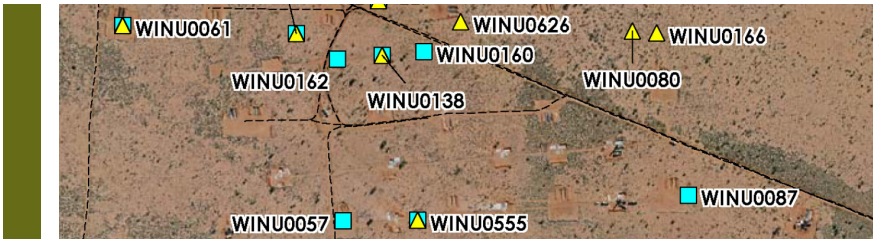
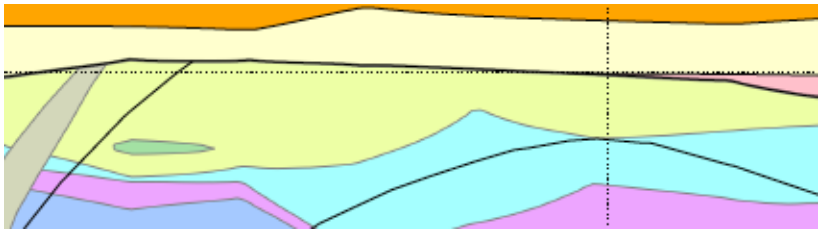
Biota Environmental Sciences

Winu Project Subterranean Fauna Desktop Study and Basic Survey





Prepared for Rio Tinto Winu Pty Ltd

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Winu Project Subterranean Fauna Assessment

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1.0 Executive Summary

Rio Tinto Winu Pty Limited (RTW) is evaluating the potential development of mineralised deposits within the Winu Project Area (hereafter 'the study area'), which is located approximately 320 km east of Port Hedland in the Great Sandy Desert.

RTW commissioned Biota Environmental Sciences (Biota) to complete a subterranean fauna desktop study and basic survey to support the design of the potential development and to inform the likely pathway for environmental approvals. The aim of the desktop study was to assess the likelihood that stygobitic fauna (stygofauna: aquatic subterranean fauna) or troglobitic fauna (troglofauna: air-breathing fauna above water table) occur within the study area based on collated information from government databases, previous sampling and publicly available information. Based on the findings of the desktop review, habitat prospectivity for subterranean fauna in the study area was categorised as Low, Moderate or High. The basic survey involved low intensity sampling for troglofauna and stygofauna within the study area to verify the findings of the desktop study.

Appraisal of drill hole core photos indicated that there was no obvious habitat suitable for subterranean fauna, with an absence of fractures, caverns or vugs, and none of the study area categorised as High prospectivity. However, the sandstone and occasionally tillite units (generally lying above the sandstone) did appear to be porous, with some small interstitial spaces that may represent potential habitat for both troglofauna and stygofauna. The prospectivity of the sandstone unit occurring above and below the water table was assessed as Moderate, and both troglofauna and stygofauna may potentially occur in this habitat. The other geological units present were assessed as Low or would not constitute habitat for troglofauna or stygofauna.

The basic survey was undertaken over three mobilisations (in September and November 2019 and September 2021). Sampling for troglofauna was undertaken using baited colonisation traps and haul net scraping. In total, 29 sites were successfully sampled for troglofauna with up to three traps installed at each site. EPA guidance for sampling troglofauna in a basic survey recommends 10 to 15 sites be sampled (EPA 2016a). Overall, 77 traps were retrieved during sampling of the study area. Drill hole scraping was undertaken at 11 sites only as most sites were angle-drilled, preventing effective use of this sampling method.

Stygofauna were sampled using modified plankton haul nets, which were slowly hauled through the water column to the surface. A total of 25 sites were sampled for stygofauna, of which 20 were deemed optimal for sampling based on installation and construction specifications. EPA guidance for sampling stygofauna in a basic survey recommends six to 10 sites be sampled (EPA 2016a).

No troglobitic or stygobitic fauna were collected from the samples. The basic survey supported the assessment of Low-Moderate habitat prospectivity, given no troglobitic or stygobitic specimens were recorded, despite sampling that exceeded the timeframe and effort normally undertaken for basic surveys. Given this, our assessment is that it is unlikely that subterranean fauna occur in most geological units of the study area, with the sandstone unit presenting the only habitat within which subterranean fauna may potentially occur.

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2.0 Introduction

2.1 Project Background

Rio Tinto Winu Pty Limited (RTW) is evaluating the potential development of mineralised deposits within the Winu Project Area, which is located approximately 320 km east of Port Hedland in the northwest of Western Australia (Figure 2.1). To support the design of the potential development and to inform the likely pathway for environmental approvals, a subterranean fauna desktop study and basic survey were required to assess the likelihood that troglobitic fauna (troglofauna: air-breathing fauna above water table) or stygobitic fauna (stygofauna: aquatic subterranean fauna) occur in the Winu Project Area. Biota Environmental Sciences (Biota) was commissioned to undertake the required work.

2.2 Terminology

For the purpose of this report, the following terms are used as defined below:

Study area: Refers to the overall area encompassing the Winu Project Area containing the drill hole and bore hole sampling locations, within which the subterranean fauna desktop study applied.

Survey: Refers to the basic survey completed for the current scope of work.

2.3 Study Objectives

The required work addressed two main objectives:

1. To undertake a desktop study to provide an assessment of the likelihood that stygofauna or troglofauna occur within the study area. The desktop study involved:
    - collation of existing relevant stygofauna and troglofauna records and information from government databases, previous sampling and publicly available information; and
    - an assessment of the likelihood that habitats present in the study area would support subterranean fauna.
2. To undertake a basic survey involving low intensity sampling for troglofauna and stygofauna within the study area to verify the findings of the desktop study.

The study was planned and implemented as far as practicable in accordance with the following State guidance statements:

- Environmental Factor Guideline - Subterranean Fauna (EPA 2016b); and
- Technical Guidance - Sampling methods for subterranean fauna (EPA 2021).

2.4 Purpose of this Report

The purpose of this report is to present the findings from the desktop study and basic survey, to provide information to support the environmental assessment process for the potential development of the Winu project.

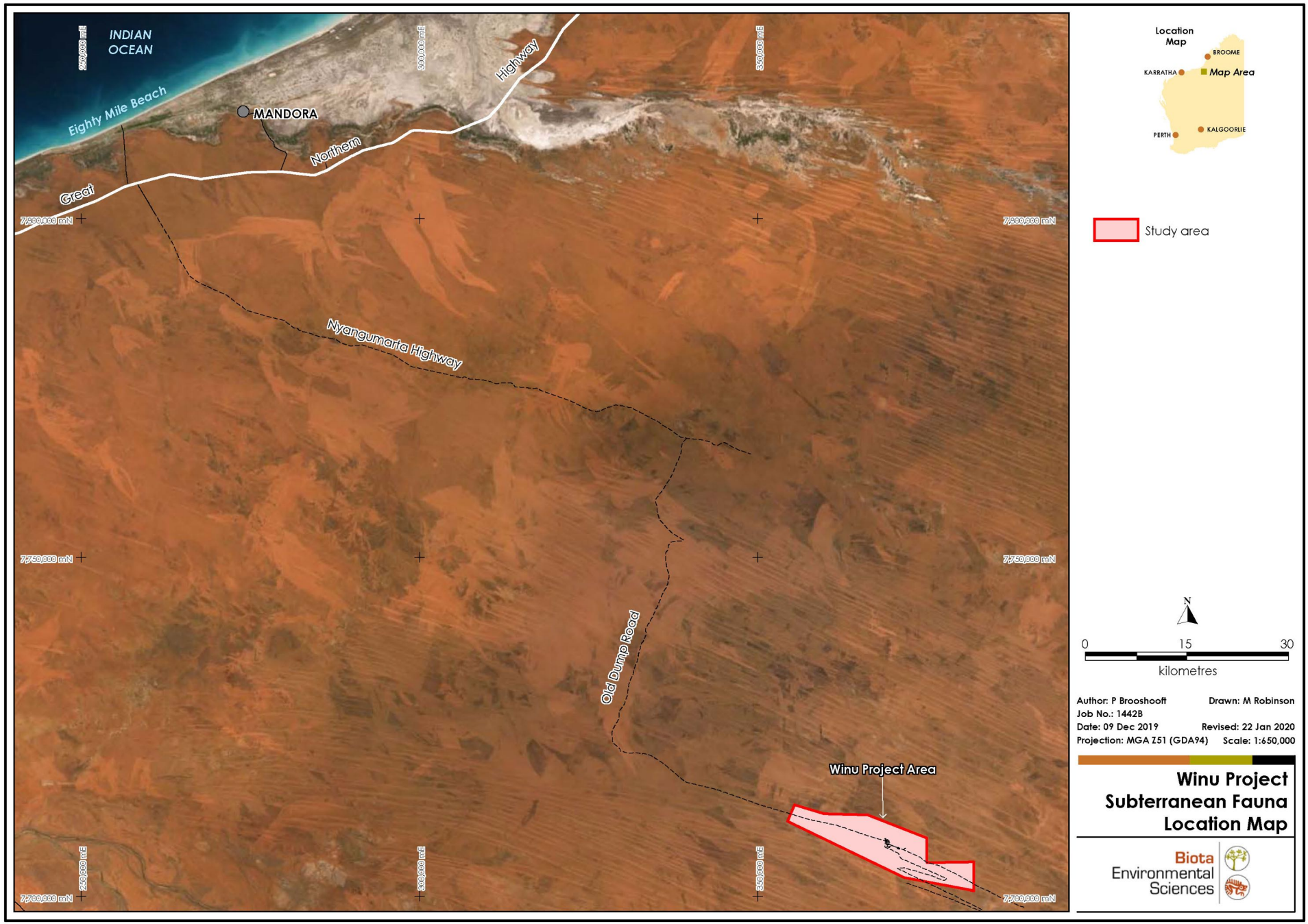

Figure 2.1: Location of the Winu study area.

2.5 Subterranean Fauna Overview

Over the past two decades, numerous studies (mostly with an emphasis on impact assessment) have revealed Australia to be highly diverse in subterranean fauna, with numerous areas of interest throughout the continent (Guzik et al. 2010). Subterranean fauna have been collected from a range of geological units throughout the Pilbara, Kimberley, Barrow Island, Cape Range, Midwest, Yilgarn, Nullarbor and the Southwest in Western Australia (EPA 2016a). Knowledge and records of subterranean fauna within the central and western desert environments of the State is limited.

Subterranean fauna habitats are characterised by shared physical parameters that include a lack of light, stable temperature, limited nutrient infiltration from surface environments and a constant humidity (Juberthie 2000, Romero 2009). These habitat characteristics have resulted in evolutionary convergence in morphological, physiological and biological adaptations amongst many subterranean fauna. These characteristics common to most subterranean fauna include reduced or lack of pigmentation, reduced or lack of eyes, elongate body morphology, appendages adapted for sensory movement, increased lifespan, decrease in metabolism, loss of water regulatory processes (Gibert and Deharveng 2002, Culver and Pipan 2009, Romero 2009). Subterranean fauna are classed into two distinct ecological groups based on habitat: troglobitic fauna (troglofauna) and stygobitic fauna (stygofauna).

2.5.1 Troglofauna

Troglofauna survive only in air-filled cavities and interstices between the ground surface and the water table. Troglofauna in semi-arid Australia are thought to be relictual rainforest fauna: fauna adapted to humid environments, which retreated underground to cave systems during the aridification of Australia (in the late Miocene; Humphreys 1993). This is inferred from affinities of the taxonomic groups represented amongst the troglofauna with other extant taxa in tropical climates. Some invertebrate groups with troglobitic representatives include the Arachnida (e.g. Schizomida, Pseudoscorpiones and Aranea), Chilopoda (e.g. Scolopendrida), Diplopoda (e.g. Polydesmida and Haplodesmida), and Insecta (e.g. Diplura, Thysanura, Coleoptera and Blattodea). A single troglobitic vertebrate species of blind snake (*Ramphotyphlops longissimus*) is known from Australia, collected from Barrow Island (Aplin 1998, Humphreys et al. 2013).

Troglofauna have been recorded from a range of geological units, including pisolitic iron formations, channel iron deposits (CID), unconsolidated alluvium, calcrete and weathered or fractured sandstone. The likelihood that geological units represent troglofauna core habitat is primarily a function of available space, ability to maintain a constantly high humidity and the potential for nutrient input from surface systems (Humphreys 1991, Wilkens et al. 2000, Biota and DC Blandford & Associates 2013). The physical characteristics of geological units known to provide habitat for troglofauna include fractures, caverns, vugs, or interstices sufficient in size to accommodate troglobitic fauna. Vertical connectivity between subsurface geological units and the surface is required for nutrient and carbon supply, and lateral connectivity between voids is required for dispersal.

Due to their dependence on constant humidity and suitable habitat spaces, dispersal and distribution of troglobitic fauna species tends to remain limited to individual blocks of inter-connected habitat, leading to long periods of population isolation and speciation. As a result, troglobitic fauna are considered to be of conservation significance, given species often display extreme short-range endemism and species may therefore be affected by relatively small-scale developments such as mining and construction.

2.5.2 Stygofauna

Stygofauna comprise aquatic taxa occurring in groundwater aquifers and subterranean water bodies. Stygal communities in Western Australia are predominantly Crustacean (e.g. Amphipoda, Isopoda, Decapoda, Syncarida, Ostracoda and Copepoda), however Annelida (e.g. Oligochaeta), Arachnida (e.g. Hydracarina) and Platyhelminthes are also commonly collected.

Three species of stygal vertebrates have been recorded from Australia, including two species of blind gudgeon (*Milyeringa veritas*, and *M. justitia*) as well as a blind cave eel (*Ophisternon candidum*).

Similar to troglofauna, the suitability of any geological formation as habitat for stygofauna is predominantly determined by the availability of space and potential for nutrient infiltration. For stygofauna, this is further refined to where rock formations supporting fractures, caverns and vugs occur below the water table. Stygofauna occur in all types of aquifers that have suitably sized voids: they occur variously in epikarst, limestone karst, pseudokarst (often sandstone, lava or laterite), fractured rock, calcretes and pisolites, and they occur widely in alluvial aquifers, except where the size of the interstices may limit the distribution of species (Humphreys 2009).

Stygofauna are tolerant of a range of groundwater physicochemical conditions. They are known to occur in groundwater with low concentrations of dissolved oxygen: stygofauna were recorded from bores with dissolved oxygen at approximately 38% saturation in the Pilbara (Biota 2008), as well as high concentrations: stygofauna were recorded from bores with dissolved oxygen at approximately 280% saturation prior to dewatering at Bungaroo in the Pilbara (Biota 2018). Stygofauna have also been recorded from fresh to brackish groundwater, but can occur in salinities up to 60,000 mg/l of total dissolved solids (TDS) (fresh water contains less than 3,000 mg/l TDS) (Bennelongia 2012). Similarly, they seem to be tolerant of a range of pH conditions: stygofauna have been recorded from locations with a pH of 5.6 (Biota 2013), up to a pH of 8.2 (Bennelongia 2012).

With increases in groundwater depth, dissolved oxygen and nutrient availability declines, so much so that habitats with slow oxygen and nutrient cycles will not support stygofauna assemblages (Subterranean Ecology 2012). This is evident in the Pilbara, where stygofauna yields depleted when depth to groundwater was greater than 30 m (Halse et al. 2014). Comparatively, stygofauna occur at greater depths where oxygen and nutrient cycles are high. For example, stygofauna have been recorded from water tables 59 m below the surface (Humphreys 2001). The strength of hydrological exchange with surface systems is therefore a key driver of habitat suitability for stygofauna (Subterranean Ecology 2012).

3.0 Existing Environment

3.1 IBRA Bioregion and Subregion

The Interim Biogeographic Regionalisation of Australia (IBRA) identifies 89 bioregions across Australia (Environment Australia 2000). The study area is located within the Great Sandy Desert IBRA bioregion, which is divided into six subregions. Of the six subregions, the study area falls entirely within the Mackay subregion. The Mackay subregion (18,636,695 ha) is described as:

"Tropical inland 'red-centre' desert. Includes the 'Percival' and 'Auld' palaeoriver systems. Mainly tree steppe grading to shrub steppe in south; comprising open hummock grassland of *Triodia pungens* and *Triodia schinzii* with scattered trees of *Owenia reticulata* and bloodwood (*Corymbia* spp.), and shrubs of *Acacia* spp., *Grevillea wickhamii* and *G. refracta*, on Quaternary red longitudinal sand dune fields. Monsoonal influences are apparent in the north-western sector of this region. The climate is arid tropical with summer rainfall." (Kendrick 2003).

3.2 Soils and Surface Geology

Two broad soil types have been mapped in the study area (Table 3.1 and Figure 3.1) (Agriculture Western Australia 1967). Unit AB39 dominates the majority (92%) of the study area, with small outer pockets of AB40 (8%) (Table 3.1). These two units are both described as gently undulating plains with longitudinal dunes, however AB40 is more elevated in the landscape than AB39 (Table 3.1).

Mapping of the surface geological units in the locality was prepared based on data from Geoscience Australia (2014). The geological units are summarised in Table 3.2 and their extent is illustrated in Figure 3.2. The majority (98.5%) of the study area is dominated by dune geology (Qd), with two smaller areas of sandstone and siltstone with interbedded conglomerate (Ksak) (Table 3.2).

Table 3.1: Description and extent of soil units in the study area.

(Geoscience Australia 2014)

Soil Unit	Description	Area (ha)	% of study area
AB39	Gently undulating plains dominated by longitudinal dunes of varying frequency; some exposures of ironstone gravels on low rises occur in the dune swales: chief soils are red earthy sands (Uc5.21) on dune slopes, and interdune plains with red siliceous sands (Uc1.23) on the dunes. Other soils include (KS-Uc5.21) on the gravelly rises where an ironstone (laterite) duricrust is present at about 45 cm depth; and (Um5.11) on small included areas of calcrete (kunkar).	12,288.65	92.0%
AB40	Gently undulating plain slightly more elevated than unit AB39, and dominated by longitudinal dunes, many exposures of ironstone gravels and some breakaways capped by ironstone (laterite) duricrust: chief soils are red earthy sands (Uc5.21), with red siliceous sands (Uc1.23) on the dunes. There is an increased amount of (KS-Uc5.21) soil compared with unit AB39, and locally it may become dominant.	1,070.32	8.0%

Table 3.2: Description and extent of surface geology units in the study area.

(Geoscience Australia 2014)

Geological Unit	Description	Area (ha)	% of study area
Ksak	Poorly sorted, cross bedded and partly bioturbated, paralic fine sandstone and siltstone with interbedded coarse sandstone and conglomerate	13,154.40	98.5%
Qd	Dunes: Sandplain with dunes and swales; may include numerous interdune claypans; residual and aeolian sand with minor silt and clay; aeolian red quartz sand, clay and silt, in places gypsiferous; yellow hummocky sand.	207.38	1.5%

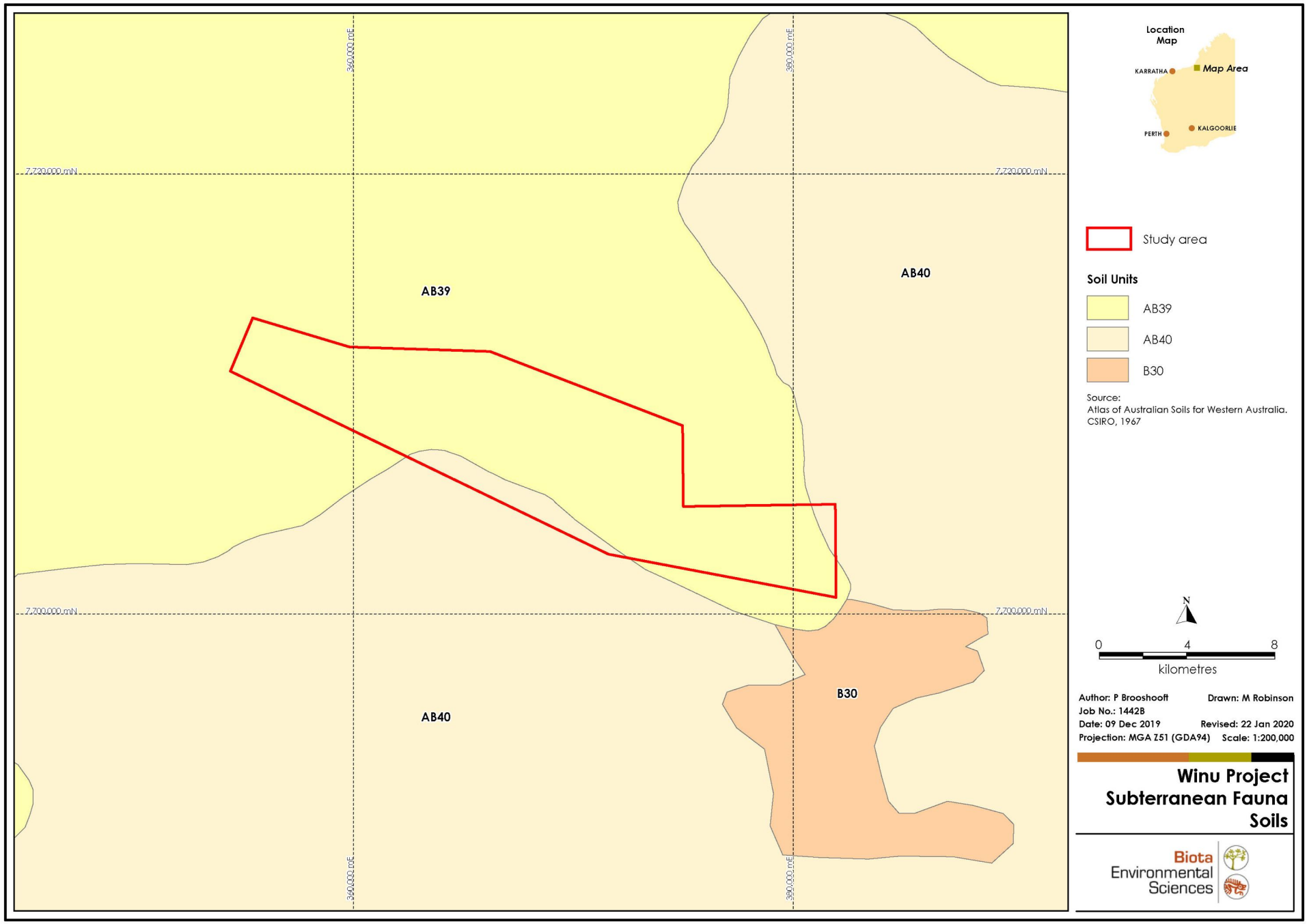

Figure 3.1: Soil units in the study area.

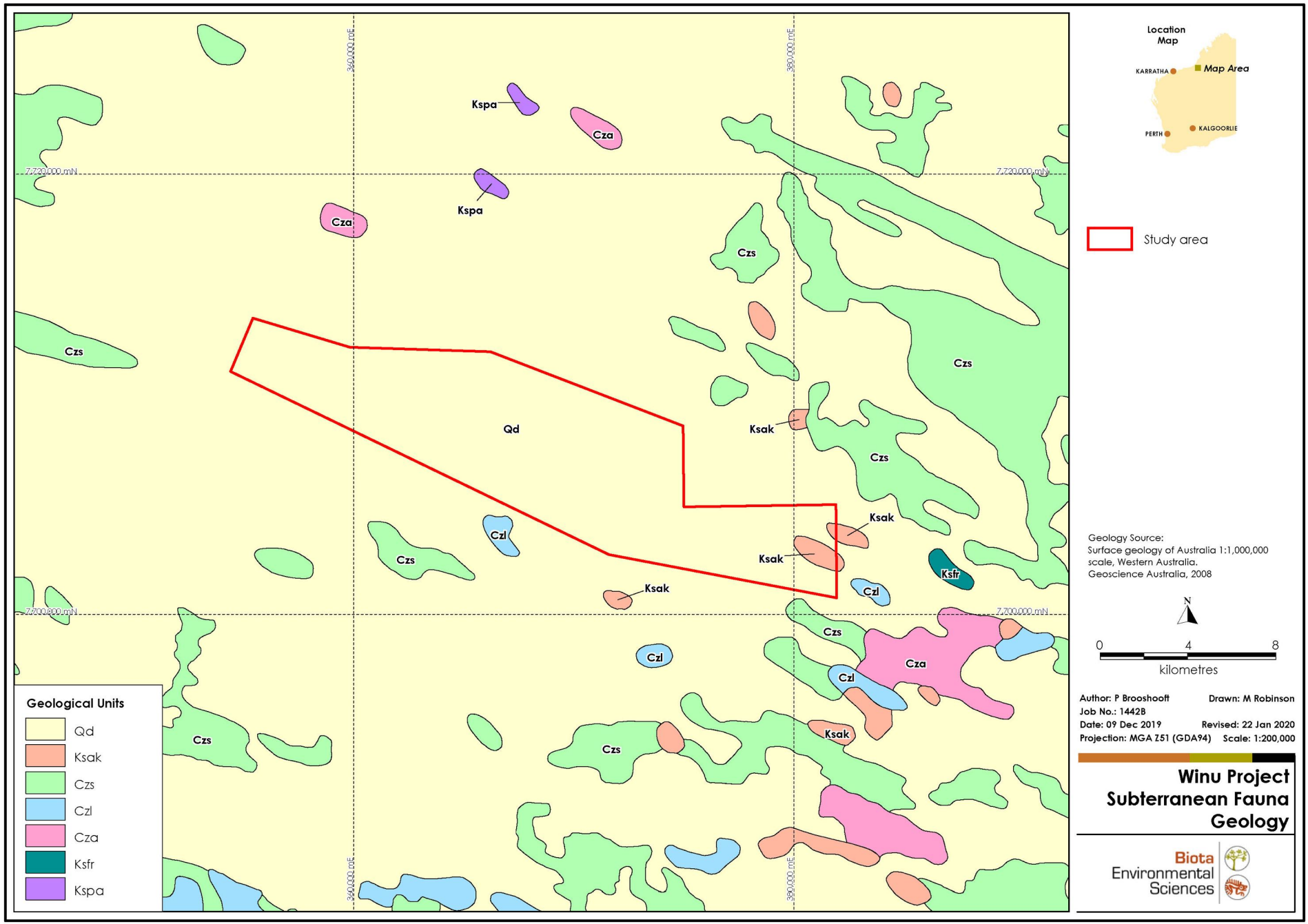

Figure 3.2: Geological units in the study area.

3.3 Subsurface Geology

The broad subsurface geology that has been drilled and sampled within the study area has been divided into three components. The shallowest component is comprised of a cover sequence of Quaternary aeolian sands extending from the surface to approximately 15 meters below ground level (mbgl). The second component extends from approximately 15 m to 50-70 mbgl and consists of variably consolidated coarse-grained sandstone, siltstone and mudstone of Permian age. These rocks were deposited in a glaciofluvial and/or glacio-lacustrine setting and are known to be extensive and continuous across the Great and Little Sandy Desert regions; the unit is commonly encountered in exploration drill holes outside of the immediate study area, and in some cases up to 200 km from the study area (for example, at the Kintyre deposit south of the study area). The Permian-aged material unconformably overlies the third component, comprising Proterozoic metamorphosed sandstone, siltstone and lesser mafic rocks of the upper Malu Formation. These metamorphic rocks host the mineralisation in the study area, and the deposit structure is dominated by a gently plunging inclined anticline/monocline with a steep west-southwest-dipping western flank and a sub-horizontal to gently east-dipping eastern flank (Figure 3.3) (geological information supplied by Adam Black, RTW Geoscientist, and Damien Ewington, RTW Exploration Manager).

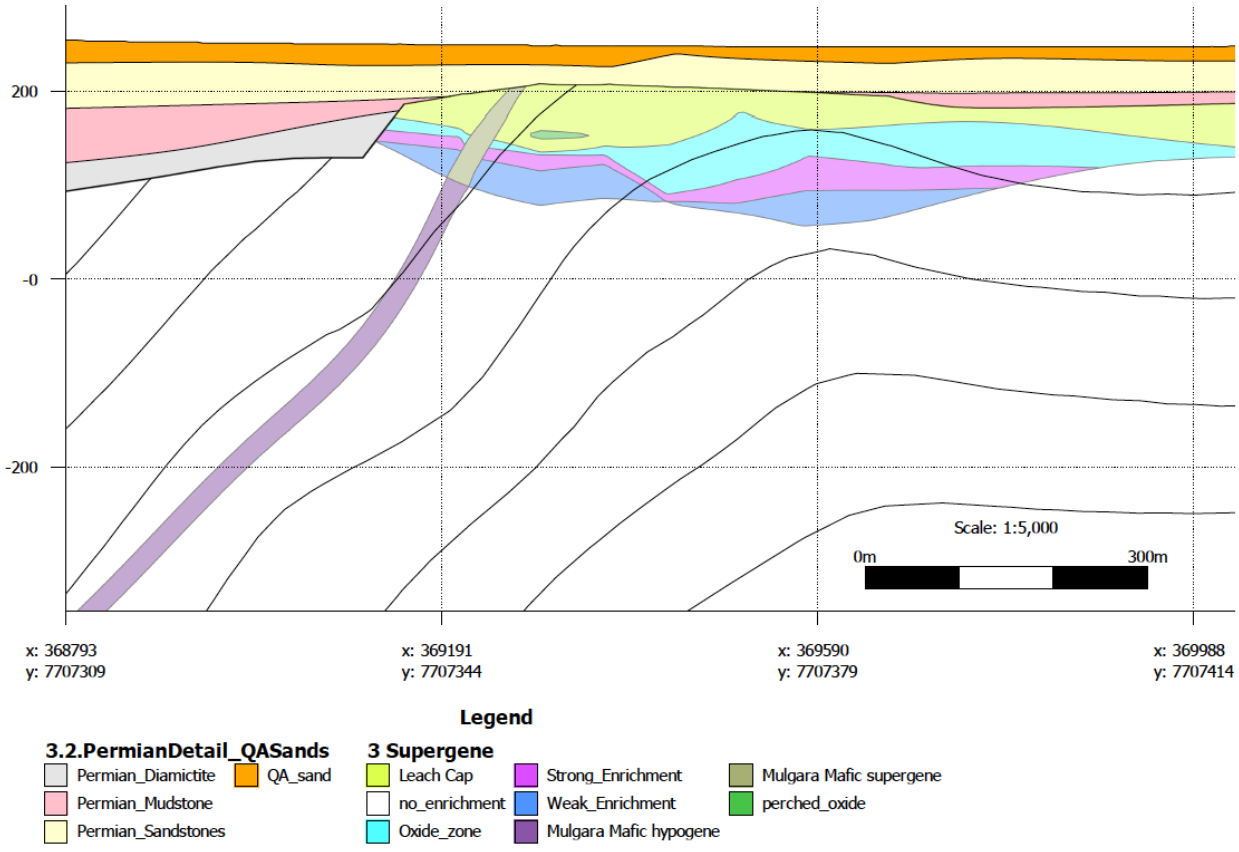

Figure 3.3: Example of east-west geology cross-section at Winu.

Supplied by RTW.

3.4 Hydrogeology

Hydrogeology within the study area was investigated by Golder Associates (2019). The hydrogeology is broadly described as:

- Cemented sandstone: 15 to 74 m partially saturated with the water table at around 50 mbgl.
- Permian mudstone: 74 to 147 m low permeability confining unit.
- Meta-sediment: >147 m main aquifer.

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4.0 Methodology

4.1 Desktop Study

4.1.1 Database and Literature Searches

Several databases were searched for subterranean fauna (troglofauna and stygofauna) records within 100 km of the study area (Table 4.1). In addition, a literature review of subterranean fauna surveys within Western Australian desert environments was undertaken (results presented in Section 5.1.2). The results from the database and literature searches were collated to:

- identify if there have been subterranean fauna records within 100 km of the study area or in similar desert environments; and
- determine whether these records may be of relevance to the study area (i.e. were they recorded from habitat analogous to that in the study area).

Table 4.1: Databases searched for subterranean fauna records relevant to the study area.

Source	Search Area	Date Completed
NatureMap	40 km buffer: 20°43'53"S, 121°44'21"E	20/08/19
EPBC Protected Matters Search Tool	40 km buffer: 20°40'26"S, 121°36'46"E (top left) 20°43'47"S, 121°52'05"E (top right) 20°47'28"S, 121°51'57"E (bottom right) 20°44'33"S, 121°35'18"E (bottom left)	20/08/19
Western Australian Museum (WAM) Arachnida and Crustacea database	100 km buffer: 20°01'06"S, 120°57'16"E (top left) 21°26'48"S, 122°31'26"E (bottom right)	20/08/19
Department of Biodiversity Conservation and Attractions (DBCA) Priority and Threatened Ecological Communities (PECs & TECs) database	120 km buffer (database searched as part of a broad desktop biological assessment of the study area)	Jacobs (2019)

4.1.2 Habitat Characterisation

Hydrogeological and geological information for the study area was also reviewed in order to identify potentially prospective geological units within the study area that may function as suitable habitat for troglofauna and stygofauna. This information was used to appraise the prospectivity of the study area to support subterranean fauna communities. The approach taken follows a framework for habitat categorisation developed jointly between Biota and Rio Tinto for previous subterranean fauna assessments (mainly Pilbara-based), which determined geological unit habitat prospectivity based on a range of attributes. This approach was modified and adapted for the study area, given that there have been few studies conducted in similar geologies.

Geological and hydrological features determining habitat prospectivity for troglofauna and stygofauna include:

A. Presence of fractures, caverns, vugs or interstitial spaces above or below the water table;

B. Presence of impeding layers to maintain stable humidity; or

C. Known occurrence of troglofauna or stygofauna from desert environments in equivalent geology types.

Based on the above attributes, habitat prospectivity was categorised as Low, Moderate or High according to the criteria outlined in Table 4.2.

Table 4.2: Criteria used to assess habitat prospectivity of geological units.

Likelihood	Criteria
Low	1. Geology may include habitat feature B, however no suitable space is available (A); and 2. Suitable geology only occurs below water table (for troglofauna); or 3. Suitable geology only occurs above water table (for stygofauna); and 4. Troglofauna or stygofauna not previously recorded from previous sampling of similar geologies in desert environments (C).
Moderate	1. Geology contains suitable spaces (A) and may include habitat feature B; and 2. Suitable geology likely partially or completely submerged below the water table (for stygofauna); or 3. Suitable geology likely or known to occur above the water table (for troglofauna); and 4. Low numbers of troglofauna or stygofauna have been recorded from similar geologies in desert environments previously (C).
High	1. Geology contains suitable spaces (A); and 2. Presence of continuous, transmissive aquifer in suitable geology which is partially or completely submerged below the water table (for stygofauna); or 3. Presence of impeding layers (B) to maintain stable humidity above suitable geology situated above the water table (for troglofauna); and 4. Troglofauna or stygofauna documented from similar geologies in desert environments (C).

4.2 Basic Survey Methodology

Two phases of sampling were undertaken for troglofauna, and three phases for stygofauna, over three mobilisations (Table 4.3). The third mobilisation was undertaken to address possible limitations after a review of the findings of the first two mobilisations (see Section 4.4). The field survey was completed under Regulation 27 "Fauna Taking (Biological Assessment) Licence") Licence Number BA27000110 issued to Ms Penny Brooshooft (Appendix 1).

Table 4.3: Field mobilisation dates and survey personnel.

Mobilisation	Survey Component	Dates	Personnel
1	Troglofauna Trap Installation Drill hole Scraping Stygofauna Sampling	25 – 26 September 2019	Penny Brooshooft, Josh Keen
2	Troglofauna Trap Retrieval Stygofauna Sampling	14 November 2019	Josh Keen, John Graff
3	Troglofauna Trap Installation Drill hole Scraping Stygofauna Sampling	9-13 September 2021	Jason Alexander, Brandon King

Troglofauna traps installed on the third mobilisation were kindly collected by Rio Tinto Winu site personnel on 27 October 2021 and despatched to Biota's laboratory in Perth for processing.

4.2.1 Troglofauna Sampling

Troglobitic fauna were sampled using two methods; baited colonisation traps and haul net scraping.

4.2.1.1 Colonisation Traps

Troglobitic fauna were sampled using custom-built litter colonisation traps suspended within drill holes in the study area. A series of traps were suspended at intervals between solid PVC casing and the water table, allowing coverage of potential voids. Within the study area, drill holes were variably cased to 30-45 m, and the water table was at approximately 50 mbgl. Traps were constructed from 60 mm internal diameter PVC irrigation pipe cut to a length of 180 mm. Each trap had a series of 20 mm holes drilled into the side, and traps remained open at the upper end. Traps were installed such that they were in contact with the interior of the sampled drill hole, facilitating fauna entry into the trap.

Leaf litter was gathered locally from the ground surface in the study area, particularly from the base of *Acacia* shrubs. The collected litter was soaked in water and irradiated in a microwave oven for two minutes on maximum power setting. This acted to kill any surface invertebrates present and assisted in the breaking down of the organic matter. The wet leaf litter was added to the traps, which were then kept in sealed containers until immediately prior to insertion into the drill holes to avoid desiccation of the litter. After traps were installed, the opening of each drill hole was sealed to maintain humidity and to avoid entry of surface fauna.

Traps were recovered from each drill hole after approximately six weeks and stored in labeled zip-lock bags in order to maintain humidity and prevent desiccation of potential troglofauna specimens during transportation to Perth.

Fauna specimens were recovered from the traps using specially designed Tullgren funnel units. Leaf litter from each trap was placed in a sieve under an aluminium lamp containing a 25-watt globe. This created a temperature of approximately 30°C at the surface of the leaf litter. A funnel situated below the leaf litter collected the fauna as they fell, directing them into an attached vial of 100% ethanol. Leaf litter was left in the Tullgren funnels for a period of 24 hours, after which time the litter was dry and the bulk invertebrate sample was removed.

4.2.1.2 Troglofauna Scraping

Troglobitic fauna were also sampled using reinforced stygofauna haul nets. These nets were constructed from 70 µm plankton mesh and had 100 mm apertures attached to a weighted catch jar. Sampling took place by lowering the net to just above the water table before being hauled slowly to the surface whilst scraping the edge of the drill hole. This potentially dislodged any fauna on the vertical surface of the drill hole interior. The contents of the net, which included dry soil, were emptied into a uniquely labelled container and preserved in-situ in 100% ethanol. The sample was then transported to Perth to complete sorting in the laboratory.

4.2.2 Stygofauna Sampling

Stygobitic fauna were sampled using modified plankton haul nets, constructed from 70 µm plankton mesh, with 50 mm and 100 mm apertures attached to a stainless steel catch cylinder. Given the depth of most drill holes (ranging between 100 and 300 m) and the known occurrence of stygofauna at depth (see Section 2.5.2), nets were lowered to approximately 80 mbgl before being slowly hauled through the water column to the surface where the contents of the cylinder were flushed into a uniquely labelled container. Each site was sampled in this way a total of six times where possible. On the final haul the net was agitated gently to stir the benthos layer and mobilise any fauna present for more effective specimen collecting. Samples were preserved in-situ with 100% ethanol for later sorting and identification. Following sampling of each site, the nets were thoroughly rinsed with water, inspected and where possible, left to dry before using again on another site. This process prevented cross-contamination of specimens between sampling sites.

4.2.3 Specimen Identifications

Fauna specimens, where collected, were identified to order level using dissecting microscopes (Olympus SZ61, magnification up to 40x). Fauna specimens were assigned a unique number based on drill hole name and location, and were tracked on customised data sheets. Specimens were preserved in 100% ethanol, which allowed for both morphological and molecular analysis. Specimens were stored at room temperature before submission to the WAM for lodgement.

4.3 Sampling Effort

4.3.1 Troglofauna

Prior to survey mobilisation, RTW supplied a drill hole database of available potential sites for subterranean fauna sampling within the study area. These data were screened for suitability for troglofauna sampling according to geological features important for troglofauna (as outlined in

Section 2.5.1) and a review of core photos, where available. Out of 105 sites identified as potentially suitable, 35 were indicatively selected for sampling as appearing to be the most prospective (Table 4.4). Seventeen of these were successfully sampled for troglofauna, while the remaining 18 sites could not be sampled due to access restrictions or down hole blockages (Table 4.4). In addition, 35 other reserve sites were opportunistically visited, but only 12 of these could be successfully sampled (Table 4.4). The remaining sites could not be sampled due to various reasons.

In total, 29 sites were successfully sampled for troglofauna with up to three traps installed at each site (Table 4.4; Figure 4.1). Given that drill holes were cased with blank PVC until approximately 30-45 mbgl, and that the water table across the study area was at approximately 50 mbgl, traps were positioned at varying depths between 30-50 mbgl to ensure contact with surrounding geology above water table (AWT) (Table 4.4). The trap depth was pre-determined to target a specific geological unit (Table 4.4). Overall, 84 traps were installed across the study area and 77 were successfully retrieved. Drill hole scraping was undertaken at 11 sites only, as most sites were angled and scraping would have been ineffective (Table 4.4)

4.3.2 Stygofauna

The drill hole database of available potential sites for subterranean fauna sampling were screened for suitability for stygofauna sampling according to geological and hydrological features important for stygofauna (outlined in Section 4.1.2) and a review of core photos, where available. Thirty-one sites appeared to have potentially suitable physical habitat features for stygofauna (i.e. the geology was porous and located below water table (BWT) at an appropriate depth) and had been drilled at least four months prior to sampling to allow for bore colonisation. Of these, 15 sites were indicatively selected for the initial mobilisation sampling (Table 4.5). Restrictions encountered on site resulted in just three of these sites being sampled during the first mobilisation (WIDI0015, WINU0061 and WINU0138; Table 4.5). An additional two sites were opportunistically sampled during that mobilisation based on advice from an on-site hydrogeologist, however geological attributes and construction details of these sites were not known until completion of the survey (WINU0076 and WINU0080; Table 4.5). Subsequent supply of this information indicated that the geology was suboptimal, and that bore construction was prohibitive for stygofauna sampling (i.e. casing was constructed out of solid steel) (Table 4.5).

To meet EPA guidance (2016a), which outlines six to 10 stygofauna samples to be taken for a basic survey, the opportunity to sample additional indicative sites in concert with troglofauna trap recovery was taken during the second mobilisation. Prior to the second mobilisation, 11 additional indicative sites were selected based on further drill hole information supplied from on-site hydrogeologists. Access restrictions resulted in seven of these sites being sampled during the second mobilisation (Table 4.5). Of the 11 additional indicative sites, geology and bore construction details were not known for five sites prior to survey (WINU0166, WINU0213, WINU0214, WINU0216 and WINU0219). Following supply of this information, three sites were assessed as not suitable for sampling stygofauna due to casing construction (WINU0166, WINU0213 and WINU0219; Table 4.5), and all five sites had been drilled less than three months before the survey, which did not align with EPA guidance (2016a) recommendations.

A third mobilisation addressed the potential limitations of the first mobilisation through the inclusion of a further 14 sites, 13 of which were successfully sampled (Table 4.5; Section 4.4).

In total, over all three mobilisations, 25 sites were sampled for stygofauna (Figure 4.1), of which 20 were deemed optimal for sampling (Table 4.5).

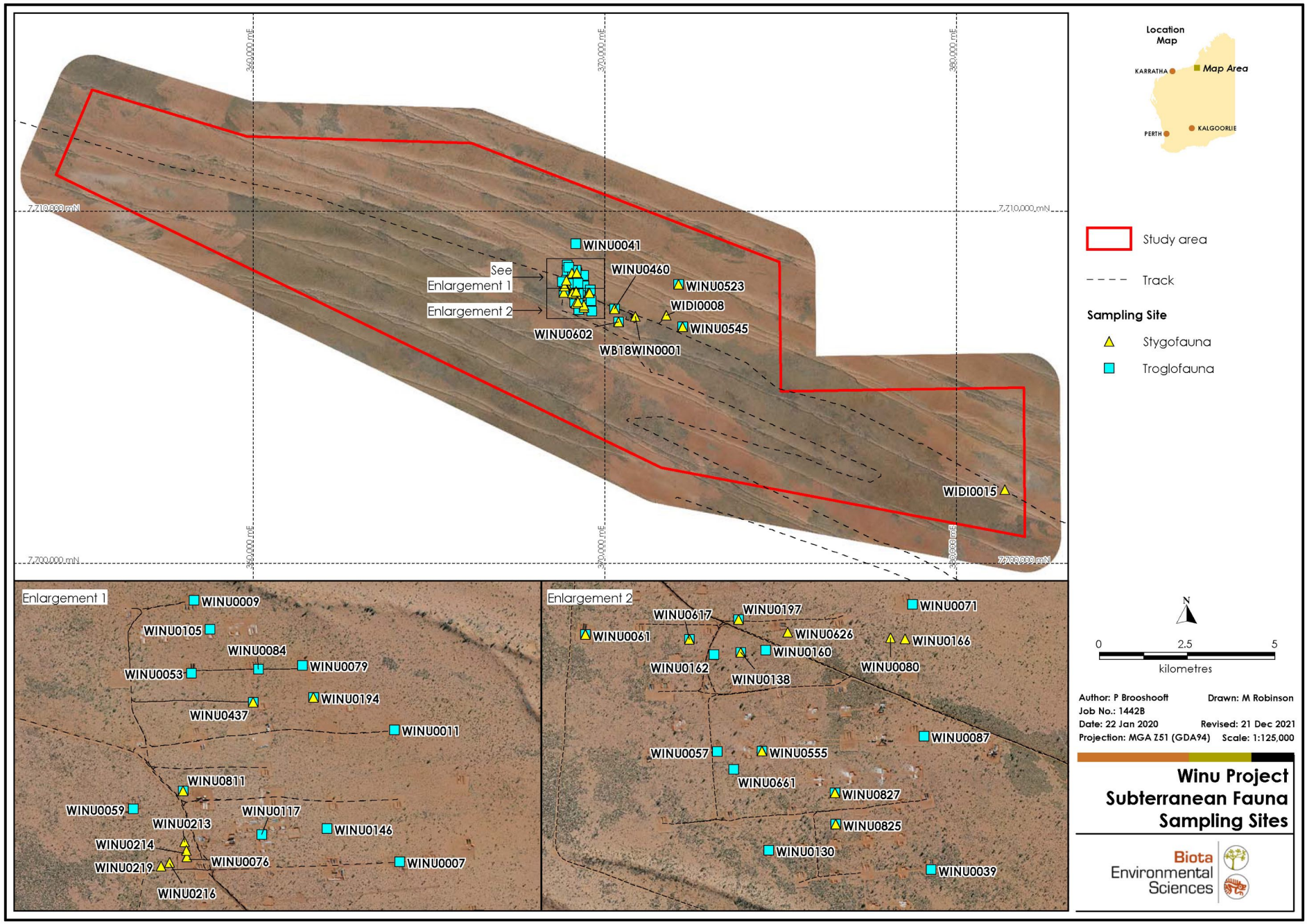

Figure 4.1: Troglofauna and stygofauna sampling site locations.

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Table 4.4: Indicative and actual troglofauna sampling sites and their attributes.

Actual sites sampled are highlighted in grey.

	Site Name	Easting (mE)	Northing (mN)	Targeted Geology AWT (mbgl)*	Drill Completion Date	Traps installed?	Scraped?	Trap Depth (mbgl) 1	2	3	Number Traps Recovered	Sampling Notes
Indicative	MONT0001	371538	7707204	Sandstone (48-59 m)	12/07/19	No	-					Inaccessible
	RC18WIN0003	369104	7707867	Tillite (13-51 m)	20/06/18	No	-					Decommissioned
	WINU0009	368934	7708476	Tillite (33-77 m)	3/10/18	Yes	Yes	32	38	44	3	-
	WINU0011	369390	7708181	Sandstone (32-51 m)	23/10/18	Yes	-	32	38	44	3	-
	WINU0041	369170	7709080	Sandstone/conglomerate (39-74 m)	20/03/19	Yes	-	39	43	47	2	Third trap lost
	WINU0048	368769	7708300	Sandstone/conglomerate (36-66 m)	31/03/19	No	-					Inaccessible
	WINU0054	369270	7707715	Sandstone (42-48 m)	11/05/19	No	-					Blocked
	WINU0071	369582	7707761	Sandstone (14-43 m)	2/07/19	Yes	-	32	36	40	3	-
	WINU0073	369556	7708059	Sandstone (29-56 m)	4/07/19	No	-					Inaccessible
	WINU0079	369181	7708328	Sandstone (14-59 m)	1/07/19	Yes	Yes	32	38	44	3	-
	WINU0101	368872	7708406	Sandstone (22-54 m)	6/04/19	No	-					Blocked
	WINU0103	368818	7708403	Sandstone (9-50 m)	13/04/19	No	-					Decommissioned
	WINU0116	369091	7707919	Sandstone (20-49 m)	7/05/19	No	-					Decommissioned
	WINU0117	369089	7707943	Sandstone (21-30 m; 31-48 m), conglomerate (30-31 m)	9/05/19	Yes	-	41	44	47	3	-
	WINU0118	369085	7707993	Sandstone (20-48 m)	11/05/19	No	-					Decommissioned
	WINU0146	369236	7707956	Sandstone (33-47 m)	28/05/19	Yes	-	40	43	46	3	-
	WINU0151	369330	7707206	Sandstone (17-56 m)	21/05/19	No	-					Blocked
	WINU0159	369650	7707539	Sandstone (19-45 m)	8/06/19	No	-					Blocked
	WINU0160	369248	7707657	Sandstone (10-62 m)	11/06/19	Yes	-	41	44	47	3	-
	WINU0171	369224	7708105	Sandstone (20-49 m)	14/06/19	No	-					Decommissioned
	WINU0617	369074	7707681	-	25/4/20	No	-					Blank-cased to water table
	WINU0825	369407	7707261	-	20/8/20	No	-					Blank-cased to water table
	WINU0460	370278	7707229	-	11/10/19	No	-					Blank-cased to water table
	WINU0523	372100	7707925	-	21/2/20	No	-					Blank-cased to water table
	WINU0661	369175	7707385	-	18/6/20	No	-					Inaccessible
	WINU0827	369405	7707332	-	24/8/20	Yes	-	45	50	55	3	-
	WINU0437	369069	7708244	-	24/9/19	Yes	Yes	40	45	50	3	-
	WINU0194	369206	7708255	-	30/6/19	Yes	Yes	45	50	55	3	-
	WINU0555	369239	7707427	-	18/11/19	Yes	Yes	45	50	-	2	-
	WINU0545	372209	7706712	-	26/2/20	Yes	Yes	45	50	55	2	-
	WINU0811	368910	7708042	-	22/8/20	Yes	Yes	45	50	-	2	-
	WINU0197	369186	7707726	-	9/7/19	Yes	Yes	30	40	45	3	-
	WINU0626	369298	7707697	-	5/5/20	Yes	-	30	35	40	3	-
	WINU0602	370386	7706857	-	8/4/20	Yes	Yes	30	40	50	3	-
Opportunistic	WINU0007	369402	7707881	Tillite (35-49 m)	12/09/18	Yes	-	35	40	45	3	-
	WINU0039	369624	7707157	Sandstone (35-56 m)	5/03/19	Yes	-	35	40	45	3	-
	WINU0053	368928	7708310	Sandstone (36-55 m)	13/04/19	Yes	-	36	40	44	3	-
	WINU0057	369137	7707426	Sandstone (41-65 m)	27/04/19	Yes	-	38	42	46	3	-
	WINU0059	368796	7708002	Sandstone (30-72 m)	26/05/19	Yes	Yes	30	35	40	2	Third trap lost
	WINU0061	368838	7707692	Conglomerate (38-69 m)	14/05/19	Yes	-	30	35	40	0	Rope destroyed, traps lost
	WINU0084	369081	7708319	Sandstone (41-49 m)	16/07/19	Yes	Yes	34	38	42	1	Second and third trap lost
	WINU0087	369608	7707461	Metasandstone (44-119 m)	5/07/19	Yes	-	35	40	45	3	-
	WINU0105	368971	7708410	Sandstone (12-60 m)	20/04/19	Yes	-	35	40	45	3	-
	WINU0130	369255	7707202	Sandstone (23-55 m)	19/05/19	Yes	-	35	38	41	3	-
	WINU0138	369191	7707651	Sandstone (11-104 m)	21/05/19	Yes	-	43	45	47	3	-
	WINU0162	369130	7707646	Sandstone (19-47 m)	29/05/19	Yes	-	42	44	46	3	-
											77	

* Where logs supplied.

Table 4.5: Indicative and actual stygofauna sites sampled during mobilisation 1 and 2 (Actual sites sampled are highlighted in grey).

	Site Name	Easting (mE)	Northing (mN)	Targeted Geology BWT*	Completion Date	Construction	Sampled?	Number of Hauls	Sampling Notes
Mobilisation 1 and 2	WIDI0007	369116	7707565	Leached cap (51-106 m)	7/07/18	PVC casing 6-30 m, 30m> open hole	No	-	Headworks for pumping attached
	WIDI0013	381761	7701875	Tillite (7-88 m)	19/10/18	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
	WIDI0015	381376	7702085	Tillite (2-59 m)	26/10/18	PVC casing 6-30 m, 30m> open hole	Yes	3	Sedimented
	WINU0006	368940	7708158	Colluvium tillite (45-51 m) and leached cap (51-100 m)	9/09/18	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
	WINU0031	369614	7707312	Mudstone (53-70 m) and leached cap (70-151 m)	3/02/19	PVC casing 6-30 m, 30m> open hole	No	-	Blocked
	WINU0050	369197	7709139	Sandstone (35-70 m)	2/06/19	PVC casing 6-30 m, 30m> open hole	No	-	Headworks for pumping attached
	WINU0059	368796	7708002	Sandstone (30-72 m)	26/05/19	PVC casing 6-30 m, 30m> open hole	No	-	No water
	WINU0061	368838	7707692	Conglomerate (38-69 m)	14/05/19	PVC casing 6-30 m, 30m> open hole	Yes	2	Very sedimented
	WINU0068	368987	7707413	Sandstone (17-71 m)	27/05/19	PVC casing 6-30 m, 30m> open hole	No	-	Blocked
	WINU0076	368918	7707892	Sandstone (35-52 m; 58-67 m) and hematite oxidisation (52-58 m)	2/06/19	Solid steel casing 0-83 m; stainless steel slotted screen 83-137 m	Yes	5	Opportunistic site. Casing solid and prevented transmission of water in target geology into bore. Sedimented
	WINU0080	369532	7707684	NA (clay and mudstone geology BWT not optimal)	5/07/19	Solid steel casing 0-94 m; slotted steel casing 94-100 m	Yes	5	Opportunistic site. Geology not porous. Casing prevented transmission of water into bore. Drilled 2 months prior to survey. Sedimented
	WINU0102	369067	7708421	Sandstone (17-58 m; 60-64m) and conglomerate (58-60m)	9/04/19	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
	WINU0107	369033	7708415	Sandstone (39-60 m), tillite (60-68 m) and conglomerate (68-73 m)	26/05/19	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
	WINU0122	369372	7707360	Leachedcap (43-106 m)	3/05/19	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
	WINU0138	369191	7707651	Sandstone (11-104 m)	21/05/19	PVC casing 6-42.5 m, 30m> open hole	Yes	4	Sedimented
	WINU0152	369402	7707215	Sandstone (39-82 m)	24/05/19	PVC casing 6-30 m, 30m> open hole	No	-	Blocked
	WINU0161	369044	7707638	Sandstone (10-46 m; 47-55 m) and metasandstone (46-47 m)	28/05/19	PVC casing 6-30 m, 30m> open hole	No	-	Decommissioned
Mobilisation 3	WINU0617	369074	7707681	-	25/4/20	Unknown	Yes	5	-
	WINU0825	369407	7707261	-	20/8/20	Unknown	Yes	5	-
	WINU0460	370278	7707229	-	11/10/19	collared to water approximately 40m	Yes	5	-
	WINU0523	372100	7707925	-	21/2/20	Collar to 42m	Yes	5	-
	WINU0661	369175	7707385	-	18/6/20	Unknown	No	-	Blocked
	WINU0827	369405	7707332	-	24/8/20	Unknown	Yes	5	-
	WINU0437	369069	7708244	-	24/9/19	PVC Cased	Yes	5	-
	WINU0194	369206	7708255	-	30/6/19	collared to 30	Yes	5	-
	WINU0555	369239	7707427	-	18/11/19	Unknown	Yes	5	-
	WINU0545	372209	7706712	-	26/2/20	Unknown	Yes	5	-
	WINU0811	368910	7708042	-	22/8/20	Unknown	Yes	5	-
	WINU0197	369186	7707726	-	9/7/19	Unknown	Yes	5	-
	WINU0626	369298	7707697	-	5/5/20	PVC Cased	Yes	5	-
	WINU0602	370386	7706857	-	8/4/20	PVC case	Yes	5	-

* Where logs supplied.

4.4 Limitations

Several limitations apply to this study, comprising:

1. Sampling for troglofauna and stygofauna relied on the use of drill holes, which were installed for exploration drilling, and thus were centred on geological units of economic importance. Sampling for subterranean fauna was therefore biased to these areas, and did not extend beyond the footprint of the target mineralisation body. This placed limitations on establishing whether troglofauna or stygofauna communities occur elsewhere within or in the locality of the study area.
2. Accessibility of sample sites was limitation of the initial mobilisations of this survey. Sampling was undertaken in an area that was subject to active drilling works, rendering some sites physically inaccessible. In addition, many sites had been decommissioned to meet Department of Mines, Industry Regulation and Safety (DMIRS) licence conditions and could not be found. Of the sites that were accessible, many were blocked, preventing installation of troglofauna traps or sampling for stygofauna. In recognition of this, additional sampling was completed during the third mobilisation, which overcame this limitation in the context of a basic survey.
3. Due to the nature of the geology in the study area, particularly the cover sequence of sand, the majority of drill holes sampled during the initial mobilisations were installed on an inclined angle. This limited our ability to sample, especially for troglofauna scraping and stygofauna sampling, as the net used for both activities would either only collect a sample from one surface in the drill hole (scraping for troglofauna typically aims to collect a substrate sample from the circumference of the entire drill hole), or the ring of the net would catch on the base of the casing, preventing retrieval of the entire sample. In recognition of this, additional sampling was completed during the third mobilisation, which utilised vertically drilled holes and overcame this limitation in the context of a basic survey.
4. Construction of many drill holes comprised solid PVC casing until approximately 30-45 mbgl, meaning that the exposed geology AWT was limited to a space of 10-20 m. This meant that sampling for troglofauna was restricted to a window between 30-50 mbgl, limiting inferences drawn from the sampling results to this stratigraphy.
5. Stygofauna sampling during the initial two mobilisations encountered limitations due to drill hole and bore hole construction and access restrictions. In recognition of this, additional sampling was completed during the third mobilisation, which overcame this limitation in the context of a basic survey.
6. Availability of groundwater in the study area was limited. Groundwater was required for project related purposes, meaning that most drill hole locations that did have water were being pumped during the time of the initial sampling mobilisations. Groundwater abstraction locally lowers the water table and reduces saturated habitat in the immediate vicinity of the bore, potentially depleting fauna numbers if present, which in turn would have limited ability to detect the presence of any stygofauna during the first mobilisations. In recognition of this, additional sampling was completed during the third mobilisation from bores which were not being actively pumped and intersected the water table, which overcame this limitation in the context of a basic survey.
7. The majority of the stygofauna samples were sedimented, meaning that the accumulation of significant amounts of mud sediment during sampling effectively prevented the recommended number of hauls from being achieved at a few sites.

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5.0 Results

5.1 Desktop Study

5.1.1 Subterranean Fauna Habitat Suitability within Subregion

The study area falls entirely within the Mackay subregion. The description of the Mackay subregion by Kendrick (2003) highlights "*the possibility of high endemism within troglobitic faunas associated with calcrete systems along palaeodrainage lines. So far not investigated, but the likelihood of unique faunas is very high*." Similarly for stygofauna in the subregion, observing that the "*underground waters, associated with calcrete deposits along palaeodrainage lines…special values possible for stygofauna – some stygofauna known from vicinity of Canning Stock Route*" Kendrick (2003).

The study area is situated between two major palaeodrainage lines (Percival and Wallal paleorivers, as per Graaff et al. (1977)), and has no obvious association to calcrete deposits. Given the predicted association of areas of high troglofauna and stygofauna biodiversity with calcrete systems in the Mackay subregion, it seems at this broad scale of consideration that it would be unlikely that the study area would be of subregional importance for subterranean fauna, in comparison to other areas in the Great Sandy Desert situated along paleodrainage channels and calcrete systems.

5.1.2 Previous Records and Relevant Surveys

Searches of the NatureMap and EPBC PMST (Appendix 2) databases did not return any records of subterranean fauna within 40 km of the study area. A search of the DBCA Priority and Threatened Ecological Communities database indicated that no PECs or TECs relevant to subterranean fauna occur within 120 km of the study area.

The review of the WAM Arachnida and Crustacea database of subterranean fauna records within 100 km revealed that the area had been poorly sampled, with the vast majority of database records coming from the Pilbara region (Appendix 3). These records from the Pilbara were not considered further in the desktop study as they were not relevant to the study area, mostly coming from significantly different geological settings.

The literature review of relevant subterranean fauna surveys demonstrated that the occurrence of troglofauna and stygofauna in deserts (including the Great Sandy Desert, Little Sandy Desert and Great Victoria Desert) was variable, with poor to moderately rich communities present (Table 5.1). Some records of troglofauna and stygofauna within other desert environments were from study areas containing similar lithologies to that of the study area (i.e. sandstone and siltstone) (Table 5.1). Further, there is evidence from Irvine Island in the Kimberley region that sandstone can provide suitable habitat for troglofauna (Biota, unpublished data). This may indicate that the study area may have some potentially suitable habitat to support a troglofauna and/or stygofauna community.

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Table 5.1: Review of subterranean fauna surveys in Western Australian desert environments.

Report (Author)	Description	Bioregion	Geological Attributes	Survey Dates	Subfauna Recorded	Location from study area
Tropicana Gold Project Troglofauna Survey Report (Ecologia 2009)	Desktop assessment, Level 2 troglofauna survey	Great Victoria Desert	• Porous Gneiss rock • Saprolitic clay with root mats	Phase 1: September – November 2007 Phase 2: April - June 2008 Phase 3: August – October 2008 Phase 4: October – December 2008	• No stygofauna recorded • 3 troglofauna orders recorded (Diplura, Chilopoda, Isopoda)	950 km southeast
Subterranean Fauna Assessment of the Kintyre Uranium Deposit (Bennelongia 2012)	Desktop assessment, Level 2 troglofauna and stygofauna survey	Little Sandy Desert	Troglofauna: • Colluvial and alluvial sediment • Laterite and silcrete • Calcrete • Kintyre shear zone, Coolbro Sandstone, fractured schists Stygofauna: • Pebble layers in Cenozoic sediment • Calcrete • Upper sand aquifers, lower basal sand, gravel and conglomerate	Troglofauna: Phase 1: 24/02/2010 – 29/04/2010 Phase 2: 2/07/2010 – 27/07/2010 Phase 3: 3/10/2010 – 15/12/2010 Stygofauna: April 2010 September 2010 December 2011 April 2012	• 12 orders of troglofauna (Pseudoscorpionida, Palpigradi, Araneae, Isopoda, Scolopendromorpha, Polyxenida, Pauropoda, Cephalostigmata, Diplura, Zygentoma, Blattodea and Hemiptera) • 15 stygofauna species (Rotifera, Oligochaeta, Copepoda, Syncarida, Amphipoda, Isopoda, Nematoda)	170 km south
Lake Disappointment Subterranean Fauna Desktop Assessment (Bennelongia 2016)	Desktop assessment	Little Sandy Desert	• Sandstone • Conglomerate	N/A	• No stygofauna or troglofauna records within 100km – due to lack of survey. • Stygofauna considered likely occur	300 km southeast
Level 1 Stygofauna Survey – Lake Disappointment Potash Project (Harewood 2016)	Level 1 stygofauna survey	Little Sandy Desert	• Sandstone • Siltstone • Shale	October 2016	• No stygofauna or any other invertebrate, however stygofauna recorded from regional bores in calcrete formations	300 km southeast
Level 1 Subterranean Fauna Assessment for the Beyondie Potash Project (Phoenix 2017)	Level 1 subterranean fauna assessment – desktop review and pilot survey	Borders Little Sandy Desert and Gascoyne	• Sandstone • Siltstone • Conglomerate • Shale	March 2017 (stygofauna haul net trapping only, no troglofauna trap installation)	• 2 troglofauna orders (Araneae and Hemiptera) • 2 orders of stygofauna (Amphipoda and Syncarida)	470 km southwest
Canning Basin Project Stygofauna Survey and Assessment (Subterranean Ecology 2012)	Level 1 stygofauna survey – desktop assessment and pilot survey	Great Sandy Desert	• Wallal Sandstone aquifer	Phase 1: 21-24/02/2012 Phase 2: 28-30/03/2012	• 1 individual from 1 stygofauna order (Polychaeta)	160 km northwest
Two new species of Leicacandona Karanovic (Ostracoda, Candoninae) from the Great Sandy Desert, Australia (Karanovic and McKay 2010)	Sampling conducted at the Telfer Gold Mine for a species taxonomic description publication	Great Sandy Desert	Not discussed	2008 dates unknown, 19 bores sampled	• 2 stygofauna species (Ostracoda)	120 km southeast

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5.1.3 Potential Habitat within the Study Area

Appraisal of drill hole core photos indicated that there was no obvious habitat suitable for subterranean fauna, with an absence of the fractures, caverns or vugs (e.g. Plate 5.1 - Plate 5.2) that are consistent with those commonly seen in subterranean fauna habitats (for example, in CID occurring in the Pilbara; Plate 5.3). However, the sandstone and occasionally tillite units did appear to have some limited porosity, with some small interstitial spaces that may represent potential habitat for both troglofauna and stygofauna (Plate 5.4 - Plate 5.5).

Plate 5.1: **Site WINU0053 at approx. 60 m: solid mudstone.**

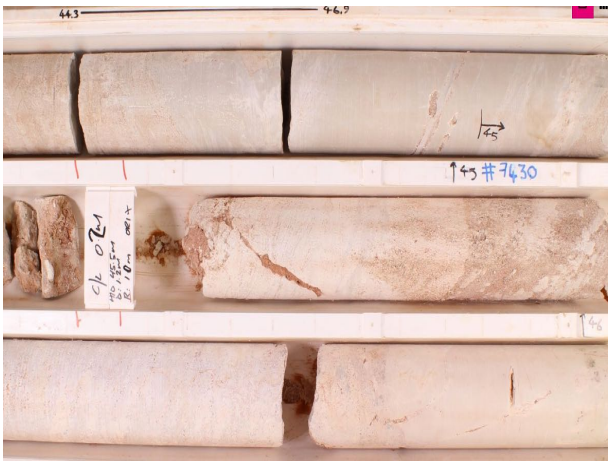

Plate 5.2: **Site WINU0071 at approx. 45 m: solid mudstone.**

Plate 5.3: **Example of a drill core from the Pilbara showing fractures and cavities typical of subterranean fauna habitat.**

Plate 5.4: **Site WINU0059 at approx. 41 m: porous sandstone.**

Plate 5.5: **Site WINU0011 at approx. 35 m: porous and fractured sandstone.**

5.1.4 Prospectivity of the Study Area for Troglofauna

The broad geology of the study area (as described in Sections 3.3 and 3.4) was assessed according to the criteria outlined in Section 4.1.2. The resulting assessment of habitat prospectivity for troglofauna is presented in Table 5.2. The upper layer of sand was assessed as having Low prospectivity as habitat for troglofauna, while the sandstone unit occurring AWT was assessed as Moderate, and troglofauna may potentially occur (Table 5.2). The mudstone and metasediment units occurring BWT would not represent habitat for troglofauna (Table 5.2).

Table 5.2: Stratigraphy of the study area and prospectivity as habitat for troglofauna.

Stratigraphy	Geology Suitable?	Geology AWT?	Troglofauna Documented from Similar Geology?	Prospectivity	Troglofauna Likelihood of Occurrence Assessment
Sand (0-15/20 m)	✗	✓	✗	Low	The loose sands occurring between 0-20 mbgl would be unlikely to represent suitable habitat. As this lithology is mobile, it is not likely to support stable spaces for troglofaunal, so it is unlikely that troglofauna would occur through this unit.
Sandstone (15/20 m – 74 m)	✓	✓	✓	Moderate	The sandstone units displayed some porosity AWT, and troglofauna have been recorded from sandstone in desert environments previously. It is possible that troglofauna occur in this unit.
Mudstone (74 m – 174 m)	✗	✗	✗	None	This geology was consolidated with no habitable space, and occurs BWT. It is unlikely that troglofauna would occur through this unit.
Metasediment (174 m+)	✓ (some)	✗	Unknown	None	While some metasediment units appeared porous, they were located BWT and would not represent troglofauna habitat.

In addition to the above assessment, a small area of gravelly lateritic rise habitat was identified in the eastern section of study area (Biota 2020). This was inferred as having a Moderate level of prospectivity for troglofauna due to the increased likelihood of subsurface vugs and cavities (and troglofauna have been recorded from laterite units previously (Biota 2009)), however no drilling has been undertaken in this area to enable quantification of this.

The desktop study identified the presence of a large geological fault and dyke running through the eastern section of the study area. These features could be isolating for any potential subterranean communities present, depending on geology and depth. It would be of interest to sample sites located on either side of these geological features, however, no drill holes were available for sampling at the time of the survey.

5.1.5 Prospectivity of the Study Area for Stygofauna

The assessment of habitat prospectivity for stygofauna is presented in Table 5.3. The sandstone unit occurring BWT was assessed as being Moderately prospective and may potentially support stygofauna, while the prospectivity of mudstone and metasediment units occurring below the sandstone were assessed as Low (Table 5.3). The upper sand unit would not represent habitat for stygofauna (Table 5.3).

Table 5.3: Stratigraphy of the study area and prospectivity as habitat for stygofauna.

Stratigraphy	Geology Suitable?	Geology BWT?	Stygofauna Documented from Similar Geology?	Prospectivity	Stygofauna Likelihood of Occurrence Assessment
Sand (0-15/20 m)	✗	✗	✗	None	The sand stratigraphy occurs AWT and would not represent habitat for stygofauna.
Sandstone (15/20 m – 74 m)	✓	✓	✓	Moderate	The sandstone units displayed some porosity BWT, and stygofauna have been recorded from sandstone in desert environments previously. Stygofauna may potentially occur in this unit.
Mudstone (74 m – 174 m)	✗	✓	✗	Low	The mudstone geology layer had low permeability and was consolidated. It is unlikely to represent transmissive habitat suitable for stygofauna.
Metasediment (174 m+)	✓ (some)	✓	Unknown	Low	Some metasediment units appeared porous, and were located BWT in the main aquifer. Given the mudstone layer acts as a confining unit, it is unlikely that nutrients would reach this stratigraphy to support a stygofauna community.

In well-sampled areas such as the Pilbara, depth to the water table is often a key factor in determining the presence of stygofauna. In open aquifers (such as karstic environments) where hydraulic conductivity is high, depth is less of a limiting factor for stygofauna presence (Subterranean Ecology 2012). However in less transmissive aquifers, stygofauna, if present, tend to be limited to near surface habitats due to lower nutrient and oxygen exchange, and depths below 40 m are unlikely to support stygofaunal communities of any significance. It remains to be seen whether this depth threshold also applies in desert environments, but the presence of a sand stratum up to 20 m thick is more consistent with attenuation of organic and nutrient inputs. The differences in geology, climate and general absence of surface waters in the desert environment likely creates a system with fewer nutrient inputs than that experienced in the Pilbara. As a result, surface nutrients may not penetrate as deeply below surface. Thus, it is more likely that stygofauna communities will also be more diverse and abundant in desert settings where the water table is closer to the surface (i.e. <40 mbgl) than it is in the study area (where the water table is at 50 mbgl).

In addition to the above, and similar to the troglofauna assessment, the area identified as gravelly lateritic habitat in the eastern section of the study area may represent Moderately prospective habitat, although lack of drilling in this area does not allow this to be quantified. Similarly, for troglofauna, the geological faults and dykes in the east may represent a barrier for any stygofauna communities that may be present either side of these features.

5.2 Basic Survey Findings

5.2.1 Troglofauna

No troglobitic specimens were collected from the study area. However, a number of edaphobitic specimens (soil dwelling fauna derived from surface environments) were collected from the troglofauna traps. These included specimens from the orders Acarina, Collembola and Psocoptera.

A single specimen from the order Araneae was collected as by-catch from the stygofauna sample of site WIDI0008. Superficially this specimen had some characteristics of a troglomorphic specimen (Plate 5.6). Advice was sought from Dr Mark Harvey, the curator of Arachnology at the WAM, on the likelihood that this specimen was troglobitic. Based on eye size and body shape, Dr Harvey suggested that the specimen was most likely epigean, having fallen into the sample from the surface.

Plate 5.6: Araneae specimen collected from the stygofauna sample of site WIDI0008.

5.2.2 Stygofauna

Analysis of the stygofauna samples indicated that no stygofauna specimens were present in any sample from either mobilisation.

A single Diptera larva was collected from site WINU0061, however this was most likely of terrestrial origin (Dr M. Harvey, pers. comm.) (Plate 5.7).

Plate 5.7: Diptera larvae collected from site WINU0061.

6.0 Conclusions

The Great Sandy Desert has been poorly surveyed for subterranean fauna, but records of troglofauna and stygofauna in other desert environments indicate that they can and do occur, albeit as only poor to moderately rich communities. However, both the desktop review of geological and hydrological information for the study area, and past records of subterranean fauna from similar desert environments, suggest that the prospectivity of troglofauna and stygofauna occurrence in the study area is generally Low.

The variably consolidated sandstone lithology occurring between 15 - 74 mbgl does appear to be porous, and may represent potential habitat, however compared to known core habitat for subterranean fauna elsewhere in Western Australia, it is considered to represent habitat of only Moderate prospectivity at best. A small area of laterite in the eastern section of the study area may also represent Moderately prospective habitat for subterranean fauna. However, no drilling has been undertaken in this area to allow quantification of habitat suitability, and it is outside the current boundaries of the mineralised deposit.

The basic survey supported the results of the desktop study; no troglobitic or stygobitic specimens were recorded, despite sampling that exceeded the timeframe and effort normally undertaken for basic surveys. Given this, our assessment is that it is unlikely that subterranean fauna occur in most geological units of the study area, with the sandstone unit presenting the only habitat within which subterranean fauna may potentially occur.

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7.0 Glossary

AWT	Above water table.
BWT	Below water table.
CID	Channel iron deposit.
DBCA	Department of Biodiversity, Conservation and Attractions
Edaphobite	Deep soil inhabitant.
EPA	Environmental Protection Authority of Western Australia.
Epigean	Fauna from above the soil level.
mbgl	Meters below ground level.
RTW	Rio Tinto Winu Pty Limited
Stygobite / Stygofauna	Fauna inhabiting the various types of groundwater.
Troglobite / Troglofauna	Species that do not exist outside caves. They may, however, occur in the superficial underground compartment or in the upper hypogean zone.
WAM	Western Australian Museum

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Appendix 1

Fauna Taking Licence: Licence Number BA27000110

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

FAUNA TAKING (BIOLOGICAL ASSESSMENT) LICENCE

Regulation 27, Biodiversity Conservation Regulations 2018

Licence Number: BA27000110

Licence Holder: Ms Penny Brooshooft
Biota Environmental Sciences
PO Box 155
Leederville WA 6903

Date of Issue: 22/08/2019

Date Valid From: 10/05/2019
Date of Expiry: 09/05/2020

LICENSED ACTIVITIES

Subject to the terms and conditions on this licence, the licence holder may –

1. Take and disturb fauna for subterranean fauna survey (Troglofauna & Stygofauna) for Rio Tinto Exploration (RTX) using PVC trap tubes and plankton haul net constructed from mesh and weighted with a collection vial.

LOCATIONS

1. Winu project approx 320 km east of Port Hedland. d

AUTHORISED PERSONS

The following persons or persons of the specified class may assist in carrying out the licensed activities:

1. Jacinta King
2. Daniel Kamien
3. Stewart Ford
4. Sylvie Schmidt
5. Michael Greenham
6. Victoria Ford
7. Joshua Keen
8. John Graff
9. Nathan Beerkens

CONDITIONS

1. Fauna must not be taken on CALM land, (as defined in the Conservation and Land Management Regulations 2002*),* unless authorised by a written notice of a lawful authority issued under regulations 4 and 8 of the Conservation and Land Management Regulations 2002.
2. If persons, other than the licence holder, are authorised to carry out/assist in carrying out the activities under the licence, the licence holder must ensure those persons have read and understand the licence terms and conditions.

3. The written authorisation of the person in possession or occupation of the land accessed and upon which fauna is taken, as required under regulation 101(2) and referred to in "Additional information" below, must:
   a) state location details (including lot or location number, street/road, suburb and local government authority);
   b) state land owner or occupier name, and contact phone number;
   c) specify the time period that the authorisation is valid for;
   d) be signed and dated; and
   e) be attached to this licence at all times.
4. This licence, and any written authorisation or lawful authority which authorises the take of fauna on specified locations must be carried at all times while conducting licensed activities and be produced on demand by a wildlife officer.
5. If a species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* is inadvertently captured, that species is to be released immediately at the point of capture. If the fauna is injured or deceased, the licence holder shall contact the DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) for advice on treatment or disposal. Details of any capture of threatened fauna must be included in the "Return of Fauna Taken."
6. The licence holder must not:
   a) release any fauna in any area where it does not naturally occur;
   b) transfer fauna to any other person or authority (other than the Western Australian Museum) unless approved in writing by the CEO; or
   c) dispose of the remains of fauna in any manner likely to interfere the natural or present day distribution of the species.
7. The licence holder must not take and remove more than ten specimens of any one protected species of fauna from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.
8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence must be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range must be offered to the Western Australian Museum.
9. All specimens and material retained under the authority of this licence must be offered to the Western Australian Museum for loan, for inclusion in its collection, or on request be made available to other persons involved in relevant scientific studies.
10. The licence holder must create, compile and maintain records and information as required in a DBCA approved "Return of Fauna Taken" of all fauna taking activities as they occur.
11. A DBCA approved "Return of Fauna Taken" must be completed in full (including nil taking details) and submitted to DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) prior to the end of each annual period of the licence (from the valid from date) (refer to "Additional Information" section below).

Danny Stefoni
LICENSING OFFICER
WILDLIFE PROTECTION BRANCH

Delegate of CEO

ADDITIONAL INFORMATION

1. It is an offence to take any species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* unless the person is authorised under Section 40. The penalty ranges between $300 000 and $500 000; Section 150 Biodiversity Conservation Act 2016.
2. Regulation 82 empowers the CEO to add, substitute or delete a term or condition of a licence or to correct errors. Such power may be exercised on application of a licence holder or by the CEO's own initiative. If an amendment to a licence term or condition is required, please contact the CEO or the Licensing Section on wildlifelicensing@dbca.wa.gov.au in the first instance. The licence holder, if adversely affected by a condition imposed in this licence, may apply to the State Administrative Tribunal for review of the decision of the CEO to impose that condition on a licence: regulation 89(2) Biodiversity Conservation Regulations 2018.
3. A person must not contravene a condition of a licence. The penalty for an offence involving the contravention of a condition of a licence is a fine of $10 000: regulation 84 of the Biodiversity Conservation Regulations 2018.
4. It is an offence for persons authorised by this licence to enter land that is not in their possession or under their control without first having the *prior* written authorisation of the current owner or occupier of the land to:

   a) enter the land; and

   b) carry out the activity authorised by this licence.

   The penalty for this offence is a fine of $5 000: regulation 101(2) of the Biodiversity Conservation Regulations 2018.
5. The licence holder must be able to produce for inspection upon request any information or records required by regulation 85(2) of the Biodiversity Conservation Regulations 2018 Penalty $10 000. It is an offence to knowingly include false or misleading information or make statements in records: regulation 85(3) of the Biodiversity Conservation Regulations 2018 Penalty $10 000. It is an offence to include any information or make any statement in a return that the licence holder knows to be false or misleading in a material particular: regulation 86 (2) of the Biodiversity Conservation Regulations 2018 Penalty $10 000.
6. The approved DBCA "Return of Fauna Taken" data file can be downloaded from the DBCA webpage (https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities).
7. The issuing of a licence under the Biodiversity Conservation Regulations 2018 does not constitute an animal ethics approval or a licence to use animals for scientific purposes as required under the *Animal Welfare Act 2002,* Animal Welfare (Scientific Purposes) Regulations 2003. It is the responsibility of a licence applicant / licence holder to ensure that they comply with the requirements of all applicable legislation. Enquiries relating to the Animal Welfare Act licences and animal ethics approvals are to be

directed to the Department of Primary Industries and Regional Development (https://www.agric.wa.gov.au/animalwelfare).

8. Threatened fauna can only be taken under a *Biodiversity Conservation Act 2016* Section 40 authorisation, Occurrences of threatened species must be reported to the CEO. For more information please see https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals.

9. Any interaction involving Nationally Listed Threatened Fauna that may be invasive and/or harmful to the fauna may require approval from the Commonwealth Department of the Environment and Energy http://www.environment.gov.au/about-us/business-us/permits-assessments-licences. Interaction with such species is controlled by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the *Biodiversity Conservation Act 2016* and Biodiversity Conservation Regulations 2018.

Appendix 2

EPBC Protected Matters Search

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

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 is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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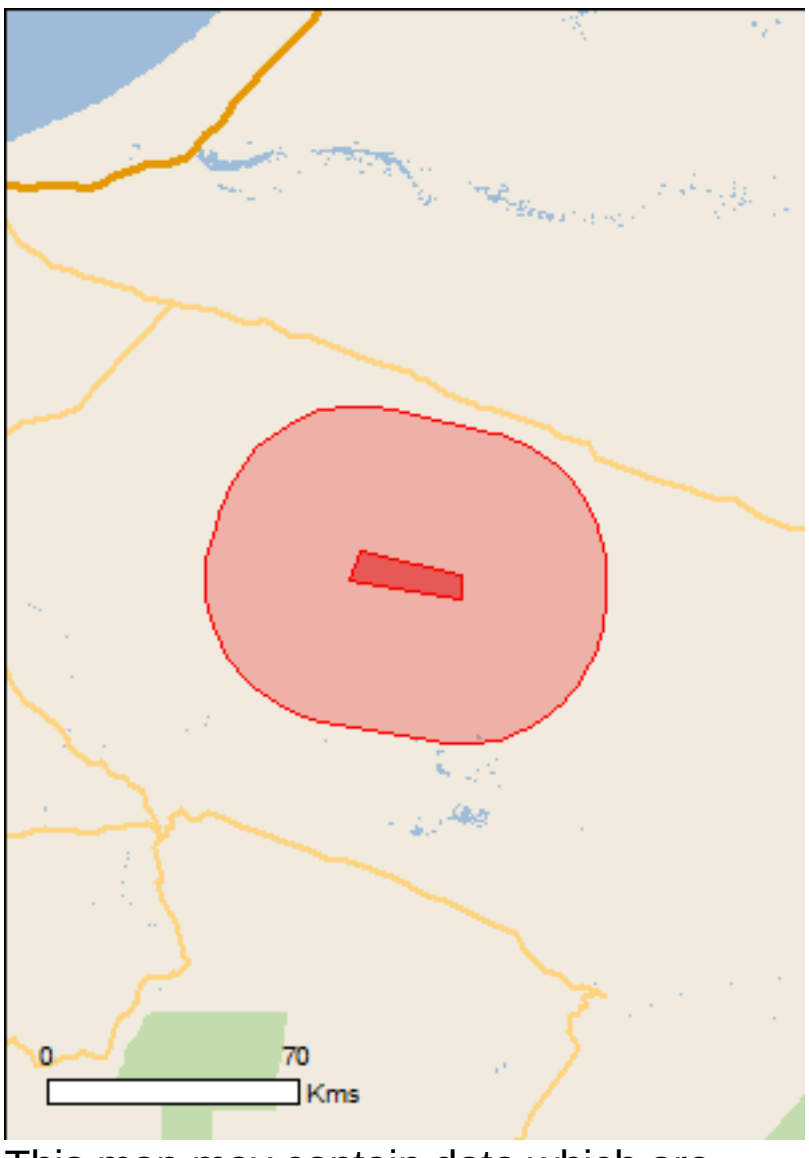

Coordinates

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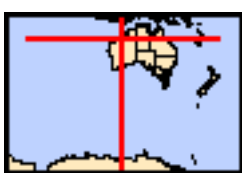

Summary

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.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	7
Listed Migratory Species:	11

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. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

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.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae		
Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis		
Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica		
Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Nyangumarta Warrarn	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		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		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
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to 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 and National Heritage properties, Wetlands of International and National 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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

-20.67389 121.61278,-20.72972 121.86806,-20.79111 121.86583,-20.7425 121.58833,-20.67389 121.61278

Acknowledgements

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-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian 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, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-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.

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Appendix 3

WAM Arachnida and Crustacea Database Search Results

Troglofauna Arachnid Records Within 100 km of Winu

ORDER	INFRAORDER	FAMILY	GENUS	SPECIES	SITE
Araneae	Araneomorphae	Corinnidae	Supunna	funerea	Cundaline mine lease, site CUN03, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Prodidomidae	Cryptoerithus	`sp.`	Cundaline mine lease, site CUN03, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Prodidomidae	Nomindra	`sp.`	Cundaline mine lease, site CUN04, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Prodidomidae	Wesmaldra	nixaut	Cundaline mine lease, site CUN03, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Prodidomidae	Wesmaldra	nixaut	Cundaline mine lease, site CUN04, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CU0059R
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CU0063R
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CU0062R
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CA0023R
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CA0024R
Araneae	Araneomorphae	Tetrablemmidae	Tetrablemma	alaus	Yarrie area, hole #CA0022R
Araneae	Araneomorphae	Trochanteriidae	Trachyspina	`sp.`	Cundaline mine lease, site CUN01, c. 14 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Trochanteriidae	Trachyspina	`sp.`	Cundaline mine lease, site CUN02, c. 14 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Zodariidae	Spinasteron	knowlesi	Cundaline mine lease, site CUN01, c. 14 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Zodariidae	Spinasteron	knowlesi	Cundaline mine lease, site CUN03, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Zodariidae	Spinasteron	knowlesi	Cundaline mine lease, site CUN04, c. 12 km NW. of Yarrie mine camp
Araneae	Araneomorphae	Oonopidae	Prethopalpus	eberhardi	Yarrie area, hole #CA0012R
Araneae	Araneomorphae	Oonopidae	Prethopalpus	eberhardi	ca. 13 km NE. of Yarrie Homestead, bore hole #CA0011R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Yarrie area, hole #CA0011R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Yarrie area, hole #CA0023R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Yarrie area, hole #CA0146R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Yarrie area, hole #CA0022R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Yarrie area, hole #CU0059R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	ca. 5 km S. of Shay Gap, Yarrie area, bore hole #CU0063R
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Callawa, Goldsworthy, 200 km E. of Port Hedland, BHP014-CA0022
Pseudoscorpiones		Chthoniidae	Lagynochthonius	leemouldi	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones		Chthoniidae	Lagynochthonius	`leemouldi?`	Callawa, Goldsworthy, 200 km E. of Port Hedland, BHP014-CA0058
Pseudoscorpiones		Chthoniidae	Tyrannochthonius	`sp. Yarrie`	Yarrie area, hole #CA0144R
Pseudoscorpiones		Chthoniidae	Tyrannochthonius	`sp. Yarrie`	Yarrie area, hole #CA0086R
Pseudoscorpiones		Chthoniidae	Tyrannochthonius	`sp. Yarrie`	Yarrie area, hole #CA0113R
Pseudoscorpiones		Chthoniidae	Tyrannochthonius	`sp. Yarrie`	Yarrie area, hole #CA0124R
Pseudoscorpiones		Chthoniidae	Tyrannochthonius	`sp. Yarrie`	Yarrie area, hole #CA0008R
Pseudoscorpiones		Chthoniidae	`Lagynochthonius?`	`leemouldi?`	Callawa, Goldsworthy, 200 km E. of Port Hedland

Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`Indohya sp. S1`	Cundaline, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Yarrie area, hole #CA0113R
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Yarrie area, hole #CA0011R
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Yarrie area, hole #CA0124R
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Yarrie area, hole #CA0022R
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Yarrie area, hole #CU0199R
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200 km E. of Port Hedland, BHP014-CA0058
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200km E. of Port Hedland
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Cundaline, Goldsworthy, 200 km E. of Port Hedland, BHP014-CU0060
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Cundaline, Goldsworthy, 200 km E. of Port Hedland, BHP014-CU0062
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Cundaline, Goldsworthy, 200 km E. of Port Hedland, BHP014-CU0059
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Cundaline, Goldsworthy, 200 km E. of Port Hedland, BHP014-CU0073
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200 km E. of Port Hedland
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Cundaline, Goldsworthy, 200 km E. of Port Hedland, BHP014-CU0057
Pseudoscorpiones	Hemictenata	Hyidae	Indohya	`PSE003`	Callawa, Goldsworthy, 200 km E. of Port Hedland
Scolopendrida		Cryptopidae	Cryptops	`sp. CA1`	Goldsworthy, 200 km E. of Port Hedland
Scorpiones		Buthidae	Lychas	`spiny hairy tail group`	Yarrie area, hole #CU0113R

Stygofauna Records Within 100 km of Winu

ORDER	INFRAORDER	FAMILY	GENUS	SPECIES	SITE
`Order indet.`		`Family indet.`	`Genus indet.`	`sp. S03`	Callawa, Goldsworthy, 200 km E. of Port Hedland