Mining Act 1971*.

There is potential to increase the resource base through exploration of nickel resources at Area 3, the Wedge and Yapan, in South Australia. At present, the activities in this area are limited to exploratory drilling.

Although not required, subterranean fauna assessments for both the Pipalyatjara calcrete and Area 3, the Wedge and Yapan areas have been included in this report, to provide regional context in relation to the findings for the Wingellina components.

4. METHODS

4.1. Literature Review and Database Search

A literature review was conducted to gather existing information on subterranean fauna from the vicinity of the Project area. The review included technical reports, scientific journal articles and government publications. Specific searches were also performed on relevant government databases, as follows:

- targeted searches for subterranean arachnids, crustaceans and myriapods were undertaken using the Western Australian Museum's (WAM) collection database, using a rectangular search area to retrieve records within 100 km of Wingellina (in Western Australia only);
- the Protected Matters Search Tool (Department of Sustainability Environment Water Population and Communities 2011) was used to search for threatened species or ecological communities of national significance within 200 km of Wingellina; and
- DEC's Naturemap database was searched for species records within a 40 km circular radius of Wingellina.

4.2. Groundwater Quality

Basic physicochemical data was collected during the stygofauna surveys in accordance with Guidance Statement 54 (Environmental Protection Authority 2003). The approximate standing water level was measured using a Solinist 101 water level meter. Groundwater samples were collected from just below the standing water level using a disposable clear poly-vinyl chloride bailer (42 mm x 900 mm). A calibrated TPS 90 FLMV multi-parameter field instrument was used to measure pH, water temperature, dissolved oxygen (DO), electrical conductivity (EC), salinity and reduction-oxidation potential (Redox) of the groundwater. The end of hole (EoH) was also estimated for each site.

4.3. Stygofauna Assessment

Stygofauna were sampled using haul nets, which have been found to be the most efficient retrieval method (Allford *et al.* 2008). Sampling was consistent with the procedures outlined in the EPA Draft Guidance Statement No. 54a (Environmental Protection Authority 2007). The sampling method was as follows:

- Samples were collected using two weighted haul nets with mesh sizes of 150 µm and 50 µm. Each net was fitted with a collection vial with a base mesh of 50 µm.
- The 150 µm net was lowered first, near to the bottom of the hole.
- Once at the bottom the net was gently raised up and down to agitate the sediments.
- The net was then raised slowly to minimise the 'bow wave' effect that may result in the loss of specimens, filtering the stygofauna from the water column on retrieval.
- Once retrieved, the collection vial was removed, the contents emptied into a 250 ml polycarbonate vial, and preserved with 100 % undenatured ethanol.
- This process was repeated three times and then carried out using the 50 µm net.

- To prevent cross-contamination, all sampling equipment was washed thoroughly with Decon 90 (2 to 5 %) and rinsed with potable water after each sampling site.
- In the field, collected samples were placed into eskies with ice bricks prior to being transferred into a refrigerated environment on-site at the end of each survey day.
- Samples were couriered back to the Outback Ecology laboratory in Perth, where they were stored in 100 % ethanol and refrigerated at approximately minus 20 ℃ for at least one week to fixate DNA prior to keeping refrigerated at approximately 4℃.

After an initial pilot survey of the Wingellina Pit area in April 2008, further stygofauna surveys were conducted between September 2010 and March 2011 (**Appendix A**, **Appendix B**). In total, 132 stygofauna samples were taken from 70 holes over four surveys (**Table 2**). Level 1 stygofauna pilot surveys were conducted for Wingellina Pit, Wingellina TSF, and Area 3, the Wedge and Yapan study areas (**Figure 3** to **Figure 4**). A level 2 stygofauna baseline survey was conducted in the Pipalyatjara calcrete deposit (**Figure 5**). The sampling effort conducted satisfied the minimum requirements recommended by the EPA Guidance statement 54a (2007) for pilot and baseline surveys.

Table 2: Summary of stygofauna sampling effort (number of holes)

Study area	Apr 2008	Sep 2010	Nov 2010	Jan 2011	Total
Wingellina Pit	11	2	10	9	**32**
Wingellina TSF	2	-	4	4	**10**
Area 3, the Wedge & Yapan	-	4	13	11	**28**
Pipalyatjara Calcrete	-	8	28	26	**62**
No. Samples	**13**	**14**	**55**	**50**	**132**

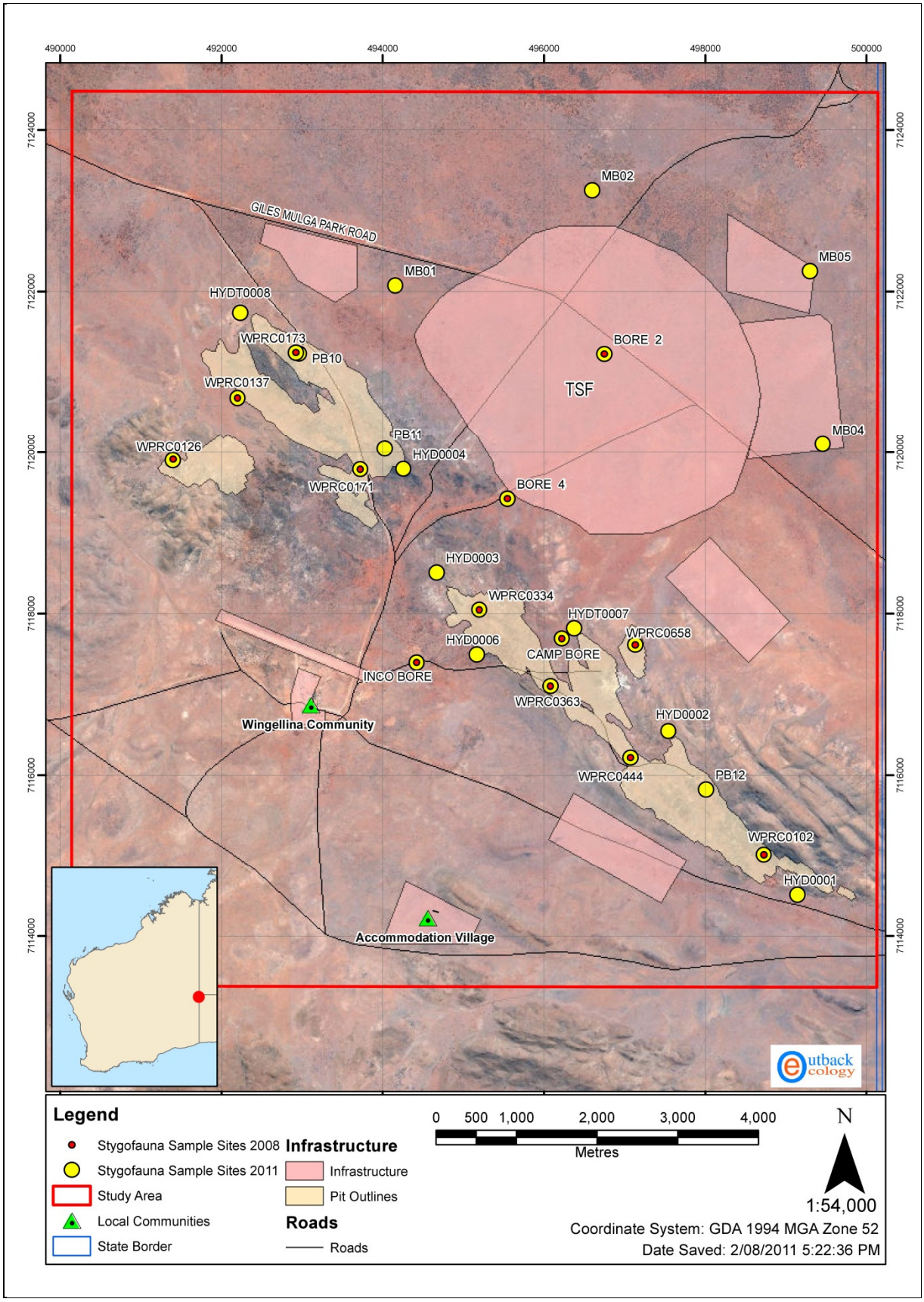

Figure 3: Location of Wingellina Pit and Wingellina TSF stygofauna survey holes

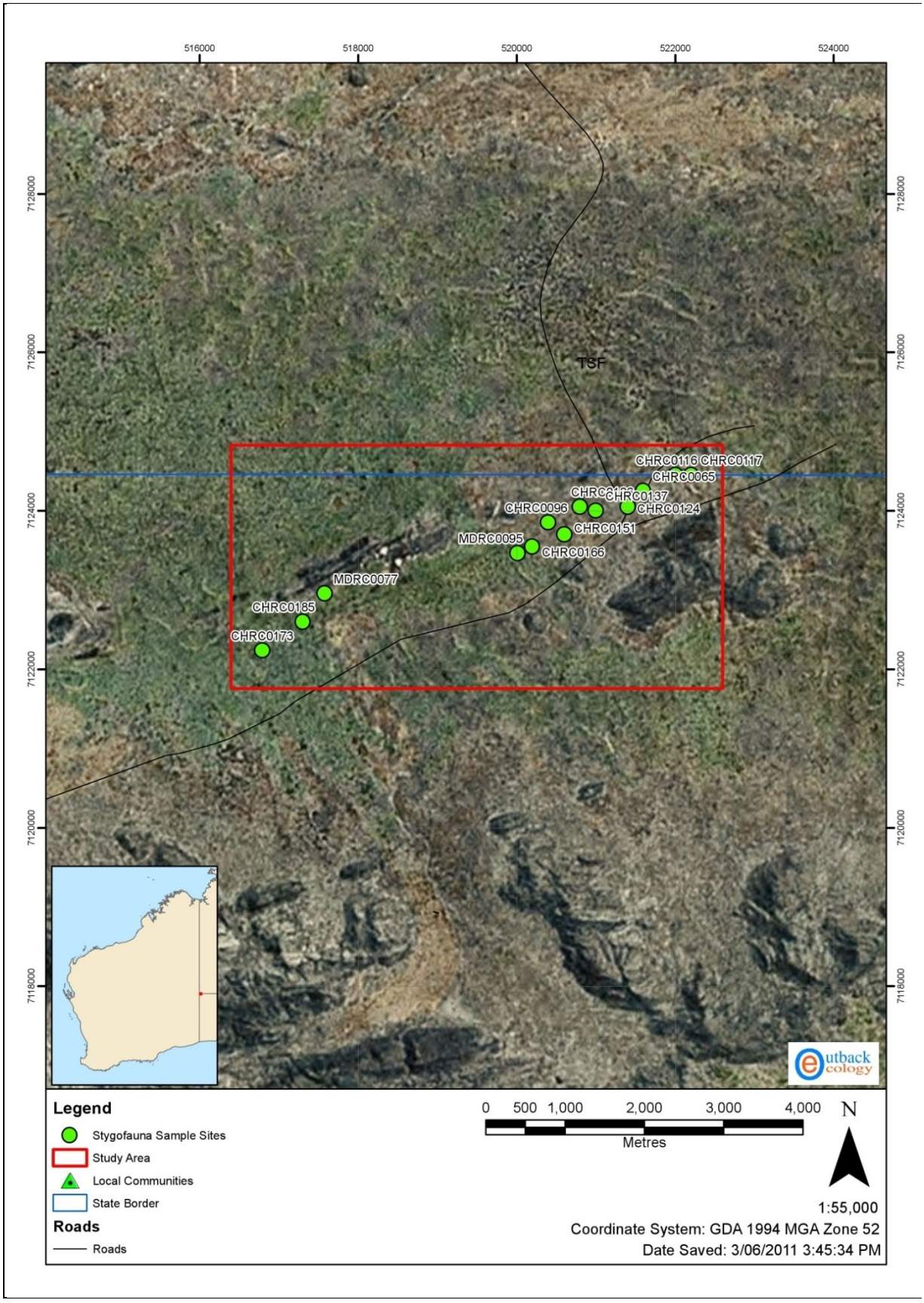

Figure 4: Location of Area 3, the Wedge and Yapan stygofauna survey holes

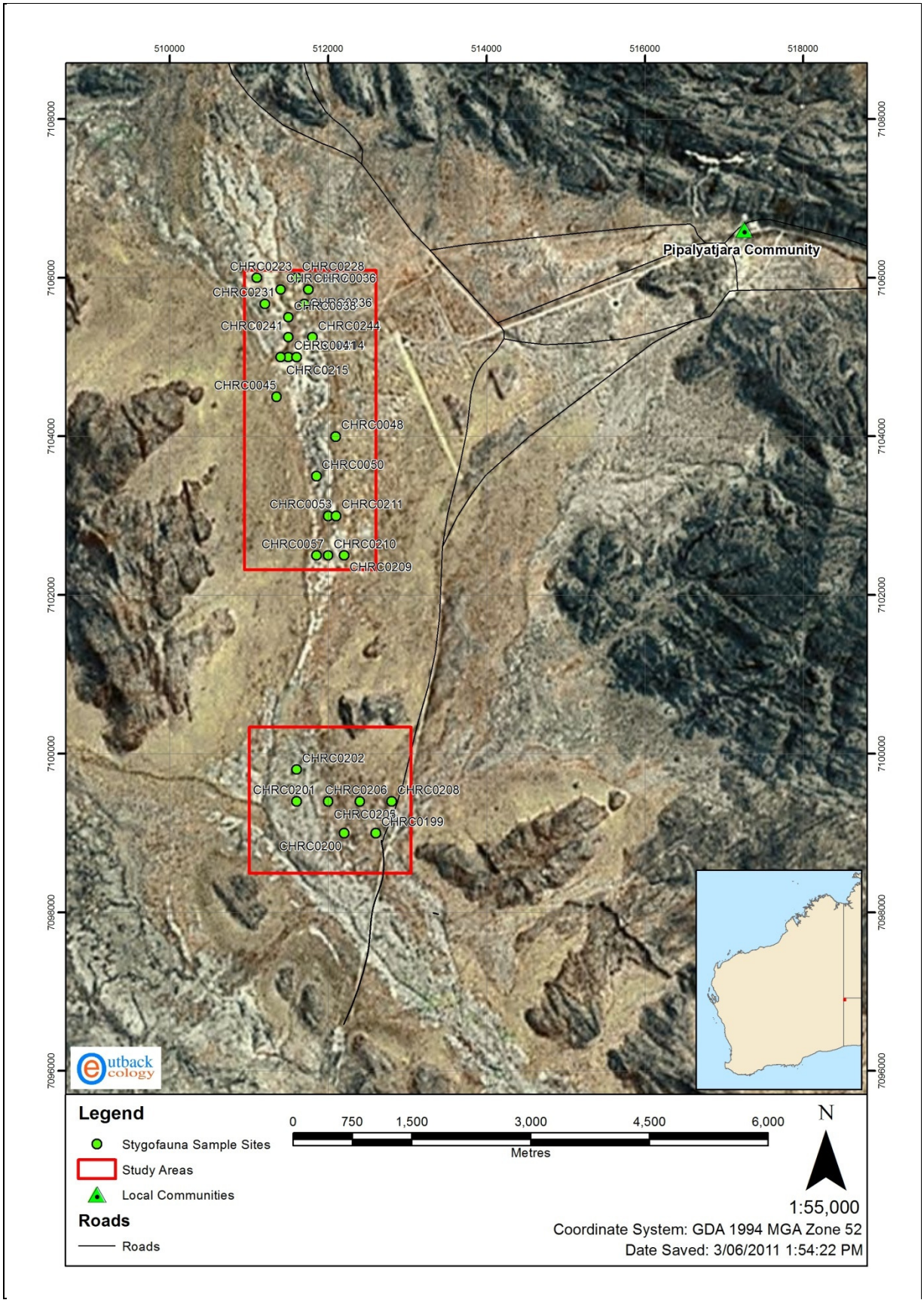

Figure 5: Location of Pipalyatjara calcrete deposit stygofauna survey holes

4.4. Troglofauna Assessment

Troglofauna were sampled with litter traps at the Wingellina TSF (**Figure 6**) and Pipalyatjara calcrete deposit (**Figure 7**) between September 2010 and March 2011. Litter traps were deployed in uncased holes as per the procedures outlined in the EPA Guidance Statement 54a (Environmental Protection Authority 2007) (**Appendix B; Appendix C**). No uncased holes suitable for troglofauna sampling were present in the Wingellina Pit area or the Area 3, the Wedge and Yapan exploration areas.

The sampling methods were as follows:

- Litter traps were packed with sterilised organic material in the Outback Ecology laboratory and then sealed to maintain moist, sterile conditions prior to field deployment.
- Traps were wet with deionised water prior to deployment. One trap was deployed per hole.
- Once installed, traps were left in place for at least two months during each survey, to provide adequate time for fauna to colonise.
- Upon retrieval, traps were sealed in zip lock bags and couriered back to the Outback Ecology laboratory in Perth.
- In the laboratory, all invertebrates were extracted from the litter using Tullgren funnels. The contents of each trap were placed into a funnel directed into a collection container containing 100 % ethanol. Lamps were positioned above the funnels so that the light and heat emitted would induce the troglofauna to travel downwards through the litter, seeking darker, more humid conditions, ultimately passing through a mesh layer into the containers below.
- After the litter samples had been exposed to the lamps for sufficient time to dry and for troglofauna to migrate downwards (typically 48 to 72 hours), the litter was removed and sorted by hand under magnification for any remaining troglofauna.
- All troglofauna specimens were stored in 100 % ethanol and refrigerated at approximately 4 ℃ until subsequent sorting and identification.

In total, 98 troglofauna litter traps were deployed with 91 successfully retrieved (**Table 3)**. Seven traps were lost due to wildlife disturbance.

Table 3: Summary of troglofauna litter trapping effort (number of holes)

Area		Sep 2010	Nov 2010	Jan 2011	Mar 2011	Total
Wingellina TSF	*Deployed*	*13*	*13*			**26**
	Retrieved		**11**	**13**		**24**
Pipalyatjara	*Deployed*	*24*	*24*	*24*		**72**
	Retrieved		**23**	**24**	**20**	**67**
Total Retrieved			**34**	**37**	**20**	**91**

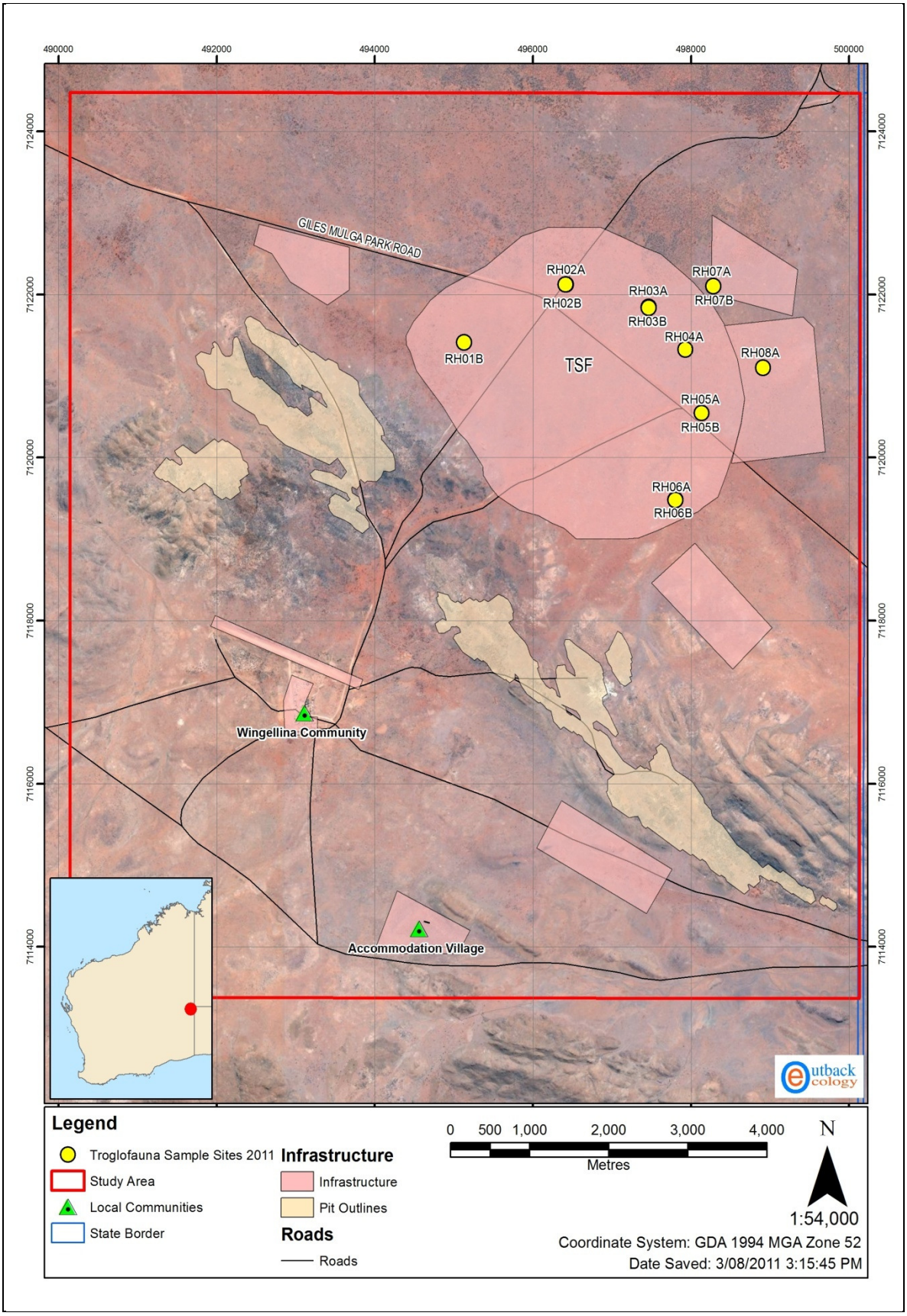

Figure 6: Location of Wingellina TSF troglofauna survey holes

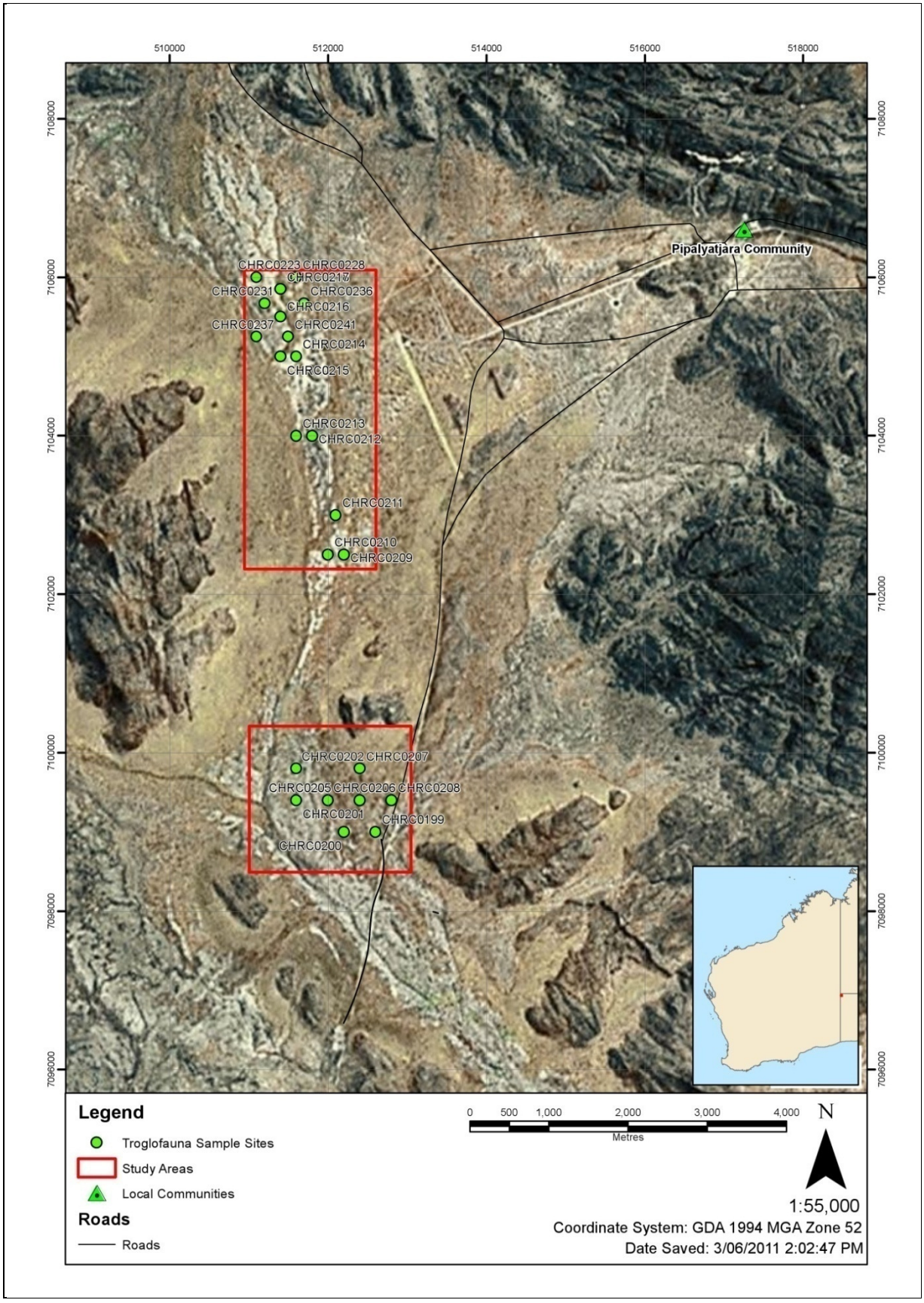

Figure 7: Location of Pipalyatjara calcrete deposit troglofauna survey holes

Additional troglofauna material was collected as scrape samples during stygofauna net hauls. This supplementary survey technique involves scraping the sides of uncased drill holes with stygofauna nets, dislodging putative troglofauna from the unsaturated strata upon net retrieval, and/or collecting specimens that have fallen into the water column (Allford *et al.* 2008). Nineteen stygofauna survey holes at Pipalyatjara calcrete were uncased, enabling troglofauna scrape samples to be taken during stygofauna net hauls. A total of 36 scrape samples were taken from these holes in November 2010 and January 2011.

4.5. Sorting and Identification of Specimens

Preserved samples were sorted manually under Leica MZ6, MZ7.5, M80 and M205C stereo microscopes, by Chris Hofmeester, Dr Jason Coughran, Richard De Lange and Syngeon Rodman. Taxa were identified to the lowest possible taxonomic rank by Dr Jason Coughran, Nicholas Stevens and Dr Erin Thomas of Outback Ecology, with specialist identification provided by external taxonomic specialists for Copepoda (Dr Tomislav Karanovic, Hanyang University, Korea) and Isopoda (Dr Rachel King, South Australian Museum). Oligochaetes were only identified to family level due to taxonomic issues and limited reliability in identifying taxa to species level. Other general aquatic or terrestrial invertebrates that were inadvertently collected in samples (including terrestrial insects and mites) were identified to the level of Order (and in the case of nematodes, to the level of Phylum).

4.6. Limitations of the Assessment

Not all specimens could be identified to the desired taxonomic level due to:

- loss or damage of important taxonomic features during collection and/or sorting of specimens;
- lack of maturity of specimens; or
- limitation in taxonomy, where the current state of taxonomy for a particular group is insufficiently advanced, and/or relevant taxonomic keys and descriptions are lacking.

Every effort was made to assess the taxonomy and conservation significance of the subterranean fauna collected using in-house data collections, publications, publicly available reports, and information provided by specialist taxonomists. However, some accounts may be limited if information was unavailable.

5. RESULTS AND DISCUSSION

5.1. Subterranean Fauna Literature Review and Database Searches

Few studies have been undertaken in the arid interior of Australia outside of the Pilbara and Yilgarn, with little known about the subterranean fauna of the central arid region. Most of the Australian subterranean fauna known to date are from the Pilbara and Yilgarn regions (Guzik *et al.* 2010). These two areas have been intensively studied, driven largely by the resources sector, and contain diverse and abundant assemblages, particularly of stygofauna (Guzik *et al.* 2010). The probability of inland desert calcrete and alluvial aquifers hosting a rich stygofauna assemblage is considered high (Environmental Protection Authority 2007), although this appears to be inferred from the Pilbara and Yilgarn examples, rather than based on survey results from the arid interior.

No stygofauna or troglofauna species are currently recorded from the Wingellina area. The nearest stygofauna are from the Ngalia Basin (NT), approximately 400 km to the north/north-east of the Project area (in the Northern Territory), where eleven species of stygobitic dytiscid diving beetle have been recorded (Watts and Humphreys 2006) (**Table 4**). The nearest troglofauna are from the south-western end of the Great Victoria Desert bioregion, approximately 560 km to the south-west of the Project area, where dipluran, centipede and slater species have been recorded (Ecologia Environment 2009).

Table 4: Examples of subterranean fauna recorded in the literature from the surrounding area

Area	Location relative to the Project area	Subterranean Fauna	Reference
Stygofauna			
Ngalia Basin (NT)	~ 400 km N/NE	dytiscid diving beetles	(Watts and Humphreys 2006)
Nullarbor Plain	~ 665 km S/SW	melitid amphipod	(Bradbury and Eberhard 2000)
Troglofauna			
Eastern Yilgarn	~ 560 km SW	diplurans, centipedes and slaters	(Ecologia Environment 2009)
Northern Yilgarn	~ 835 km E/SE	pseudoscorpions and palpigrades	(Barranco and Harvey 2008, Edward and Harvey 2008)
Northern Yilgarn	~ 860 km E	spider	(Platnick 2008)

The database searches yielded no records for subterranean fauna in the Wingellina area. Specifically:

- there were no records of subterranean arachnids, crustaceans or myriapods in the Western Australian Museum collection database;
- no subterranean species or ecological communities were found using the DSEWPC's Protected Matters Search Tool (**Appendix D**); and
- no subterranean species or ecological communities were found using the DEC's Naturemap database (**Appendix E**).

5.2. Stygofauna Assessment

5.2.1. Groundwater Quality

A distinct difference in standing water level was recorded across the different Project areas (**Appendix A**). Standing water was much closer to the surface at Pipalyatjara (<12 m), reflecting local topography, with the area situated within a valley floor. The other Project areas occur in areas of higher elevation, and the distance to groundwater was much greater (typically 25 to 40 m).

Across the various Project areas, groundwater was of suitable quality for stygofauna habitation. Salinity ranged from freshwater (86 ppm) to hyposaline (4,650 ppm), *sensu* Hammer (1986) (**Table 5**). The salinity was notably higher at the Wingellina TSF compared to the other Project areas. However, all of the salinities recorded were relatively low, and well within an acceptable range for stygofauna (Environmental Protection Authority 2007, Humphreys 2008).

Table 5: Summary of groundwater quality for all Project areas (DO = dissolved oxygen; n = number of holes)

Project Area		pH (units)	Salinity (ppm)	Temp (°C)	DO (ppm)	Redox (mV)
Wingellina Pit	min	6.81	86	24.6	0.70	-287
	max	9.83	2,200	37.0	7.80	143
	mean	7.84	915	27.4	3.39	26
	n	30	30	30	30	17
Wingellina TSF	min	6.99	321	25.6	1.96	-178
	max	8.03	4,650	30.0	8.10	139
	mean	7.43	2,127	28.4	4.75	-12
	n	8	8	8	8	8
Area 3, the Wedge and Yapan	min	7.35	210	24.9	2.13	-128
	max	8.22	826	35.3	13.42	163
	mean	7.75	454	30.0	6.40	108
	n	23	23	23	23	23
Pipalyatjara	min	6.33	187	23.3	1.71	-314
	max	8.08	640	33.1	10.69	214
	mean	7.72	419	27.6	5.54	19
	n	61	61	61	61	60
Overall	min	6.33	86	23.3	0.70	-314
	max	9.83	4,650	37.0	13.42	214
	mean	7.73	660	28.1	5.13	37
	n	122	122	122	122	108

Groundwater pH was also optimal for stygofauna, which are less commonly encountered in acidic waters (Humphreys 2008). Apart from one hole that had an acidic pH (6.33), the groundwater pH across all Project areas was circumneutral (6.5 to 7.5) to alkaline (>7.5), *sensu* Foged (1978) (**Appendix F**).

Groundwater temperatures ranged from 23.3 to 37.0 ℃ and varied according to season, being notably higher in all Project areas during the January 2011 survey. Dissolved oxygen concentrations ranged from <1 to 13 ppm, and were generally higher in the Pipalyatjara and Area 3, the Wedge and Yapan areas. The mean dissolved oxygen concentrations in the Wingellina Pit and TSF areas were below 5 ppm, however this is still sufficient for stygofauna habitation. While concentrations below 5 ppm may adversely affect surface aquatic biota, stygofauna have been documented from sub-oxic conditions well below 1 ppm (Chapman and Kimstach 1996, Humphreys 2008).

5.2.2. Stygofauna

A total of 1,370 aquatic and terrestrial invertebrate specimens were collected by net hauling during the stygofauna assessment. These represented 13 invertebrate groups including Araneae, Acarina, Cladocera, Coleoptera, Collembola, Cyclopoidea, Diptera, Hymenoptera, Isopoda, Oligochaeta, Pauropoda, Pseudoscorpionida, and Zygentoma (**Table 6**). The majority (89.5 %) of these specimens were collected from the Pipalyatjara calcrete aquifer.

Table 6: Abundance of invertebrates collected during the stygofauna assessment (*=*Dussartcyclops* sp. TK1)

Group		Wingellina Pit	Wingellina TSF	Area 3, the Wedge & Yapan	Pipalyatjara Calcrete	Overall
Non-Stygofauna	Orders	2	3	2	12	13
	Specimens	14	5	124	1,217	1,360
Stygofauna	Orders	-	-	-	1	1
	Species*	-	-	-	1	1
	Specimens	-	-	-	10	10
Total Specimens		**14**	**5**	**124**	**1,227**	**1,370**

Only 10 specimens (<1 %), were considered stygobitic, representing the undescribed copepod species Dussartcyclops sp. TK1 (**Appendix G**). This stygal species was only recorded from Pipalyatjara calcrete hole CHRC0209 (**Figure 5**). The recently erected genus *Dussartcyclops*, to which the species belongs, has previously been considered endemic to Western Australia (Karanovic 2011, Karanovic et al. 2011). Therefore a new record of this taxon in South Australia is considered of scientific importance. As only ten specimens were collected during the assessment, it would appear to be limited in occurrence and distribution. Additional targeted surveys in South Australia may clarify its status in this regard.

A second species of copepod, *Microcyclops varicans* (Sars, 1863), was also recorded at Pipalyatjara from hole CHRC0048. This cosmopolitan species has been recorded many times in Australia and is considered a stygoxene rather than stygobitic taxon, and can occur in groundwaters with a connection to surface habitats such as pastoral wells, open bores and caves with large entrances (Karanovic 2004, 2006, 2011).

While Enchytraeid oligochaetes were collected in net hauls from six holes, they were indistinguishable from specimens collected in the troglofauna litter traps. They were therefore regarded as terrestrial specimens that had inadvertently been collected as the nets were retrieved.

5.3. Troglofauna Assessment

A total of 4,600 terrestrial invertebrate specimens were collected in troglofauna litter traps, representing nine invertebrate groups including Araneae, Acarina, Coleoptera, Collembola, Diptera, Hymenoptera, Isopoda, Oligochaeta, and Pseudoscorpionida (**Table 7**). Similar to stygofauna, most specimens collected were from the Pipalyatjara calcrete deposit. A further 265 terrestrial invertebrates were collected in scrape samples taken during stygofauna net haul sampling of uncased bore holes at Pipalyatjara calcrete deposit.

Table 7: Abundance of invertebrates collected during the troglofauna assessment (*=*Tyrannochthonius* sp. OES6)

Group		Wingellina TSF	Pipalyatjara Calcrete		Overall
		Litter Trap	Litter Trap	Scrape	
Non-Troglofauna	Orders	7	8	7	10
	Specimens	1,743	2,857	264	4,864
Troglofauna	Orders	-	-	1	1
	Species*	-	-	1	1
	Specimens	-	-	1	1
Total		**1,743**	**2,857**	**265**	**4,865**

No troglofauna species were collected from the Wingellina TSF. One species of troglofauna, *Tyrannochthonius* sp. OES6 (Pseudoscorpionida: Chthoniidae), was recorded from the Pipalyatjara calcrete. This comprised a single adult female specimen collected in a scrape sample of bore hole CHRC0205 (**Figure 5**). *Tyrannochthonius* sp. OES6 is morphologically near to the troglobitic species *Tyrannochthonius basme* known from the Pilbara. However, it can be differentiated by the setation of the Tergites and has an indistinct epistome (Edward and Harvey 2008). The taxon would appear to be limited in distribution and abundance, and additional targeted surveys in South Australia may clarify these aspects.

Two species of isopod were also collected in troglofauna scrape samples and litter traps. A species of *Buddelundia* was collected from Pipalyatjara (bore CHRC0210) and a species of *Trichorhina* was collected from Wingellina TSF (bores RH02 and RH03). The limited taxonomy for isopod genera hindered full taxonomic clarification of these specimens, although it is likely that both represent new species within these genera (King 2011; **Appendix H**). While there are obligate subterranean isopod representatives in Western Australia (Environmental Protection Authority 2007), the taxa collected in this assessment were pigmented with well developed eyes, and regarded as trogloxenes rather than troglobites. Similarly, troglobitic species of Araneae, Coleoptera and Zygentoma are known to occur in Western Australia, but the taxa recorded in this assessment were terrestrial fauna with no troglomorphic features.

Two specimens of a Pauropodidae (Pauropoda) species were collected from Pipalyatjara calcrete in scrape samples, from hole CHRC0223 (**Figure 5**). The subterranean affinities of the Pauropoda are poorly known because of their 'troglomorphic' morphology and commonly known ecological niche within the soil profile. Unfortunately, the specimens of Pauropoda collected as part of this assessment were in poor condition, and were unable to be identified further. However, they are considered more likely to be troglophiles or trogloxenes rather than troglobites.

5.4. Summary of Subterranean Fauna Habitat

Although the groundwater was of suitable quality at all of the Project areas, there were very few subterranean fauna species collected during the surveys. The methods and timing of the surveys were all within accepted guidelines for subterranean fauna, and the work was carried out by experienced personnel. It can therefore be concluded that the limited number and abundance of subterranean fauna species that were recorded reflect a depauperate regional assemblage.

The subterranean fauna of the central arid zone is poorly known, but it is not regarded as having as high a potential for significant subterranean communities as areas such as the Pilbara and Yilgarn (Environmental Protection Authority 2007). Calcrete deposits are recognized as providing optimal subterranean habitat conditions in arid areas of Australia (Allford *et al.* 2008, Cooper *et al.* 2008, Environmental Protection Authority 2007, Humphreys 2008), and the findings of this assessment are consistent with this. Of the four study areas, the Pipalyatjara calcrete deposit in South Australia appeared to be the most favourable for obligate stygofauna and troglofauna. However, even in this study area the subterranean community had a low diversity and abundance.

The Pipalyatjara calcrete habitat extends beyond the boundaries of the E3555 tenement to the north, south-east and west. It is also noted that additional calcrete habitats are located 20 to 30 km to the north and north-west of Wingellina, forming part of a palaeodrainage that heads west and then south-west towards the Eucla Basin (Rockwater Pty Ltd 2007, 2008). The subterranean taxa recorded within the tenement areas at Pipalyatjara calcrete are likely to occur outside of the study area within Pipalyatjara deposit, and may also occur in the nearby calcrete habitats.

6. CONCLUSION AND RISK ASSESSMENT

A review of the literature found no records of subterranean fauna in the vicinity of the Project, with the nearest records located approximately 400 km away. Relevant database searches also yielded no regional records of subterranean fauna in the WAM collection database, the DEC Naturemap database, or the Australian Protected Matters database. No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) have been identified in Western Australia within 200 km of the Project.

The subterranean fauna surveys undertaken for the Project represented the most substantial assessment in the arid central interior of Australia, providing a comprehensive characterisation of stygofauna and troglofauna in the Wingellina region. Despite yielding numerous general aquatic and terrestrial invertebrate taxa, only one stygobitic species, *Dussartcyclops* sp. TK1 (Copepoda), and one troglobitic species, *Tyrannochthonius* sp. OES6 (Pseudoscorpionida) were recorded. Both of these species were recorded from the Pipalyatjara calcrete deposit, in South Australia, with similar calcrete habitats likely to occur nearby, which have the potential to support these taxa. Further surveys could establish the broader distribution of these species outside the Pipalyatjara area.

The subterranean fauna risk assessment for the Wingellina Nickel Project can be summarised as follows:

1. No obligate subterranean fauna were recorded from Wingellina Pit, Wingellina TSF, or Area 3, the Wedge, and Yapan. Therefore, there are no significant stygofauna species or communities at risk from these Project components.
2. Two undescribed species of obligate subterranean fauna were recorded at the Pipalyatjara calcrete deposit. While these species may be at risk from future mining activities, no further assessment is currently required because of the location of the calcrete in South Australia.

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8. GLOSSARY

alluvium – sediment deposited by a stream or river

aquatic – relating to water

aquifer – a body of permeable rock or sediment capable of storing groundwater

arid – a region characterised by a severe lack of available water, to the extent that the growth and development of biota is hindered or prevented

bedrock – consolidated rock attached to the earth's crust

biodiversity – the diversity of biota in a particular environment or region

calcrete – carbonate deposits that form in arid environments, as a result of groundwater evaporation

cave – a subsurface cavity of sufficient size that a human could enter

dissolved oxygen – a measure of the amount of gaseous oxygen dissolved in a solution

distribution range – the overall geographic area that a species is known to occur in

divergence – degree of separation from a common ancestor

diversity – species richness

drawdown – the lowering of the adjacent water table or piezometric surface as a result of groundwater extraction

electrical conductivity – an estimate of the total dissolved salts in a solution, or salinity

endemic – having a distribution restricted to a particular geographic region

epigean – pertaining to the surface zone

fractured rock – a rock formation characterized by separation or discontinuity, usually as a result of geological stress (e.g. faulting)

freshwater – salinity less than 5,000 µS/cm (3,000 mg/L)

geological ages (e.g. Cainozoic) – distinct time periods within the geological history of the earth

groundwater – water occurring below the ground surface

habitat – an ecological or environmental area that is inhabited by a particular animal or plant species

hypogean – pertaining to the subterranean zone

invertebrates – animals lacking vertebrae

karst – a region of limestone or other soluble rock, characterized by distinctive features such as caves, caverns, sinkholes, underground streams and springs

lineage – a group of organisms related by descent from a common ancestor

molecular – pertaining to the genetic characteristics of an organism or group

morphology – the specific form and structure of an organism or taxon

morpho-species – a general grouping of organisms that share similar morphological traits, but is not necessarily defined by a formal taxonomic rank

palaeoriver, palaeochannel, palaeodrainage – a remnant of a stream or river channel cut in older rock and filled by the sediments of younger overlying rock

pH – a measure of the hydrogen ion concentration of a soil or solution (values below pH of 6.5 are 'acidic', and those above pH 7.5 are 'alkaline')

relictual – having survived as a remnant

salinity – the concentration of all dissolved salts in a solution

semi-arid – a climatic region that receives low annual rainfall (250 – 500 mm)

species – a formal taxonomic unit defining a group or population of organisms that share distinctive characters or traits, are reproductively viable and/or are otherwise identifiable as a related group

species diversity – the number of species present in a particular habitat, ecosystem or region

species accumulation curve – a model used to estimate species diversity or richness

standing water level – the depth to groundwater from a particular reference point (e.g. in a monitoring bore)

stygal, stygo – pertaining to groundwater habitat or biota

stygobite – an obligate aquatic species of groundwater habitats

stygobiont – another term used to describe obligate inhabitants of groundwater systems

stygofauna – a general term for aquatic groundwater fauna

stygophile – an aquatic species that temporarily or permanently inhabits groundwater habitats

stygoxene – an aquatic species that has no fixed affinity with groundwater habitats, but may nonetheless occur in groundwater habitats

taxon – an identifiable group of organisms, usually based on a known or inferred relationship or a shared set of distinctive characteristics

troglobite – an obligate terrestrial species of subterranean habitats

troglofauna – a general term for terrestrial subterranean fauna

troglomorphic features – morphological characteristics resulting from an adaptation to subterranean habitats (e.g. a reduction in pigment)

troglophile – a terrestrial species that temporarily or permanently inhabits subterranean habitats

trogloxene – a terrestrial species that has no fixed affinity with subterranean habitats, but may nonetheless occur in subterranean habitats

void – a pore space in the rock or stratum

Yilgarn – pertaining to the Yilgarn Craton, a 65,000 km^2 body of the earth's crust in south-western Australia that dates back to the Archaean period, 2.6 to 3.7 million years ago

APPENDIX A

Stygofauna Survey Hole Data

Wingellina Pit

UTM format used is WGS 84: zone 52 J

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Hole name	Eastings	Northings	Sample Date	Casing Description	EOH	SWL
Camp Bore	496224	7117690	10/04/2008	Cased (slotted below SWL)	na	na
HYDT0001	499141	7114510	1/12/2010	Cased (slotted below SWL)	100	24.24
HYDT0001	499141	7114510	18/01/2011		na	24.50
HYDT0002	497543	7116543	1/12/2010	Cased (slotted below SWL)	100	57.8
HYDT0002	497543	7116543	18/01/2011		100	57.81
HYDT0003	494670	7118506	1/12/2010	Cased (slotted below SWL)	100	52.40
HYDT0003	494670	7118506	18/01/2011		100	54.43
HYDT0004	494257	7119791	1/12/2010	Cased (slotted below SWL)	na	56.02
HYDT0004	494257	7119791	18/01/2011		100	55.92
HYDT0006	495168	7117491	1/12/2010	Cased (slotted below SWL)	100	na
HYDT0006	495168	7117491	18/01/2011		100	17.43
HYDT0007	496376	7117815	1/12/2010	Cased (slotted below SWL)	100	39.56
HYDT0007	496376	7117815	18/01/2011		na	na
HYDT0008	492236	7121733	30/11/2010	Cased (slotted below SWL)	70	na
HYDT0008	492236	7121733	18/01/2011		70	28.32
INCO Bore	494425	7117393	9/04/2008	Cased (slotted below SWL)	14	12.90
PB10	492966	7121228	1/12/2010	Cased (slotted below SWL)	75	38.68
PB10	492966	7121228	18/01/2011		75	38.36
PB11	494024	7120041	1/12/2010	Cased (slotted below SWL)	75	52.76
PB11	494024	7120041	18/01/2011		75	52.49
PB12	498013	7115821	1/12/2010	Cased (slotted below SWL)	75	42.95
PB12	498013	7115821	18/01/2011		75	54.28
WPRC0102	498728	7115010	9/04/2008	Cased (slotted below SWL)	70	51.00
WPRC0126	491400	7119900	9/04/2008	Cased (slotted below SWL)	76	43.54
WPRC0126	491400	7119900	22/09/2010		53	42.71
WPRC0137	492203	7120677	9/04/2008	Cased (slotted below SWL)	52	38.18
WPRC0171	493722	7119786	9/04/2008	Cased (slotted below SWL)	70	53.63
WPRC0173	492921	7121240	9/04/2008	Cased (slotted below SWL)	70	38.82
WPRC0173	492921	7121240	22/09/2010		70	38.97
WPRC0334	495198	7118043	9/04/2008	Cased (slotted below SWL)	60	52.54
WPRC0363	496083	7117099	9/04/2008	Cased (slotted below SWL)	60	51.65
WPRC0444	497076	7116212	9/04/2008	Cased (slotted below SWL)	60	48.68
WPRC0658	497133	7117610	9/04/2008	Cased (slotted below SWL)	62	41.82

Wingellina TSF

UTM format used is WGS 84: zone 52 J

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Hole name	Eastings	Northings	Sample Date	Casing Description	EOH	SWL
BORE 2	496751	7121221	9/04/2008	Cased (slotted below SWL)	78	41.82
BORE 4	495550	7119420	9/04/2008	Cased (slotted below SWL)	85	38.72
MB01	494160	7122070	30/11/2010	Cased (slotted below SWL)	40	29.82
MB01	494160	7122070	18/01/2011		40	29.32
MB02	496600	7123250	28/11/2010	Cased (slotted below SWL)	36	25.85
MB02	496600	7123250	18/01/2011		36	25.61
MB04	499460	7120100	30/11/2010	Cased (slotted below SWL)	30	18.06
MB04	499460	7120100	18/01/2011		30	17.74
MB05	499299	7122250	30/11/2010	Cased (slotted below SWL)	30	17.96
MB05	499299	7122250	18/01/2011		30	17.90

Area 3, the Wedge and Yapan

UTM format used is WGS 84: zone 52 J

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Hole name	Eastings	Northings	Sample Date	Casing Description	EOH	SWL
CHRC0096	520400	7123850	24/09/2010	Cased (slotted below SWL)	na	41.56
CHRC0065	521595	7124249	29/11/2010	Cased (slotted below SWL)	90	41.36
CHRC0065	521595	7124249	17/01/2011		na	41.69
CHRC0073	521196	7124199	29/11/2010	Cased (slotted below SWL)	72	41.35
CHRC0080	520799	7123698	29/11/2010	Cased (slotted below SWL)	60	na
CHRC0096	520400	7123850	29/11/2010	Cased (slotted below SWL)	90	na
CHRC0096	520400	7123850	16/01/2011		na	na
CHRC0106	520799	7124057	29/11/2010	Cased (slotted below SWL)	88	41.10
CHRC0106	520799	7124057	16/01/2011		na	41.05
CHRC0116	522000	7124450	24/09/2010	Cased (slotted below SWL)	72	39.24
CHRC0116	522000	7124450	30/11/2010		132	41.81
CHRC0116	522000	7124450	17/01/2011		na	40.77
CHRC0117	522203	7124451	29/11/2010	Cased (slotted below SWL)	96	39.76
CHRC0117	522203	7124451	17/01/2011		na	39.70
CHRC0124	521400	7124049	29/11/2010	Cased (slotted below SWL)	60	43.06
CHRC0124	521400	7124049	17/01/2011		na	43.22
CHRC0137	520998	7124000	29/11/2010	Cased (slotted below SWL)	72	42.10
CHRC0137	520998	7124000	16/01/2011		na	41.00
CHRC0151	520600	7123700	24/09/2010	Cased (slotted below SWL)	81	40.55
CHRC0151	520600	7123700	29/11/2010		78	41.60
CHRC0151	520600	7123700	16/01/2011		na	41.80
CHRC0166	520200	7123550	24/09/2010	Cased (slotted below SWL)	54	42.85
CHRC0166	520200	7123550	29/11/2010		90	42.95
CHRC0166	520200	7123550	16/01/2011		na	43.03
CHRC0173	516806	7122200	30/11/2010	Cased (slotted below SWL)	60	37.45
CHRC0173	516806	7122200	17/01/2011		n	37.31
CHRC0185	517300	7122616	30/11/2010	Cased (slotted below SWL)	78	na
CHRC0185	517300	7122616	17/01/2011		na	43.96
MDRC0077	517574	7122955	30/11/2010	Cased (slotted below SWL)	72	47.88
MDRC0077	517574	7122955	17/01/2011		na	48.00
MDRC0095	520012	7123464	30/11/2010	Cased (slotted below SWL)	93	45.70
MDRC0095	520012	7123464	16/01/2011		na	na

Pipalyatjara calcrete

UTM format used is WGS 84: zone 52 J

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Hole name	Eastings	Northings	Sample Date	Casing Description	EOH	SWL
CHRC0036	511750	7105850	24/09/2010	Cased (slotted below SWL)	na	11.07
CHRC0036	511750	7105850	28/11/2010		na	11.07
CHRC0036	511750	7105850	16/01/2011		na	11.28
CHRC0038	511500	7105500	24/09/2010	Cased (slotted below SWL)	30	9.90
CHRC0038	511500	7105500	28/11/2010		na	10.00
CHRC0038	511500	7105500	16/01/2011		na	10.03
CHRC0041	511500	7105000	24/09/2010	Cased (slotted below SWL)	30	11.24
CHRC0041	511500	7105000	27/11/2010		na	11.24
CHRC0041	511500	7105000	15/01/2011		na	11.30
CHRC0045	511350	7104500	24/09/2010	Cased (slotted below SWL)	30	9.37
CHRC0045	511350	7104500	28/11/2010		na	9.41
CHRC0045	511350	7104500	15/01/2011		na	9.35
CHRC0048	512000	7104000	24/09/2010	Cased (slotted below SWL)	30	10.76
CHRC0048	512000	7104000	28/11/2010		na	10.85
CHRC0048	512000	7104000	15/01/2011		na	10.80
CHRC0050	511850	7103500	24/09/2010	Cased (slotted below SWL)	30	11.37
CHRC0050	511850	7103500	27/11/2010		na	11.30
CHRC0050	511850	7103500	15/01/2011		na	11.26
CHRC0053	512000	7103000	24/09/2010	Cased (slotted below SWL)	18	10.15
CHRC0053	512000	7103000	27/11/2010		na	10.15
CHRC0053	512000	7103000	15/01/2011		na	10.17
CHRC0057	511850	7102500	24/09/2010	Cased (slotted below SWL)	30	11.14
CHRC0057	511850	7102500	27/11/2010		na	11.25
CHRC0057	511850	7102500	15/01/2011		na	11.29
CHRC0199	512600	7099000	26/11/2010	Uncased	12	11.47
CHRC0199	512600	7099000	15/01/2011		12	11.40
CHRC0200	512200	7099000	26/11/2010	Uncased	12	8.85
CHRC0200	512200	7099000	15/01/2011		12	8.78
CHRC0201	511600	7099400	26/11/2010	Uncased	12	9.26
CHRC0201	511600	7099400	15/01/2011		12	9.26
CHRC0202	511600	7099800	26/11/2010	Uncased	12	8.60
CHRC0202	511600	7099800	15/01/2011		12	8.60
CHRC0205	512000	7099400	26/11/2010	Uncased	12	9.30
CHRC0205	512000	7099400	15/01/2011		12	9.37
CHRC0206	512400	7099400	26/11/2010	Uncased	12	10.52
CHRC0206	512400	7099400	15/01/2011		12	10.50
CHRC0208	512800	7099400	26/11/2010	Uncased	12	10.17
CHRC0208	512800	7099400	15/01/2011		12	10.10
CHRC0209	512200	7102500	26/11/2010	Uncased	12	10.23
CHRC0209	512200	7102500	15/01/2011		12	10.30
CHRC0210	512000	7102500	26/11/2010	Uncased	12	11.48
CHRC0210	512000	7102500	15/01/2011		12	10.45
CHRC0211	512100	7103000	26/11/2010	Uncased	12	10.11
CHRC0211	512100	7103000	15/01/2011		12	10.00
CHRC0214	511600	7105000	26/11/2010	Uncased	na	10.55
CHRC0214	511600	7105000	15/01/2011		na	10.42
CHRC0215	511400	7105000	26/11/2010	Uncased	12	10.35
CHRC0215	511400	7105000	15/01/2011		12	10.21
CHRC0217	511400	7105850	26/11/2010	Uncased	12	10.19
CHRC0217	511400	7105850	16/01/2011		12	10.53
CHRC0223	511100	7106000	26/11/2010	Uncased	12	10.00
CHRC0223	511100	7106000	15/01/2011		12	10.13

Pipalyatjara calcrete (continued)

UTM format used is WGS 84: zone 52 J

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Hole name	Eastings	Northings	Sample Date	Casing Description	EOH	SWL
CHRC0228	511600	7106000	26/11/2010	Uncased	12	10.56
CHRC0228	511600	7106000	15/01/2011		12	10.84
CHRC0231	511200	7105670	26/11/2010	Uncased	12	10.58
CHRC0231	511200	7105670	15/01/2011		12	11.55
CHRC0236	511700	7105670	26/11/2010	Uncased	12	10.83
CHRC0236	511700	7105670	14/01/2011		na	na
CHRC0241	511500	7105250	26/11/2010	Uncased	12	9.85
CHRC0241	511500	7105250	15/01/2011		12	9.80
CHRC0244	511800	7105250	28/11/2010	Uncased	18	12.54
CHRC0244	511800	7105250	16/01/2011		na	12.64

APPENDIX B

Representative Survey Site Photos

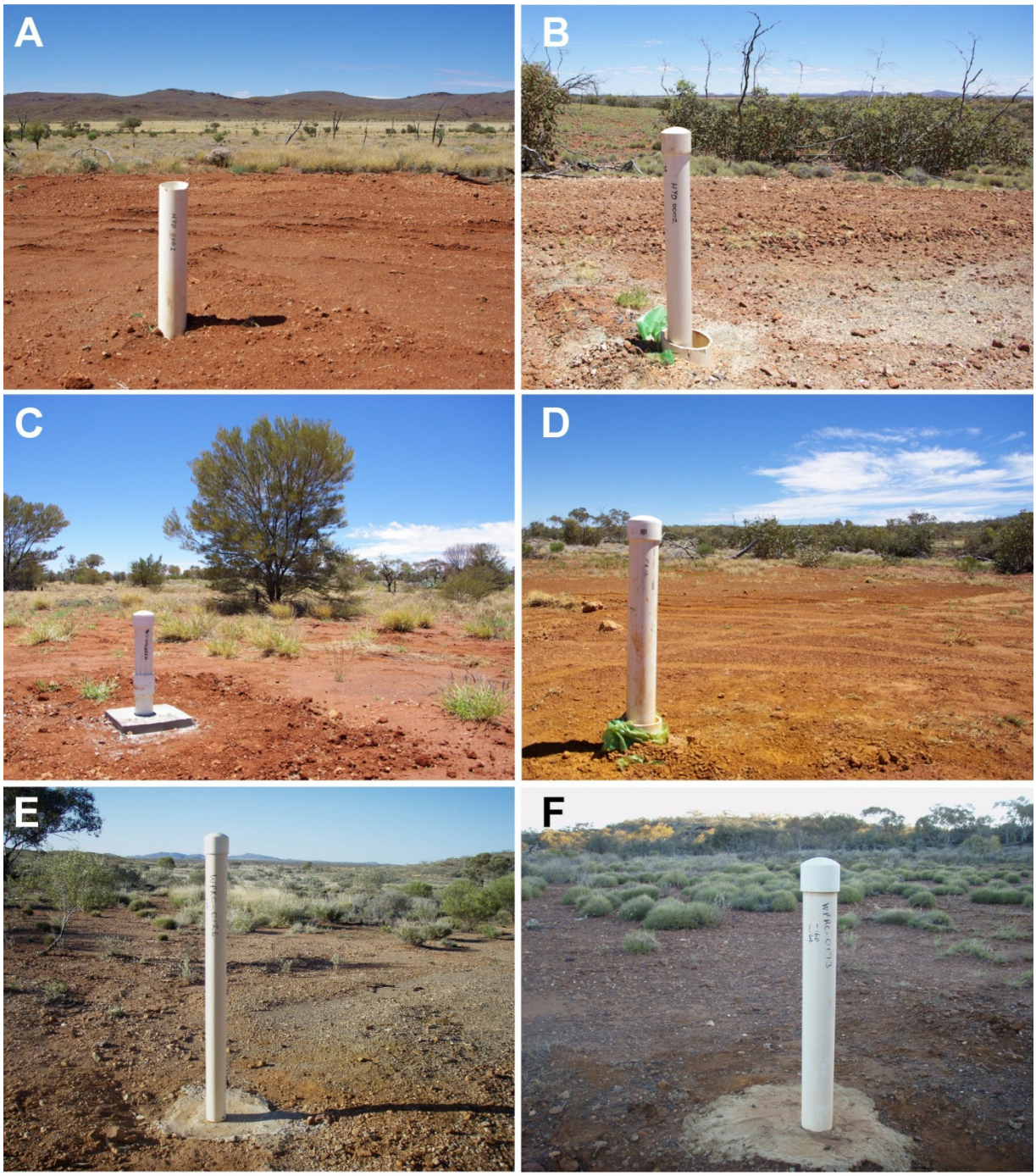


Plate 1: Representation of Wingellina Pit study area holes: A) HYDT0001, B) HYDT0002, C) HYDT0006, D) PB12, E) WPRC0126 and F) WPRC0173.

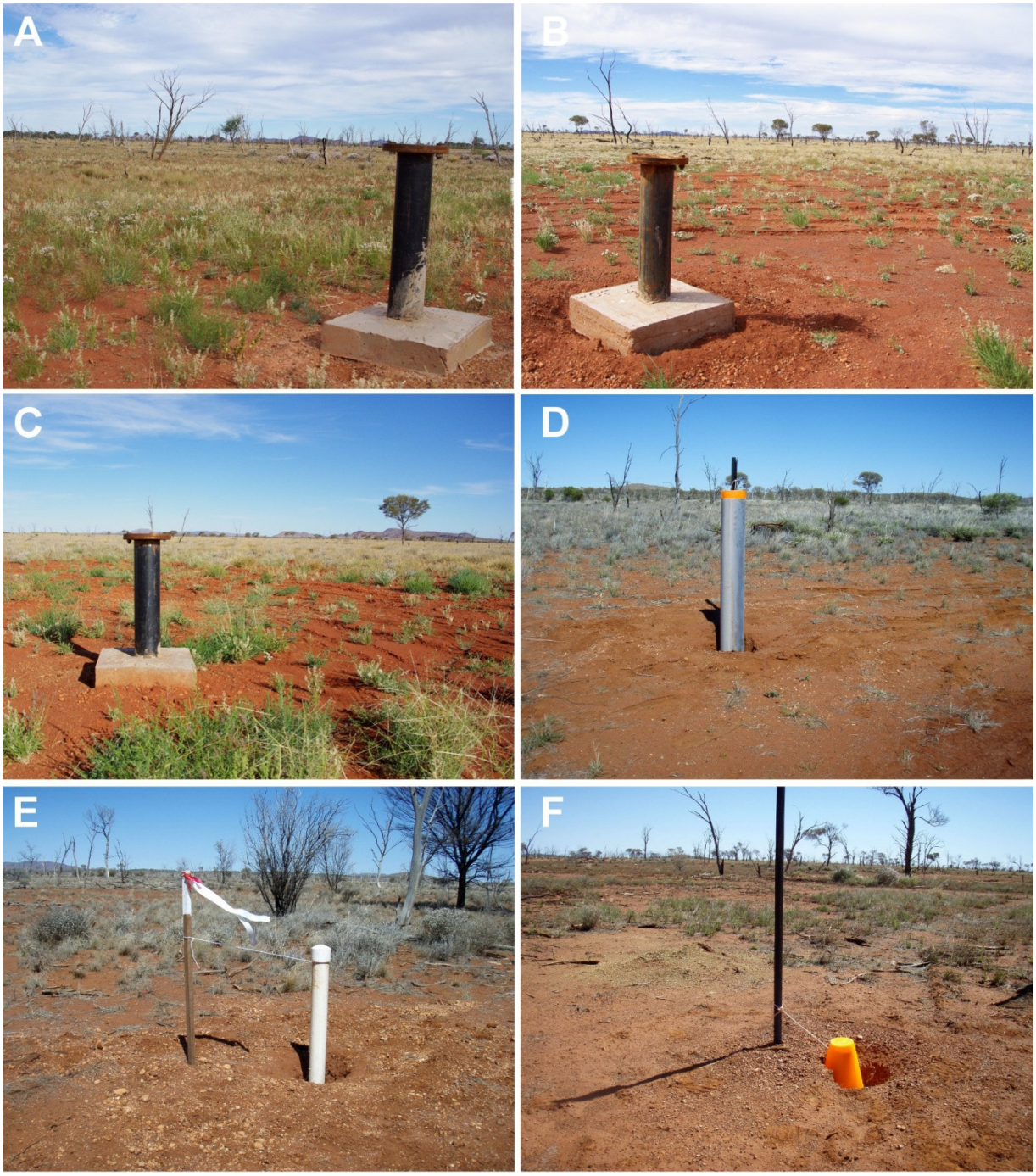


Plate 2. Representation of Wingellina TSF survey area holes: A) MB01, B) MB2, C) MB05, D) RH01b, E) RH02a and F) RH05a.

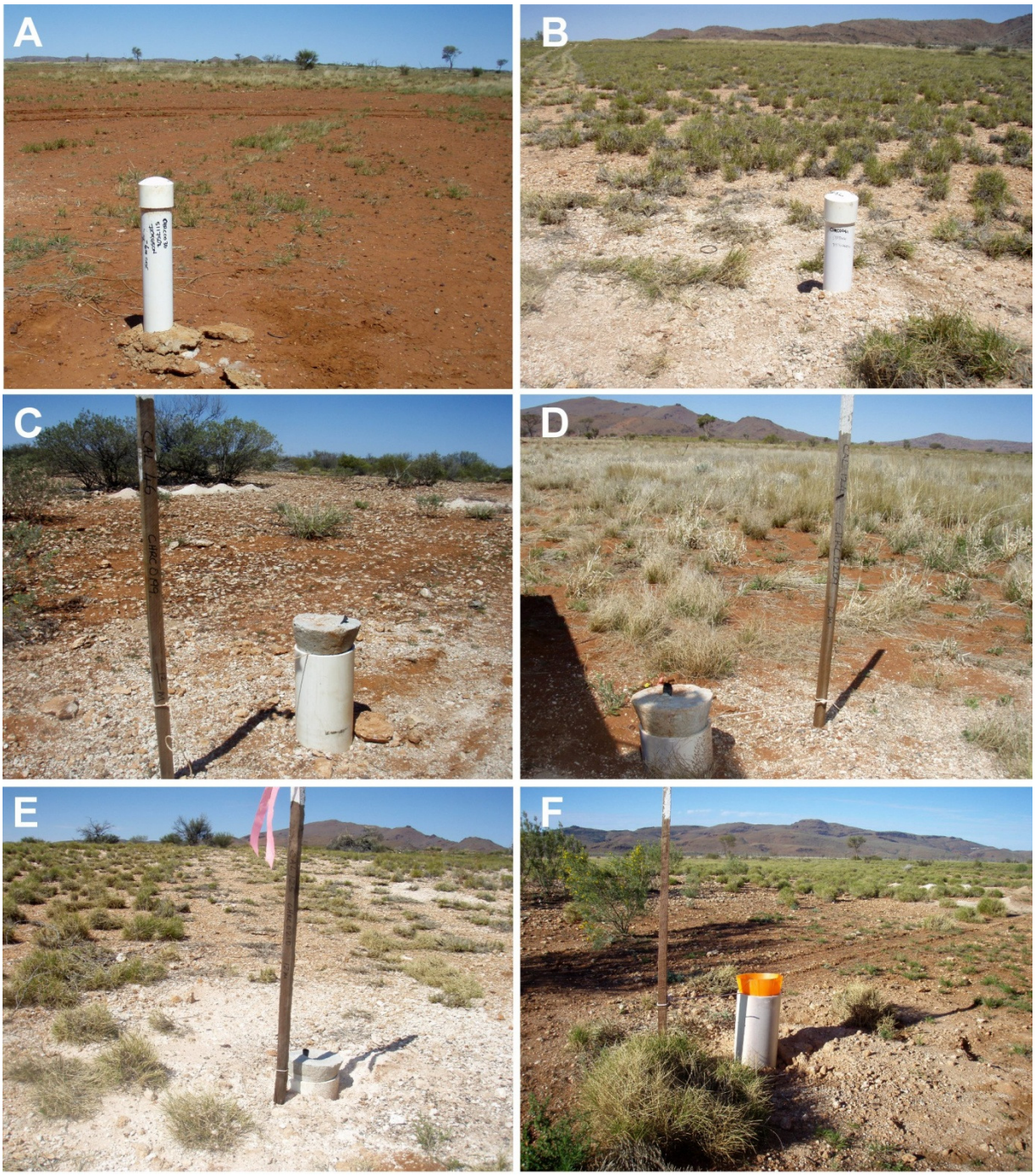


Plate 3. Representation of Pipalyatjara calcrete deposit survey holes: A) CHRC0036, B) CHRC0041, C) CHRC0199, D) CHRC0209, E) CHRC0210 and F) CHRC0217.

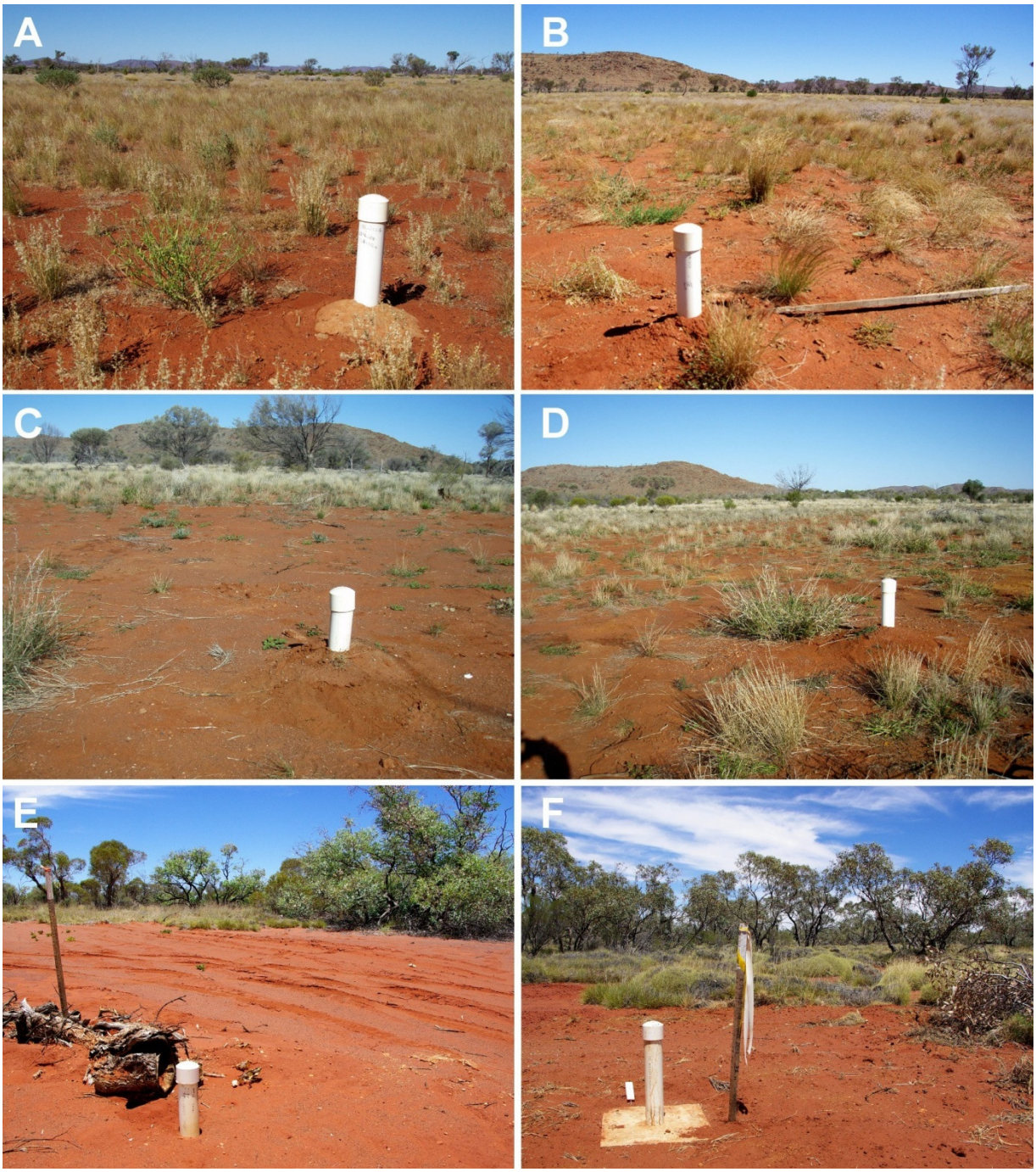


Plate 4. Representation of Area 3, the Wedge and Yapan exploration areas survey holes: A) CHRC0124, B) CHRC0137, C) CHRC0151, D) CHRC0166, E) CHRC0185 and F) MDRC0077.

APPENDIX C

Troglofauna Survey Hole Data

Wingellina TSF

UTM format used is WGS 84: zone 52 J

Hole name	Eastings	Northings	Start Date	End Date	Trap Depth
RH01b	495128	7121413	22/09/2010	26/11/2010	5
RH01b	495128	7121413	26/11/2010	14/01/2011	5
RH02a	496418	7122123	22/09/2010	26/11/2010	14
RH02a	496418	7122123	26/11/2010	14/01/2011	14
RH02b	496410	7122123	22/09/2010	26/11/2010	5
RH02b	496410	7122123	26/11/2010	14/01/2011	5
RH03a	497524	7121892	22/09/2010	26/11/2010	12
RH03a	497524	7121892	26/11/2010	14/01/2011	12
RH03b	497463	7121840	22/09/2010	26/11/2010	5
RH03b	497463	7121840	26/11/2010	14/01/2011	5
RH04a	497930	7121326	22/09/2010	26/11/2010	12
RH04a	497930	7121326	26/11/2010	14/01/2011	12
RH05a	498136	7120544	22/09/2010	26/11/2010	10
RH05a	498136	7120544	26/11/2010	14/01/2011	10
RH05b	498136	7120544	22/09/2010	26/11/2010	5
RH05b	498136	7120544	26/11/2010	14/01/2011	5
RH06a	497802	7119486	22/09/2010	26/11/2010	8
RH06a	497802	7119486	26/11/2010	14/01/2011	8
RH06b	497802	7119480	22/09/2010	26/11/2010	5
RH06b	497802	7119480	26/11/2010	14/01/2011	5
RH07a	498280	7122101	22/09/2010	26/11/2010	11
RH07a	498280	7122101	26/11/2010	14/01/2011	11
RH07b	498280	7122101	22/09/2010	LOST	4
RH07b	498280	7122101	26/11/2010	14/01/2011	4
RH08	498911	7121108	22/09/2010	LOST	10
RH08	498911	7121108	26/11/2010	14/01/2011	10

Pipalyatjara calcrete

UTM format used is WGS 84: zone 52 J

Hole name	Eastings	Northings	Start Date	End Date	Trap Depth (m)
CHRC0199	512600	7099000	23/09/2010	26/11/2010	10
CHRC0199	512600	7099000	26/11/2010	14/01/2011	10
CHRC0199	512600	7099000	15/01/2011	11/04/2011	10
CHRC0200	512200	7099000	23/09/2010	26/11/2010	7
CHRC0200	512200	7099000	26/11/2010	14/01/2011	7
CHRC0200	512200	7099000	15/01/2011	11/04/2011	7
CHRC0201	511600	7099400	23/09/2010	26/11/2010	8
CHRC0201	511600	7099400	26/11/2010	14/01/2011	8
CHRC0201	511600	7099400	15/01/2011	11/04/2011	8
CHRC0202	511600	7099800	23/09/2010	26/11/2010	7
CHRC0202	511600	7099800	26/11/2010	14/01/2011	7
CHRC0202	511600	7099800	15/01/2011	11/04/2011	7
CHRC0205	512000	7099400	23/09/2010	26/11/2010	8
CHRC0205	512000	7099400	26/11/2010	14/01/2011	8
CHRC0205	512000	7099400	15/01/2011	11/04/2011	8
CHRC0206	512400	7099400	23/09/2010	26/11/2010	9
CHRC0206	512400	7099400	26/11/2010	14/01/2011	9
CHRC0206	512400	7099400	15/01/2011	11/04/2011	9
CHRC0207	512400	7099800	23/09/2010	26/11/2010	9
CHRC0207	512400	7099800	26/11/2010	14/01/2011	9
CHRC0207	512400	7099800	15/01/2011	11/04/2011	9
CHRC0208	512800	7099400	23/09/2010	26/11/2010	9
CHRC0208	512800	7099400	26/11/2010	14/01/2011	9
CHRC0208	512800	7099400	15/01/2011	11/04/2011	9
CHRC0209	512200	7102500	23/09/2010	26/11/2010	9
CHRC0209	512200	7102500	26/11/2010	14/01/2011	9
CHRC0209	512200	7102500	15/01/2011	11/04/2011	9
CHRC0210	512000	7102500	23/09/2010	26/11/2010	9
CHRC0210	512000	7102500	26/11/2010	14/01/2011	9
CHRC0210	512000	7102500	15/01/2011	11/04/2011	9
CHRC0211	512100	7103000	23/09/2010	26/11/2010	9
CHRC0211	512100	7103000	26/11/2010	14/01/2011	9
CHRC0211	512100	7103000	15/01/2011	11/04/2011	9
CHRC0212	511800	7104000	23/09/2010	26/11/2010	9
CHRC0212	511800	7104000	26/11/2010	14/01/2011	9
CHRC0212	511800	7104000	15/01/2011	11/04/2011	9
CHRC0213	511600	7104000	23/09/2010	LOST	9
CHRC0213	511600	7104000	26/11/2010	14/01/2011	9
CHRC0213	511600	7104000	15/01/2011	11/04/2011	9
CHRC0214	511600	7105000	23/09/2010	26/11/2010	9
CHRC0214	511600	7105000	26/11/2010	14/01/2011	9
CHRC0214	511600	7105000	15/01/2011	11/04/2011	9
CHRC0215	511400	7105000	23/09/2010	26/11/2010	9
CHRC0215	511400	7105000	26/11/2010	14/01/2011	9
CHRC0215	511400	7105000	15/01/2011	11/04/2011	9
CHRC0216	511400	7105500	23/09/2010	26/11/2010	9
CHRC0216	511400	7105500	26/11/2010	14/01/2011	9
CHRC0216	511400	7105500	15/01/2011	11/04/2011	9

Pipalyatjara calcrete (continued)

UTM format used is WGS 84: zone 52 J

Hole name	Eastings	Northings	Start Date	End Date	Trap Depth
CHRC0217	511400	7105850	23/09/2010	26/11/2010	9
CHRC0217	511400	7105850	26/11/2010	14/01/2011	9
CHRC0217	511400	7105850	15/01/2011	11/04/2011	9
CHRC0218	511400	7105850	23/09/2010	26/11/2010	9
CHRC0218	511400	7105850	26/11/2010	14/01/2011	9
CHRC0218	511400	7105850	15/01/2011	LOST	9
CHRC0223	511100	7106000	23/09/2010	26/11/2010	9
CHRC0223	511100	7106000	26/11/2010	14/01/2011	9
CHRC0223	511100	7106000	15/01/2011	11/04/2011	9
CHRC0228	511600	7106000	23/09/2010	26/11/2010	9
CHRC0228	511600	7106000	26/11/2010	14/01/2011	9
CHRC0228	511600	7106000	15/01/2011	11/04/2011	9
CHRC0231	511200	7105670	23/09/2010	26/11/2010	9
CHRC0231	511200	7105670	26/11/2010	14/01/2011	9
CHRC0231	511200	7105670	15/01/2011	LOST	9
CHRC0236	511700	7105670	23/09/2010	26/11/2010	9
CHRC0236	511700	7105670	26/11/2010	14/01/2011	9
CHRC0236	511700	7105670	15/01/2011	LOST	9
CHRC0237	511100	7105250	23/09/2010	26/11/2010	9
CHRC0237	511100	7105250	26/11/2010	14/01/2011	9
CHRC0237	511100	7105250	15/01/2011	11/04/2011	9
CHRC0241	511500	7105250	23/09/2010	26/11/2010	8
CHRC0241	511500	7105250	26/11/2010	14/01/2011	8
CHRC0241	511500	7105250	15/01/2011	LOST	8

APPENDIX D

Protected Matters Search Tool Results

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

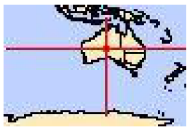
EPBC Act Protected Matters Report: Coordinates

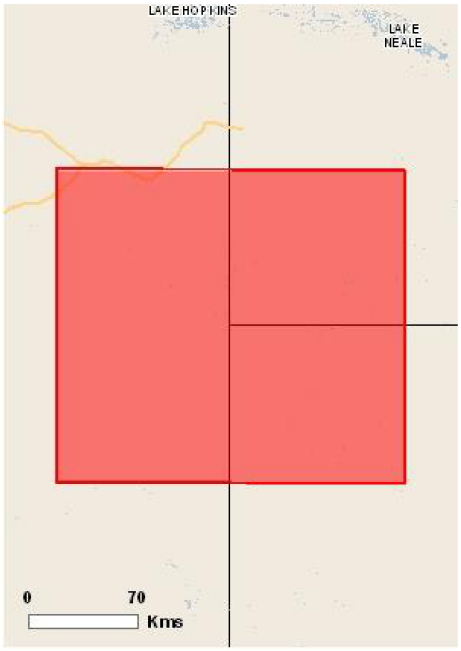
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 27/06/11 14:26:12





This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 1.0Km

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance (Ramsar Wetlands):	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communitites:	None
Threatened Species:	6
Migratory Species:	5

Other Matters Protected by the EPBC Act

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

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

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

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

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	4
Whales and Other Cetaceans:	None

Critical Habitats:	None
Commonwealth Reserves:	None

Report Summary for Extra Information

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

Place on the RNE:	1
State and Territory Reserves:	3
Regional Forest Agreements:	None
Invasive Species:	4
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

Threatened Species		**[Resource Information]**
Name	Status	Type of Presence
BIRDS		
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
MAMMALS		
Dasycercus cristicauda Mulgara [328]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes typhlops Southern Marsupial Mole, Yitjarritjarri, Itjaritjari [296]	Endangered	Species or species habitat likely to occur within area
Petrogale lateralis MacDonnell Ranges race Warru, Black-footed Rock-wallaby (MacDonnell Ranges race) [66649]	Vulnerable	Species or species habitat may occur within area
Sminthopsis psammophila Sandhill Dunnart [291]	Endangered	Species or species habitat likely to occur within area
REPTILES		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Migratory Species		**[Resource Information]**
Name	Status	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area

Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Defence - WOOMERA AIR WEAPONS RANGE

Listed Marine Species [Resource Information]

Name	Status	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	Status
Natural	
Ranges of the Western Desert WA	Registered

State and Territory Reserves [Resource Information]

Watarru, SA
Kalka / Pipalyatjara, SA
Ngaanyatjarra, WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area

Oryctolagus cuniculus Rabbit, European Rabbit [128]	Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]	Species or species habitat likely to occur within area
Plants	
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]	Species or species habitat may occur within area

Caveat

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

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

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

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

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

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

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

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

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

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

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

Coordinates

-25.09656 128.00625,-25.1037 130.00976,-26.90257 130.0169,-26.89782 128.01101,-25.09656 128.00625

Acknowledgements

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

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

APPENDIX E

Naturemap Database Search Results

NatureMap Species Report

Created By Guest user on 25/08/2011

Method 'By Circle'
Centre 128°56' 44" E,26°03' 00" S
Buffer 40km
Group By Species Group

Species Group	Species	Records
Amphibian	1	3
Bird	67	436
Dicotyledon	96	110
Gymnosperm	1	1
Mammal	2	6
Monocotyledon	14	17
Reptile	7	14
TOTAL	**188**	**587**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Amphibian					
1.	25434	*Pseudophryne occidentalis (Western Toadlet)*			
Bird					
2.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
5.	25536	*Accipiter fasciatus (Brown Goshawk)*			
6.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
7.	25646	*Amytornis purnelli (Dusky Grasswren)*			
8.	24538	*Amytornis purnelli subsp. purnelli*			
9.	24316	*Anas superciliosa (Pacific Black Duck)*			
10.	-396	*Anthus novaeseelandiae*			
11.	25528	*Aphelocephala leucopsis (Southern Whiteface)*			
12.	24610	*Ardeotis australis (Australian Bustard)*		P4	
13.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
14.	24356	*Artamus personatus (Masked Woodswallow)*			
15.	-326	*Barnardius zonarius*			
16.	-374	*Cacomantis pallidus*			
17.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
18.	-386	*Cheramoeca leucosterna*			
19.	24833	*Cincloramphus cruralis (Brown Songlark)*			
20.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			
21.	24289	*Circus assimilis (Spotted Harrier)*			
22.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
23.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
24.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
25.	24416	*Corvus bennetti (Little Crow)*			
26.	25593	*Corvus orru (Torresian Crow)*			
27.	-419	*Corvus sp.*			
28.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
29.	25595	*Cracticus tibicen (Australian Magpie)*			
30.	25596	*Cracticus torquatus (Grey Butcherbird)*			
31.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
32.	-384	*Elanus axillaris*			
33.	24570	*Epthianura tricolor (Crimson Chat)*			
34.	24368	*Eurostopodus argus (Spotted Nightjar)*			
35.	25621	*Falco berigora (Brown Falcon)*			
36.	25622	*Falco cenchroides (Australian Kestrel)*			
37.	25623	*Falco longipennis (Australian Hobby)*			
38.	24401	*Geopelia cuneata (Diamond Dove)*			
39.	24443	*Grallina cyanoleuca (Magpie-lark)*			
40.	-334	*Lalage sueurii*			
41.	24578	*Lichenostomus penicillatus (White-plumed Honeyeater)*			

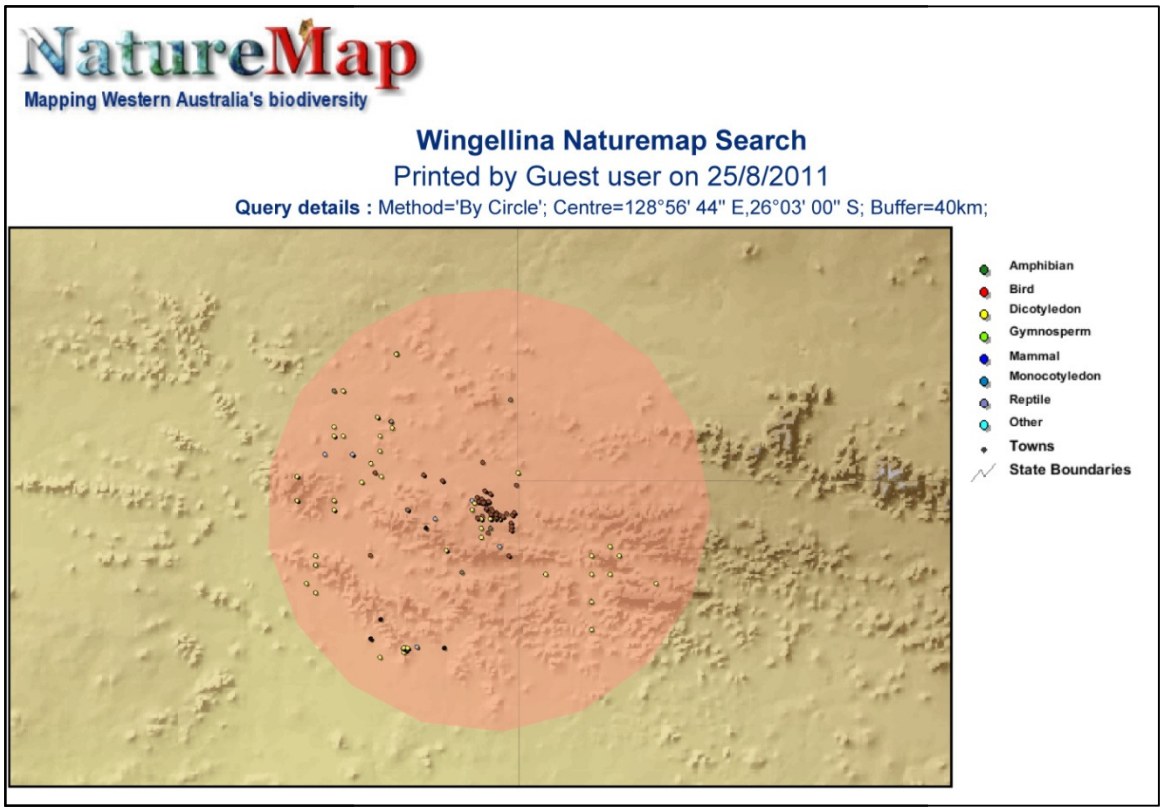
	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
42.	24579	*Lichenostomus plumulus (Grey-fronted Honeyeater)*			
43.	24581	*Lichenostomus virescens (Singing Honeyeater)*			
44.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
45.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
46.	24583	*Manorina flavigula (Yellow-throated Miner)*			
47.	-354	*Melanodryas cucullata*			
48.	24736	*Melopsittacus undulatus (Budgerigar)*			
49.	24598	*Merops ornatus (Rainbow Bee-eater)*			
50.	25693	*Microeca fascinans (Jacky Winter)*			
51.	25542	*Milvus migrans (Black Kite)*			
52.	-323	*Neopsephotus bourkii*			
53.	24742	*Nymphicus hollandicus (Cockatiel)*			
54.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
55.	24618	*Oreoica gutturalis (Crested Bellbird)*			
56.	34012	*Oreoica gutturalis subsp. pallescens (Crested Bellbird)*			
57.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
58.	24627	*Pardalotus rubricatus (Red-browed Pardalote)*			
59.	24409	*Phaps chalcoptera (Common Bronzewing)*			
60.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
61.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
62.	-348	*Psephotus varius*			
63.	-409	*Purnella albifrons*			
64.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
65.	25656	*Stipiturus ruficeps (Rufous-crowned Emu-wren)*			
66.	30870	*Taeniopygia guttata (Zebra Finch)*			
67.	-397	*Todiramphus pyrrhopygius*			
68.	24851	*Turnix velox (Little Button-quail)*			
Dicotyledon					
69.	3364	*Acacia helmsiana*			
70.	3419	*Acacia ligulata (Umbrella Bush)*			
71.	19305	*Acacia melleodora*			
72.	12952	*Acacia minyura*			
73.	3473	*Acacia oswaldii (Miljee)*			
74.	3475	*Acacia pachyacra*			
75.	36800	*Acacia pteraneura*			
76.	3563	*Acacia strongylophylla (Round-leaf Wattle)*			
77.	3577	*Acacia tetragonophylla (Kurara)*			
78.	3592	*Acacia validinervia*			
79.	7817	*Actinobole uliginosum (Flannel Cudweed)*			
80.	19469	*Aluta maisonneuvei subsp. maisonneuvei*			
81.	2333	*Anthobolus leptomerioides*			
82.	2456	*Atriplex elachophylla*			
83.	2774	*Boerhavia repleta*			
84.	2775	*Boerhavia schomburgkiana*			
85.	4999	*Brachychiton gregorii (Desert Kurrajong)*			
86.	7413	*Brunonia australis (Native Cornflower)*			
87.	2860	*Calandrinia polyandra (Parakeelya)*			
88.	7904	*Calotis latiuscula*		P3	
89.	-9825	*Calotis sp.*			
90.	-11998	*Chthonocephalus sp.*			
91.	-4261	*Corymbia terminalis*			
92.	3774	*Crotalaria cunninghamii (Green Birdflower)*			
93.	6752	*Dicrastylis beveridgei*			
94.	6762	*Dicrastylis gilesii*			
95.	11704	*Einadia nutans subsp. eremaea (Climbing Saltbush)*			
96.	15052	*Eremophila forrestii subsp. forrestii*			
97.	7213	*Eremophila gibsonii*			
98.	16732	*Eremophila gilesii subsp. gilesii*			
99.	15054	*Eremophila platythamnos subsp. exotrachys*			
100.	4331	*Erodium aureum*	Y		
101.	20530	*Erodium carolinianum*			
102.	4334	*Erodium crinitum (Corkscrew)*			
103.	5655	*Eucalyptus gamophylla (Twin-leaf Mallee)*			
104.	18057	*Eucalyptus gypsophila*			
105.	13019	*Eucalyptus mannensis subsp. mannensis*			
106.	5734	*Eucalyptus oxymitra (Sharp-capped Mallee)*			
107.	5773	*Eucalyptus socialis (Red Mallee)*			
108.	29733	*Eucalyptus trivalva (Victoria Spring Mallee)*			
109.	4617	*Euphorbia australis (Namana)*			
110.	4637	*Euphorbia parvicaruncula*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
				P1	
111.	12097	*Euphorbia tannensis subsp. eremophila (Desert Spurge)*			
112.	7498	*Goodenia centralis*			
113.	7529	*Goodenia mueckeana*			
114.	2789	*Gyrostemon tepperi*			
115.	6700	*Heliotropium asperrimum (Rough Heliotrope)*			
116.	8089	*Ixiochlamys filicifolia*			
117.	19636	*Keraudrenia velutina subsp. elliptica*			
118.	13289	*Lawrencella davenportii*			
119.	-11473	*Leiocarpa panaetioides*			
120.	3033	*Lepidium oxytrichum*			
121.	3037	*Lepidium phlebopetalum (Veined Peppercress)*			
122.	2562	*Maireana scleroptera*			
123.	5906	*Melaleuca dissitiflora*			
124.	5915	*Melaleuca glomerata*			
125.	3052	*Menkea lutea*		P1	
126.	3053	*Menkea sphaerocarpa*			
127.	3054	*Menkea villosula*			
128.	6793	*Newcastelia spodiotricha*			
129.	6981	*Nicotiana velutina*			
130.	6723	*Omphalolappula concava (Burr Stickseed)*			
131.	7300	*Plantago drummondii (Sago Weed)*			
132.	12702	*Prostanthera sericea*			
133.	8191	*Pterocaulon serrulatum*			
134.	2709	*Ptilotus chippendalei*			
135.	11225	*Ptilotus exaltatus var. exaltatus (Tall Mulla Mulla)*			
136.	2731	*Ptilotus helipteroides (Hairy Mulla Mulla)*			
137.	2741	*Ptilotus macrocephalus (Featherheads)*			
138.	2747	*Ptilotus obovatus (Cotton Bush)*			
139.	2751	*Ptilotus polystachyus (Prince of Wales Feather)*			
140.	10809	*Ptilotus sessilifolius*			
141.	2582	*Rhagodia eremaea (Thorny Saltbush)*			
142.	13254	*Rhodanthe stricta*			
143.	13299	*Rhodanthe tietkensii*			
144.	11609	*Rostellularia adscendens var. pogonanthera*			
145.	30434	*Salsola australis*			
146.	13006	*Sarcostemma viminale subsp. australe*			
147.	20226	*Sauropus sp. Central Ranges (D.J. Edinger et al. 2420)*			
148.	13285	*Schoenia ayersii*			
149.	8200	*Schoenia cassiniana (Schoenia)*			
150.	2602	*Sclerolaena convexula*			
151.	9366	*Senecio gregorii (Fleshy Groundsel)*			
152.	35376	*Sida cunninghamii*			
153.	6995	*Solanum centrale (Desert Raisin)*			
154.	7006	*Solanum ellipticum (Potato Bush)*			
155.	7018	*Solanum lasiophyllum (Flannel Bush)*			
156.	7028	*Solanum petrophilum (Rock Nightshade)*			
157.	7036	*Solanum sturtianum (Thargomindah Nightshade)*			
158.	3082	*Stenopetalum velutinum (Velvet Thread Petal)*			
159.	4238	*Swainsona oroboides (Variable Swainsona)*			
160.	13585	*Swainsona tenuis*			
161.	11317	*Teucrium grandiusculum subsp. grandiusculum*		P2	Y
162.	-8603	*Xerochrysum sp.*			
163.	18140	*Zygophyllum eichleri*			
164.	4396	*Zygophyllum tesquorum*			
Gymnosperm					
165.	8466	*Callitris columellaris (White Cypress Pine)*			
Mammal					
166.	24216	*Leggadina forresti (Forrest's Mouse)*			
167.	34048	*Petrogale lateralis subsp. ssp. (ANWC CM15314) (Black-footed Rock-wallaby)*		T	
Monocotyledon					
168.	207	*Aristida contorta (Bunched Kerosene Grass)*			
169.	12063	*Aristida holathera var. holathera*			
170.	310	*Digitaria brownii (Cotton Panic Grass)*			
171.	365	*Enneapogon polyphyllus (Leafy Nineawn)*			
172.	386	*Eragrostis laniflora (Hairy-flowered Woollybutt)*			
173.	393	*Eragrostis setifolia (Neverfail Grass)*			
174.	399	*Eragrostis xerophila (Knotty-butt Neverfail)*			
175.	11011	*Eulalia aurea*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
176.	514	*Paractaenum refractum*			
177.	673	*Themeda triandra*			
178.	17879	*Triodia helmsii*			
179.	688	*Triodia irritans (Porcupine Grass)*			
180.	706	*Triraphis mollis (Needle Grass)*			
181.	1257	*Xanthorrhoea thorntonii (Grass Tree)*			
Reptile					
182.	24882	*Ctenophorus nuchalis (Central Netted Dragon)*			
183.	25052	*Ctenotus leonhardii*			
184.	24953	*Gehyra montium*			
185.	24959	*Gehyra variegata*			
186.	25184	*Menetia greyii*			
187.	25199	*Proablepharus reginae*			
188.	25215	*Varanus gilleni (Pygmy Mulga Monitor)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



APPENDIX F

Groundwater Physicochemical Data

Wingellina Pit

EC = Electrical conductivity

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Bore ID	Survey Date	SWL	EoH	pH	Salinity (ppm)	EC (µS/cm)	Temp (°C)	DO (ppm)	Redox (mV)
BORE 2	9/04/2008	41.82	78	7.62	1303	2144	25.5	2.0	na
BORE 4	9/04/2008	38.72	85	6.81	86	158	27.0	0.9	na
Camp Bore	10/04/2008	na	n	7.75	1078	1776	28.0	4.3	na
HYDT0001	1/12/2010	24.24	100	8.23	297	715	26.7	2.2	-223
HYDT0001	18/01/2011	24.50	na	8.15	219	557	27.3	4.4	-54
HYDT0002	1/12/2010	57.80	100	na	na	na	na	na	na
HYDT0002	18/01/2011	57.81	100	9.83	558	1367	25.9	7.3	48
HYDT0003	1/12/2010	52.40	100	na	na	na	na	na	na
HYDT0003	18/01/2011	54.43	100	7.34	549	1363	28.4	5.1	83
HYDT0004	1/12/2010	56.02	na	na	na	na	na	na	na
HYDT0004	18/01/2011	55.92	100	8.69	618	1498	37	5.6	40
HYDT0006	1/12/2010	na	100	8.23	505	1198	28.7	2.2	109
HYDT0006	18/01/2011	17.43	100	7.86	539	1354	25.5	5.2	114
HYDT0007	1/12/2010	39.56	100	8.30	777	1726	30.9	2.0	-287
HYDT0007	18/01/2011	na	na	na	na	na	na	na	na
HYDT0008	30/11/2010	na	70	7.87	897	2053	26.3	5.4	40
HYDT0008	18/01/2011	28.32	70	7.45	1090	2650	30.1	5.5	89
INCO Bore	9/04/2008	12.90	14	7.09	2200	3550	27.40	0.7	na
PB10	1/12/2010	38.68	75	7.80	1440	3250	24.6	2.0	-24
PB10	18/01/2011	38.36	75	7.43	1009	2412	28.9	4.7	-14
PB11	1/12/2010	52.76	75	7.75	1030	2490	24.9	3.0	74
PB11	18/01/2011	52.49	75	7.48	754	1881	32.4	5.6	104
PB12	1/12/2010	42.95	75	7.71	595	1374	29.3	2.6	78
PB12	18/01/2011	54.28	75	7.47	650	1577	28.1	4.6	143
WPRC0102	9/04/2008	51.00	70	7.33	1022	1694	25.0	7.8	na
WPRC0126	9/04/2008	43.54	76	7.77	903	1531	24.6	1.6	na
WPRC0126	22/09/2010	42.71	53	7.39	890	1752	25.0	1.9	115
WPRC0137	9/04/2008	38.18	52	7.69	1119	1831	26.1	2.2	na
WPRC0171	9/04/2008	53.63	70	8.07	1280	2090	27.4	1.5	na
WPRC0173	9/04/2008	38.82	70	8.72	1339	2173	25.1	1.7	na
WPRC0173	22/09/2010	38.97	70	na	na	na	na	na	na
WPRC0334	9/04/2008	52.54	60	8.21	854	775	27.0	4.7	na
WPRC0363	9/04/2008	51.65	60	7.86	1154	1876	27.5	2.1	na
WPRC0444	9/04/2008	48.68	60	7.66	1377	2251	25.0	1.0	na
WPRC0658	9/04/2008	41.82	62	7.62	1303	2144	25.5	2.0	na

Wingellina TSF

EC = Electrical conductivity

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Bore ID	Survey Date	SWL	EoH	pH	Salinity (ppm)	EC (µS/cm)	Temp (°C)	DO (ppm)	Redox (mV)
MB01	30/11/2010	29.82	40	7.49	1320	2930	26.8	2.1	-178
MB01	18/01/2011	29.32	40	7.34	779	1858	30.0	4.5	-98
MB02	28/11/2010	25.85	36	7.18	3980	8360	25.6	2.0	-140
MB02	18/01/2011	25.61	36	6.99	2650	6110	30.0	4.2	-97
MB04	30/11/2010	18.06	30	7.94	321	783	27.5	4.6	131
MB04	18/01/2011	17.74	30	8.03	364	907	29.9	6.7	53
MB05	30/11/2010	17.96	30	7.30	4650	9970	27.6	5.8	139
MB05	18/01/2011	17.90	30	7.15	2950	6860	29.7	8.1	95

Pipalyatjara Calcrete Deposit

EC = Electrical conductivity

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Bore ID	Survey Date	SWL	EoH	pH	Salinity (ppm)	EC (µS/cm)	Temp (°C)	DO (ppm)	Redox (mV)
CHRC0036	24/09/2010	11.07	na	7.76	630	1271	25.2	4.7	82
CHRC0036	28/11/2010	11.07	na	7.94	506	1191	25.9	6.4	51
CHRC0036	16/01/2011	11.28	na	7.78	490	1209	28.3	7.6	96
CHRC0038	24/09/2010	9.90	30	7.72	500	1012	25	4.6	82
CHRC0038	28/11/2010	10.00	na	7.82	241	583	25.8	1.9	-260
CHRC0038	16/01/2011	10.03	na	6.33	187	486	26.4	5.8	-214
CHRC0041	24/09/2010	11.24	30	7.61	550	1108	25.3	4.5	83
CHRC0041	27/11/2010	11.24	na	7.83	420	980	25.4	6.9	114
CHRC0041	15/01/2011	11.30	na	7.82	418	1029	31	6.1	-194
CHRC0045	24/09/2010	9.37	30	7.77	510	1035	25.6	4.7	85
CHRC0045	28/11/2010	9.41	na	7.95	400	893	25.1	5.4	126
CHRC0045	15/01/2011	9.35	na	7.73	261	657	31.9	4.9	80
CHRC0048	24/09/2010	10.76	30	7.59	530	1073	24.8	2.7	88
CHRC0048	28/11/2010	10.85	na	7.85	369	882	23.3	3.5	141
CHRC0048	15/01/2011	10.80	na	7.60	380	958	32.5	6.6	101
CHRC0050	24/09/2010	11.37	30	7.62	560	1119	24.7	5.1	90
CHRC0050	27/11/2010	11.30	na	7.88	297	707	25.5	6.1	120
CHRC0050	15/01/2011	11.26	na	7.60	304	759	31.5	7.5	81
CHRC0053	24/09/2010	10.15	18	7.58	570	1118	24.2	4.3	90
CHRC0053	27/11/2010	10.15	na	7.75	464	1093	26.3	5.4	128
CHRC0053	15/01/2011	10.17	na	7.47	293	747	32.8	9.3	65
CHRC0057	24/09/2010	11.14	30	7.71	590	1162	23.3	5.0	na
CHRC0057	27/11/2010	11.25	na	7.94	456	1072	26.6	6.0	36
CHRC0057	15/01/2011	11.29	na	7.69	300	759	32.9	9.1	6
CHRC0199	26/11/2010	11.47	12	7.89	509	1192	26.8	3.0	-141
CHRC0199	15/01/2011	11.40	12	7.90	327	835	31.3	6.1	95
CHRC0200	26/11/2010	8.85	12	7.09	489	1148	26	5.9	136
CHRC0200	15/01/2011	8.78	12	7.75	311	785	30.9	10.1	106
CHRC0201	26/11/2010	9.26	12	7.90	427	1007	26.3	5.8	120
CHRC0201	15/01/2011	9.26	12	7.77	383	1064	30.4	10.7	106
CHRC0202	26/11/2010	8.60	12	7.92	435	1029	26.4	5.8	69
CHRC0202	15/01/2011	8.60	12	7.91	280	719	30.1	9.1	121
CHRC0205	26/11/2010	9.30	12	7.74	497	1169	25.9	5.2	127
CHRC0205	15/01/2011	9.37	12	7.58	479	878	31.2	9.3	162
CHRC0206	26/11/2010	10.52	12	8.02	314	732	24.9	5.5	129
CHRC0206	15/01/2011	10.50	12	7.84	341	855	31.3	8.7	140
CHRC0208	26/11/2010	10.17	12	7.26	421	1000	24.9	6.7	214
CHRC0208	15/01/2011	10.10	12	7.40	284	715	28.2	5.2	13
CHRC0209	26/11/2010	10.23	12	7.69	514	1208	26.1	3.1	108
CHRC0209	15/01/2011	10.30	12	6.99	425	1060	32	3.3	-314
CHRC0210	26/11/2010	11.48	12	8.06	523	1224	25.7	2.1	-260
CHRC0210	15/01/2011	10.45	12	7.69	379	933	33.1	3.7	-270
CHRC0211	26/11/2010	10.11	12	7.88	289	694	26.2	5.7	89
CHRC0211	15/01/2011	10.00	12	7.56	304	765	31.7	9.2	66
CHRC0214	26/11/2010	10.55	na	8.00	441	1041	25.1	5.5	123
CHRC0214	15/01/2011	10.42	na	7.76	439	1093	31.1	8.0	25
CHRC0215	26/11/2010	10.35	12	7.95	420	990	25.4	2.5	-22
CHRC0215	15/01/2011	10.21	12	7.94	271	691	31.9	4.5	82
CHRC0217	26/11/2010	10.19	12	8.08	376	890	25.4	2.7	-57
CHRC0217	16/01/2011	10.53	12	7.40	232	588	26.2	5.9	84

Pipalyatjara Calcrete Deposit (continued)

EC = Electrical conductivity

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Bore ID	Survey Date	SWL	EoH	pH	Salinity (ppm)	EC (µS/cm)	Temp (°C)	DO (ppm)	Redox (mV)
CHRC0223	26/11/2010	10.00	12	8.00	472	1131	25.1	5.6	22
CHRC0223	15/01/2011	10.13	12	7.78	459	1129	30.2	5.8	-184
CHRC0228	26/11/2010	10.56	12	7.84	573	1336	25.8	2.4	-218
CHRC0228	15/01/2011	10.84	12	7.40	525	1294	30.6	5.3	-72
CHRC0231	26/11/2010	10.58	12	7.87	640	1479	25.9	3.1	-7
CHRC0231	15/01/2011	11.55	12	7.67	584	1429	31	4.5	-237
CHRC0236	26/11/2010	10.83	12	7.82	541	1267	26.3	1.7	-262
CHRC0236	14/01/2011	na	na	na	na	na	na	na	na
CHRC0241	26/11/2010	9.85	12	7.91	355	854	25.2	2.9	83
CHRC0241	15/01/2011	9.80	12	7.36	238	602	27.2	5.4	-204
CHRC0244	28/11/2010	12.54	18	8.04	531	1235	25.1	5.7	103
CHRC0244	16/01/2011	12.64	na	7.62	320	812	27.1	8.8	17

Area 3, the Wedge and Yapan

EC = Electrical conductivity

EoH = end of hole (mbgl)

SWL = standing water level (mbgl)

Bore ID	Survey Date	SWL	EoH	pH	Salinity (ppm)	EC (µS/cm)	Temp (°C)	DO (ppm)	Redox (mV)
CHRC0096	24/09/2010	41.56	na	7.51	750	1560	27.1	4.0	82
CHRC0065	29/11/2010	41.36	90	na	na	na	na	na	na
CHRC0065	17/01/2011	41.69	na	7.76	535	1309	29.9	9.3	117
CHRC0073	29/11/2010	41.35	72	7.95	567	1323	28.1	5.7	133
CHRC0080	29/11/2010	na	60	7.80	401	953	29.6	2.3	124
CHRC0096	29/11/2010	na	90	7.74	671	1554	28.7	4.8	163
CHRC0096	16/01/2011	na	na	na	na	na	na	na	na
CHRC0106	29/11/2010	41.10	88	7.96	362	865	28.1	5.1	131
CHRC0106	16/01/2011	41.05	na	7.70	379	935	32.3	6.8	142
CHRC0116	24/09/2010	39.24	72	na	na	na	na	na	na
CHRC0116	30/11/2010	41.81	132	7.92	498	1174	24.9	6.6	137
CHRC0116	17/01/2011	40.77	na	7.60	323	803	31	13.4	118
CHRC0117	29/11/2010	39.76	96	na	na	na	na	na	na
CHRC0117	17/01/2011	39.70	na	7.61	339	853	31.3	12.4	125
CHRC0124	29/11/2010	43.06	60	na	na	na	na	na	na
CHRC0124	17/01/2011	43.22	na	7.91	210	524	29.9	8.4	102
CHRC0137	29/11/2010	42.10	72	7.92	548	1282	28.4	2.7	131
CHRC0137	16/01/2011	41.00	na	7.66	555	1365	31.4	4.4	143
CHRC0151	24/09/2010	40.55	81	7.68	500	1072	27.3	5.0	73
CHRC0151	29/11/2010	41.60	78	7.90	403	951	28.5	6.6	133
CHRC0151	16/01/2011	41.80	na	7.80	253	673	33.5	8.3	142
CHRC0166	24/09/2010	42.85	54	7.55	620	1282	26.7	4.4	82
CHRC0166	29/11/2010	42.95	90	na	na	na	na	na	na
CHRC0166	16/01/2011	43.03	na	7.77	313	773	34.1	7.6	43
CHRC0173	30/11/2010	37.45	60	7.69	353	843	30.1	5.3	113
CHRC0173	17/01/2011	37.31	n	7.35	275	695	34.4	6.9	115
CHRC0185	30/11/2010	na	78	na	na	na	na	na	na
CHRC0185	17/01/2011	43.96	na	7.59	271	689	35.3	8.3	118
MDRC0077	30/11/2010	47.88	72	na	na	na	na	na	na
MDRC0077	17/01/2011	48.00	na	8.22	826	1963	33.0	6.9	-128
MDRC0095	30/11/2010	45.70	93	7.70	489	1144	27.2	2.1	137
MDRC0095	16/01/2011	na	na	na	na	na	na	na	na

APPENDIX G

Morphological assessment of Copepods

Wingellina Nickel Project Copepoda Morphological Assessment

Prepared by
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May, 2011

RE:

Taxa: Copepods
Job Number: TMWN-TF-0510
Region: Wingellina
Total Number of Samples: 4 vials

RESULTS

1, WAM C 47399, LN0733, CHRC0048, 512000, 7104000, S26°11'00" E129°07'16", 11/28/2010, Cyclopoida, 62

Microcyclops varicans (Sars, 1863) – 25 males + 23 females (5 ovigerous) + 25 copepodids

2, WAM C 47400, LN1787, CHRC0048, 512000, 7104001, S26°11'00" E129°07'16", 9/24/2010, Cyclopoida, 70

Microcyclops varicans (Sars, 1863) – 6 males + 13 females (3 ovigerous) + 23 copepodids

3, WAM C 47401, LN1183, CHRC0048, 512000, 7104002, S26°11'00" E129°07'16", 1/15/2011, Cyclopoida, 112

Microcyclops varicans (Sars, 1863) – 23 males + 29 females (12 ovigerous) + 43 copepodids

4, WAM C 47402, LN0166, CHRC0209, 512200, 7102500, S26°11'49" E129°07'20", 11/27/2010, Cyclopoida, 10

Dussartcyclops wingellina n. sp. – 2 males + 6 females + 2 copepodids

SYSTEMATIC LIST

Order Cyclopoida Rafinesque, 1815

Family Cyclopidae Rafinesque, 1815
Subfamily Cyclopinae Rafinesque, 1815
Genus *Microcyclops* Claus, 1893
Microcyclops varicans (Sars, 1863)
Genus *Dussartcyclops* Karanovic et al., 2011 [syn. *Goniocyclops* Kiefer partim.]
Dussartcyclops wingellina n. sp.

COMMENTS

Microcyclops varicans (Sars, 1863)
This is a cosmopolitan and surface water species, recorded many time previously in Australia (Karanovic, 2004, 2006). It explores subterranean waters with good connection to surface habitats, such as pastoral wells, open bores, caves with large entrances, etc. It is a sygophile.

Dussartcyclops sp. TK1 ('wingellina') n. sp.
This species belongs to a recently erected endemic WA genus Dussartcyclops Karanovic, Eberhard & Murdoch (2011). I have other three new species currently from this genus that await description, and they mostly differ in the armature of the swimming legs and proportions of the caudal rami. The population from Wingellina in addition has a very long anal operculum. Stygobiont.

REFERENCES

Karanovic T. (2004): Subterranean Copepoda from arid Western Australia. *Crustaceana Monographs*, 3: 366pp.

Karanovic T. (2006): Subterranean copepods (Crustacea, Copepoda) from the Pilbara region in Western Australia. *Records of the Western Australian Museum, Supplement* 70: 239pp.

Karanovic T., Eberhard S.M., Murdoch A. (2011): A cladistic analysis and taxonomic revision of Australian *Metacyclops* and *Goniocyclops*, with description of four new species and three new genera (Copepoda, Cyclopoida). *Crustaceana*, 84: 1-67.

APPENDIX H

Morphological Assessment of Isopods

Morphological assessment of subterranean/terrestrial isopod crustaceans from the Wingellina region of Western Australia

Prepared by
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Introduction

Isopod crustaceans were collected by Outback Ecology staff at three localities in the Wingellina region of Western Australia. Six specimens from four subterranean sampling efforts (net hauls and litter traps in bores) were received for morphological analysis. Specific objectives were to determine lowest possible taxonomic level identification of the specimens.

Methods

Morphological assessment was performed at the South Australian Museum through examination of all specimens using both a stereomicroscope and a compound microscope with camera and drawing tube attachments. Specimens were also photographed using a camera and automontage software system. Fine dissections and mounting of appendages on slides for closer examination were performed on selected specimens when deemed necessary.

Results

Morphological results indicate that one species of *Buddelundia* Michaelsen, 1912 (Family Armadillidae) is present at “Pip Calcrete”, bore CHRC0210 and was sampled twice (LN 0853 and LN0162) (Table 1: Figure 1). The pleopods form a united structure (seen ventrally) and this is characteristic of *Buddelundia and Kimberlydillo* Dalen, 1993. *Buddelundia* species are additionally characterised by a notched lateral epimera 1 (associated with rolling), and all three specimens from bore CHRC0210 have this notched epimeron 1. At least 23 species of *Buddelundia* are described from Western Australia with six of these positively identified from troglobitic habitats (caves). Further determination to species level was not possible as existing descriptions are inadequate for positive identification; however, as all the known species are distributed along the western plateau and coastal margins of Western Australia it is likely that the Wingellina specimens examined here are new species. The specimens had pigmentation and substantial eye development (15+ ommatidia) and could be determined as “facultative troglobite” - not strictly confined within an aquifer but able to move within/over sediments to the surface, cave entrance etc.

Table 1

Lot no.	Date collected	Sample description	Identification
LN 0162	28/11/2010	2 individuals (male and female)	Armadillidae, *Buddelundia* sp. undet.
LN 0853	15/01/2011	1 individual (male)	Armadillidae, *Buddelundia* sp. undet.
LN 0812	26/11/2011	2 individuals (male and immature female)	Platyarthridae, *Trichorhina* sp. undet.
LN 1176	27/11/2010	1 individual (small male)	Platyarthridae, *Trichorhina* sp. undet.

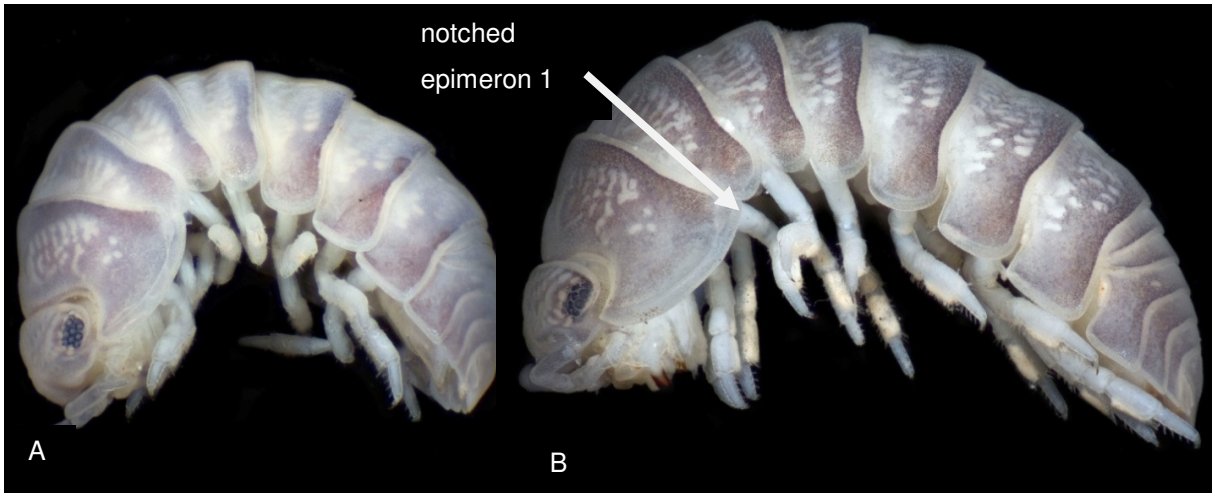

Figure 1. *Buddelundia* sp. undetermined: A) sample LN0162; B) sample LN0853.

Three specimens belonging to the Family Platyarthridae (agreeing with *Trichorhina* Budde-Lund, 1908 - this is the only genus of this family described from Australia) were examined from two litter-trap samples (LN 0812 and LN1176) **(Figure 2)**. One species of *Trichorhina* is known in Western Australia (*T. australiensis* from near Perth), however the existing description is poor and so specimens can not readily be compared to it and positively identified. Given their geographic distance from Perth, It is likely that the Wingellina specimens belong to a new (undetermined) species of *Trichorhina*. The three specimens from the two separate traps more than likely belong within the same species, however some morphological differences were noted: the smaller male in LN1176 (Figure 2B) had a more robust antenna 2 with a shorter flagellum and was slightly broader than the larger male in LN0812 (Figure 2A). This morphological variance could be related to size/age class differences and be intraspecific variation. All three specimens had well developed eyes and light pigmentation was evident dorsally over the pereonal segments (with some concentration at the head) indicating that these species too may be facultative troglobites.

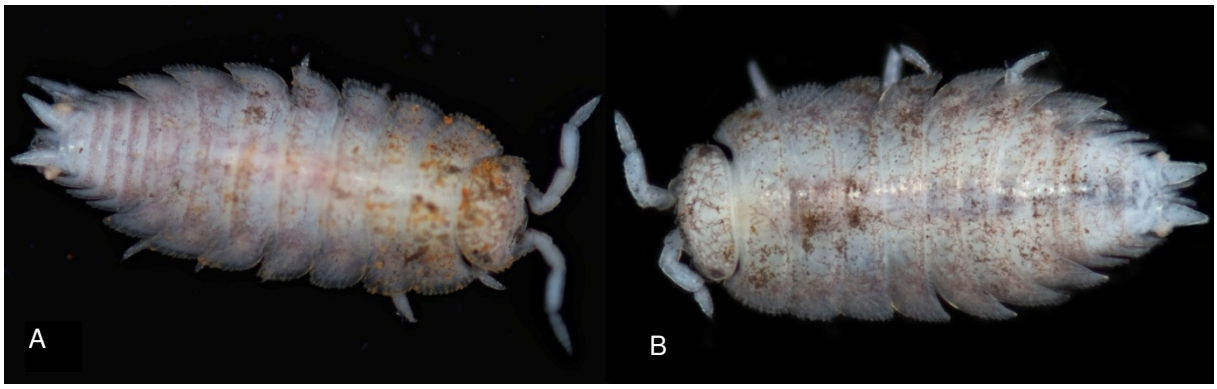

Figure 2. *Trichorhina* species undetermined. A) sample LN0812; B) sample LN1176

Discussion

The troglobitic and terrestrial isopods of Western Australia remain largely undescribed and many existing species are poorly described. Descriptive taxonomy continues to lag behind discovery of new species by a large margin. This means that identification to genus level is difficult for many groups (including the Platyarthridae and the Armadillidae).

Summary of results

- One undetermined species of *Buddelundia* was collected twice at one bore (CHRC0210). The species has developed eyes and pigmented body. It could not be reliably identified due to existing poor descriptions but is likely to be a new species based on its distribution in eastern Western Australia.
- One undetermined species of *Trichorhina* (likely to be a new species) was discovered at two different bores (LN 0812 and LN1176). This species has well developed eyes and a lightly pigmented body