Woodie Woodie Subterranean Fauna Survey

Prepared for:

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Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

Woodie Woodie Subterranean Fauna Survey

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EXECUTIVE SUMMARY

The Woodie Woodie Mine and associated Woodie Continued Operations Project are owned and operated by Pilbara Manganese Pty Ltd, a wholly owned subsidiary of Consolidated Minerals Pty Ltd (ConsMin). The Project involves the extension of the current approved operational boundary (Active Mining Area) to the north, south and west, which will extend the currently approved operational boundary from 7,589 hectares (ha) to 12,708 ha as the Development Envelope. The Project is located approximately 160 km southeast of Marble Bar, in the Eastern Pilbara region of Western Australia (Figure 1). The mine is currently operational with approved activities set to continue until 2028. Proposed developments are collectively referred to as the 'Indicative Footprint', which include pits, dumps, haul roads and associated infrastructure within the Development Envelope. The area enclosing all subterranean fauna sampling, both inside and outside the Development Envelope, is called the Survey Area.

The term subterranean fauna includes two groups of underground animals: aquatic stygofauna and air-breathing troglofauna. Subterranean fauna species characteristically have reduced or absent eyes and are poorly pigmented because of the lack of light. All subterranean species require access to subterranean habitat for persistence; many spend their entire life cycles below ground (stygobites and troglobites), while others also have a life-stage in surface habitats (stygophiles and troglophiles). The Environmental Protection Authority (EPA) recognises the importance subterranean fauna in Western Australia and requires such fauna to be considered as part of environmental impact assessments (EIA) for mining developments and similar operations (EPA 2021).

Geology influences the presence, richness and distribution of subterranean fauna through the different types of habitats it provides. Karstic geologies, and other geologies with extensive networks of internal spaces, support larger assemblages of subterranean fauna, both in terms of abundance and diversity, than consolidated geologies. The geology of the Development Envelope and surrounding landscape is considered highly prospective for subterranean fauna because of the presence of vuggy lithologies across most of the area.

Based on the results of the field survey it is evident that moderately rich troglofauna and stygofauna communities occur at, and in the vicinity of, the Project. The 163 stygofauna samples collected yielded 943 specimens of at least 26 species. Despite some field survey limitations, 153 troglofauna samples yielded 108 specimens belonging to at least 24 species.

Of the 26 stygofauna species collected, 13 species are potentially known only from the Survey Area. Five of these species currently show restricted occurrences within the modelled extent of groundwater drawdown associated with the Project. The species are the syncarids Bathynellidae sp., *Billibathynella* `BSY192` and *Billibathynella* `BSY230`, and the harpacticoid copepods *Dussartstenocaris* `BHA324` and *Parastenocaris* `BHA311`. For four species these species the threat from Project development is minor, while for *Parastenocaris* 'BHA311' it is either minor or moderate.

Of the 24 troglofauna species recorded at Woodie Woodie, 21 species are potentially known only from the Survey Area. Four of these species currently show restricted occurrences within the Indicative Disturbance Footprint. These species are the pseudoscorpions *Tyrannochthonius* `BPS398` and *Tyrannochthonius* `BPS434`, the isopod *Troglarmadillo* `BIS474` and the dipluran Projapygidae `BDP209`. The threat to *Troglarmadillo* `BIS474` is either minor or moderate, while the threat to the other three species is moderate. Moderate threats are likely only to reduce species population size and, in the unlikely event of species distributions being very tightly restricted, the threats can be managed to mitigate the possibility of significant impact.

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1. INTRODUCTION

The Woodie Woodie Mine and associated Woodie Continued Operations Project (referred to hereafter as the 'Project') are owned and operated by Pilbara Manganese Pty Ltd, a wholly owned subsidiary of Consolidated Minerals Pty Ltd. The Project involves the extension of the current approved operational boundary (Active Mining Area) to the north, south and west, extend the currently approved operational boundary from 7,589 hectares (ha) to 12,708 ha in a new Development Envelope. The Project is located approximately 160 km southeast of Marble Bar, in the Eastern Pilbara region of Western Australia (Figure 1). The mine is currently operational with approved activities set to continue until 2028. Proposed developments are collectively referred to as the 'Indicative Disturbance Footprint', which include pits, dumps, haul roads and associated infrastructure within the Development Envelope. The disturbance related to groundwater drawdown is referred to as modelled groundwater drawdown.

Subterranean fauna, although difficult to see without a microscope, contribute to the overall biodiversity of Australia and play important roles in the functioning of subterranean ecosystems (Hose *et al.* 2015a). The Pilbara and Yilgarn regions of Western Australia are recognised as biodiversity hotspots because of their subterranean fauna. It is estimated there are more than 4,000 obligate subterranean fauna species in the western half of Australia (Guzik *et al.* 2010), with 80% of these species remaining to be discovered. Furthermore, subterranean fauna typically exhibit high rates of short-range endemism (Gibert and Deharveng 2002). Eberhard *et al.* (2009) proposed a range of 1,000 km^2 for Pilbara subterranean fauna, recognising the generally small ranges of stygofauna species. Troglofauna species mostly have substantially smaller ranges than stygofauna (Halse and Pearson 2014). Given that locally restricted species are more vulnerable to extinction following habitat loss or degradation than wider-ranging species (Ponder and Colgan 2002), it follows that subterranean species are potentially more susceptible to habitat loss caused by mining and groundwater abstraction than surface species.

The Environmental Protection Authority (EPA) recognises the importance subterranean fauna in Western Australia and its sensitivity to disturbance. Accordingly, the EPA requires that subterranean fauna be considered as part of environmental impact assessments for mining developments and similar operations (EPA 2016a, b, c). The Project has been referred for assessment under Part IV of the Environmental Protection Act 1996 (EP Act) with subterranean fauna being a key factor (EPA 2016a). This report addresses the subterranean fauna factor and provides the results of a field survey undertaken to determine the conservation values of subterranean fauna in the Project area and the potential impacts of the Project on subterranean fauna species.

2. SUBTERRANEAN FAUNA FRAMEWORK

2.1. Conservation Legislation

Native flora and fauna in Western Australia are protected at both State and Commonwealth levels. At the state level, the Biodiversity Conservation Act 2016 (BC Act) provides a legal framework for protection of species, particularly for species listed by the Minister for the Environment as threatened. In addition to the formal list of threatened species under the BC Act, the Department of Biodiversity, Conservation and Attractions (DBCA) also maintains a list of priority fauna species that are of conservation importance but, for various reasons, do not meet the criteria for listing as threatened. Both the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and BC Act provide frameworks for the protection of Threatened Ecological Communities (TECs). Within Western Australia, DBCA also informally recognises communities of potential conservation concern, but for which there is little information, as Priority Ecological Communities (PECs). The list of TECs recognised under the BC Act is larger than the EPBC Act list and has much greater focus on subterranean communities. At the national level, the EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna and ecological communities. However, the threatened fauna lists of the EPBC Act currently do not cover inland subterranean fauna.

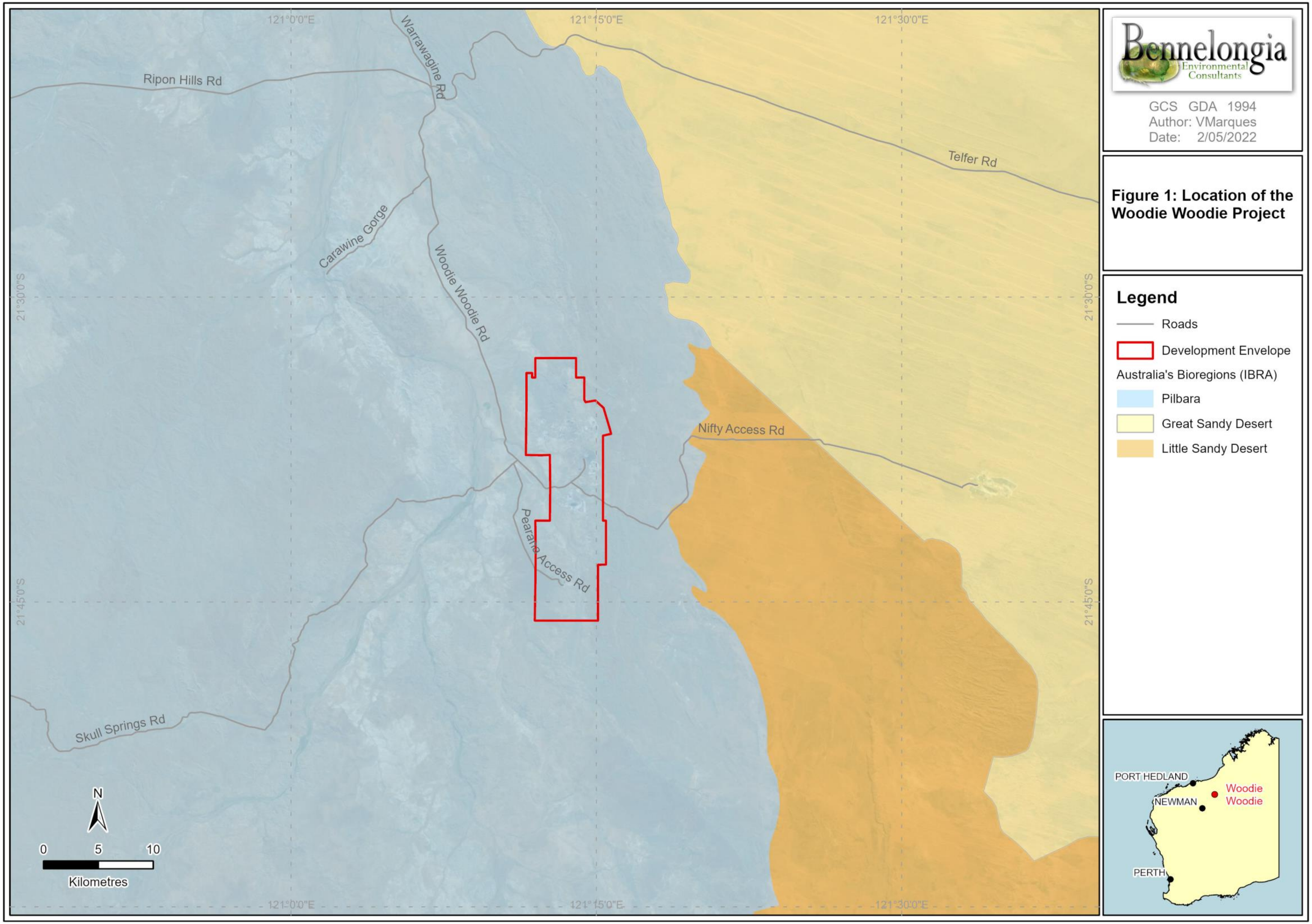


Figure 1: Location of the Woodie Woodie Project

2.2. Subterranean Fauna

Subterranean fauna includes two distinct animal communities: aquatic stygofauna in aquifers and air-breathing troglofauna in the vadose zone between the surface and the watertable. Due to relatively uniform selection pressures in underground habitats, subterranean fauna typically exhibit many convergent morphological and physiological characteristics, such as reduced or absent eyes, lack of pigmentation, loss of wings, elongate sensory structures, a shift towards K-selection breeding strategy and decreased metabolism (Gibert and Deharveng 2002). The overwhelming majority of subterranean fauna species in Western Australia are invertebrates, apart from a few species of fish and snakes.

The occurrence and abundance of subterranean fauna is closely tied to geological structure. Both troglofauna and stygofauna require subterranean spaces such as interstices, voids, vughs, and fissures in which to live. The connectivity of these spaces both vertically and laterally is important. Vertical connectivity facilitates water movement from the surface to recharge aquifers and to transport carbon and nutrients into the vadose zone and then into underlying aquifers. Lateral connectivity allows animals to move about and interact in viable-sized species populations.

Outside the hyporheic zone, important habitats for stygofauna in the Pilbara are detritals (especially alluvium), calcrete and some iron formations. The aquifers in other fractured or vuggy rock formations also have the potential to support stygofauna. Important habitats for troglofauna in the Pilbara are mineralized or weathered iron formations and calcrete. Other mafic vuggy rock formations may support troglofauna but there has been insufficient systematic of different geologies to determine their prospectivity with confidence. Colluvium hosts at least some species (Halse 2018).

In general, stygofauna community richness declines with increasing depth to the water table (Halse *et al*. 2014), with highest densities occurring at depths of less than 30m although animals have been recorded where depth to watertable is nearly 90m (Halse *et al.* 2014). The reason for the general decline in richness with increasing depth is principally the reduced supply of carbon and nutrients (Humphreys 2006). Stygofauna occur in varying salinities but are mostly found in fresh to saline groundwater with conductivities of less than 50,000 µS/cm. While oxygen levels are difficult to measure accurately, stygofauna are uncommon in hypoxic groundwater (<0.3 mg O2/L; Hose *et al*. 2015b; Halse 2018).

The factors controlling troglofauna occurrence within preferred geologies are less well studied, although it is well documented that relative humidity close to saturation is important. Areas with very shallow watertables that occasionally are saturated with water from the surface to watertable are unsuitable for troglofauna.

2.3. Potential Impacts on Subterranean Fauna

Open cut mining and abstraction of underlying groundwater has the potential to impact populations of subterranean fauna present within the area of impact by removing or degrading suitable habitat.

2.3.1. Impacts on Stygofauna

Open cut and underground mining often require a dewatering program to enable access to the mineral resource and to prevent the mine being flooded. Abstracted groundwater is typically also used in ore processing. The consequent drawdown of aquifers can threaten stygofauna communities that occur within the dewatering footprint. In particular, species restricted to any areas of substantial groundwater drawdown face possible extinction. Besides dewatering, the excavation of the pit itself causes complete loss of stygofauna habitat within the pit area, while construction of other infrastructure such as tunnels, drainage and tailing dams may degrade or remove networks of suitable habitat within the mine area or could disrupt the connectivity between populations on either side of the infrastructure.

2.3.2. Impacts on Troglofauna

The direct habitat loss from mine pit excavation is the primary mine-related threat to troglofauna in the Project area. The extent of habitat loss will depend on the area and depth of mine pits and other excavations, as well as the occurrence and connectivity of suitable habitat outside the impact zone. Animals utilising small, isolated pockets of habitat are more vulnerable to significant primary impacts than those inhabiting more extensive geologies. Other disturbed areas, such as stockpiles and waste dumps, may reduce carbon and nutrient input and potentially decrease population densities of species under such areas over many years, but are unlikely to cause species extinctions.

3. REGIONAL SETTING

3.1. Geology

Based on the Interim Biogeographic Regionalisation of Australia, Woodie Woodie lies within the Chichester subregion (PIL1) of the Pilbara region. The primary lithology unit that underlies most of the Project area is identified as the Carawine Dolomite, which is part of the Hamersley Group of the Hamersley Basin in the Pilbara Craton. The formation varies from grey and brown to dark orange (due to iron and manganese impurities), but is mainly a brown-weathered, well-bedded grey dolomite (Williams and Trendall 1998). Although thickness is thought to vary from 0 to 200 m, an accurate value is difficult to obtain due to the eroded surface of the Carawine Dolomite, which is irregularly and unconformably overlain by a residual Proterozoic deposit known as Pinjian Chert Breccia (Figure 2). The breccia, which is locally crudely bedded, consists of randomly mixed angular chert fragments in a siliceous matrix (Williams and Trendall 1998).

The Pinjian Chert Breccia is commonly broken, jointed and vuggy and the contact surface between the Pinjian Chert Breccia and the underlying Carawine Dolomite is interpreted as a palaeokarst topography. Carawine Dolomite remnants within or beneath the Pinjian Chert Breccia surface have undergone deep chemical weathering, which resulted in the formation of many fissures, caves, and dolines (now partly filled with soil and sand), and the redistribution of manganese- and iron-oxides (Williams and Trendall 1998).

Hence, the manganese mineralisation in the Woodie Woodie area is closely associated with the Carawine Dolomite, the overlying Pinjian Chert Breccia, and the palaeokarst surface existent between these two units. The distribution suggests that the most abundant manganese deposits are preferentially located in the lower part of the Carawine Dolomite. Some large tabular orebodies are capped by the Waltha Woora Formation, or by thick clay deposits. Siliceous duricrust, including silcrete and secondary chert breccia, overlies the Pinjian Chert Breccia in certain places. The duricrust is locally derived from the breccia by deep weathering and secondary silicification. This dominantly chemical weathering process also produced the supergene manganese oxide deposits in the Woodie Woodie region, which have overprinted primary Proterozoic manganese deposits (Williams and Trendall 1998).

The Carawine Dolomite and Pinjian Chert Breccia are overlain by younger units, including the Waltha Woora Sandstone, Paterson Formation (glacial deposits), and various Tertiary sedimentary units (Williams and Trendall 1998). One of these Tertiary units is the Oakover Formation, which can be divided into two units: a siliceous, vuggy unit with lesser amounts of calcareous sandstone, that can vary between 3 and 10 m thick; and a lower, more widespread, carbonate unit, which is at least 30 m thick (Williams and Trendall 1998). The superficial Cainozoic deposits present in the area range from older, consolidated, lacustrine–fluvial deposits and lateritic residual deposits, to recent unconsolidated alluvial, colluvial, eluvial, eolian, and lacustrine deposits (Figure 2).

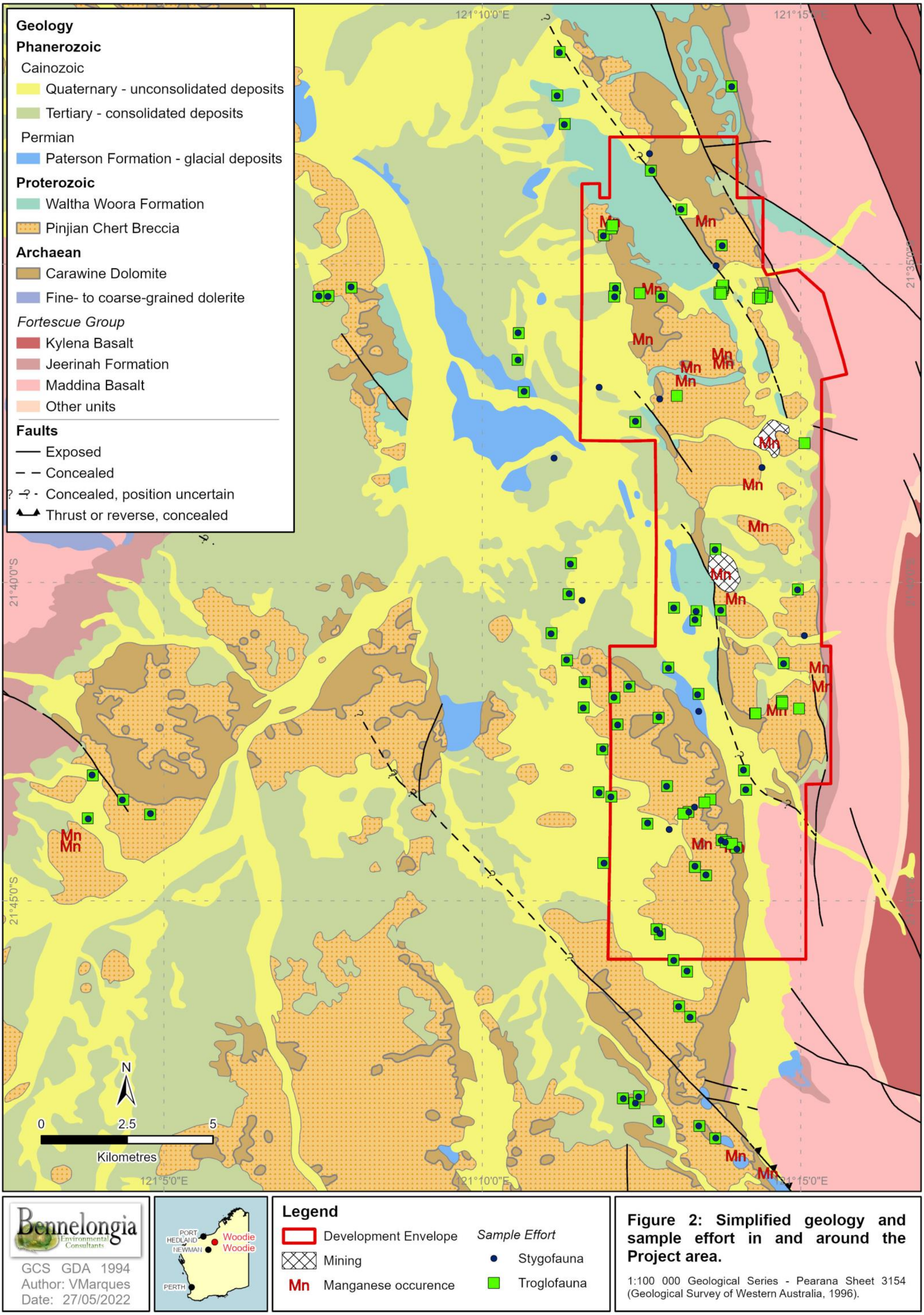


Figure 2: Simplified geology and sample effort in and around the Project area.

1:100 000 Geological Series - Pearana Sheet 3154 (Geological Survey of Western Australia, 1996).

3.2. Hydrogeology

The main aquifers in the Woodie Woodie region are the Pinjian Chert Breccia and the Upper Carawine Dolomite. In the Oakover River valley, these are overlain by Permian sediments. The basal Fortescue Group, including the Jeerinah Formation and Maddina Basalt, have negligible permeability and are also interpreted to be aquitards (GRM 2004).

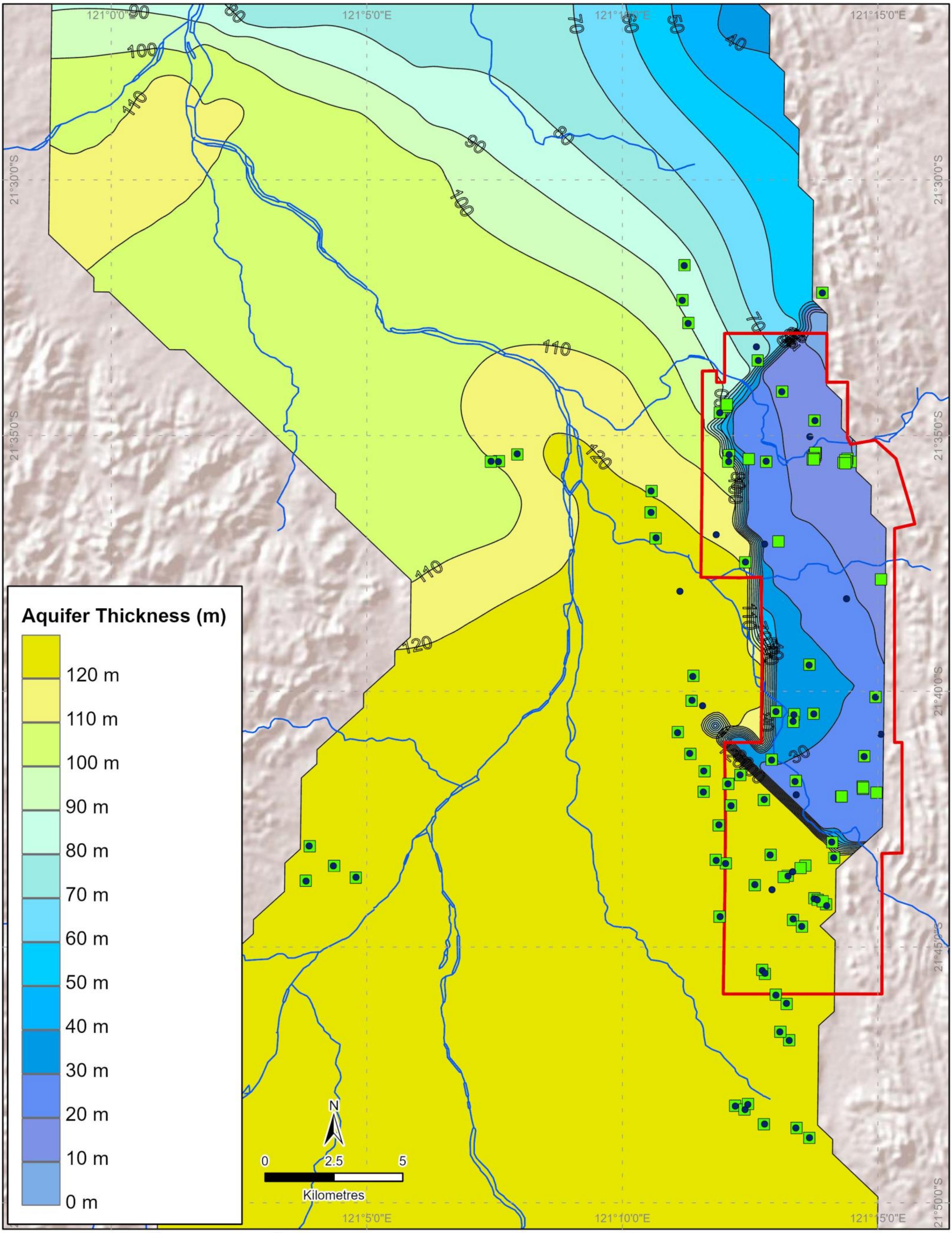
The Pinjian Chert Breccia is highly permeable, as it is often vuggy, with voids either open or infilled with clay or other fine-grained sediments. The hydraulic conductivity is considered to range from about 5 to 150 m/day. The Upper Carawine Dolomite, defined as the dolomite near the contact with the Pinjian Chert Breccia and/or manganese, forms another unconfined aquifer within the region (Rockwater 2015). With its discontinuities (such as fractures) and vugs, the hydraulic conductivity of this aquifer is estimated to be about 5 m/day, although some faulted occurrences could present values as high as 30 m/day (Rockwater 2021). The Lower Carawine Dolomite, which occurs beneath about 150 m AHD, is generally less fractured and more massive, which results in lower permeability (approximately 0.1 m/day regionally and 1 m/day within the mine corridor). Where present, less permeable tertiary surficial clayey sediments of varying thickness (but not always saturated) overlie the two main aquifers (Rockwater 2021).

Significant faulting has been described to occur at the Woodie Woodie mine corridor (Jones 2010, 2011). Faults tend to act as hydraulic barriers as they are commonly sealed during mineralisation events. Subsequent deformation, however, can occasionally rupture these faults, resulting in extreme high hydraulic conductivities as they act as conduits. Although the specific yield for the two aquifers is likely to be low due to low primary porosity, higher values could be associated with well-developed faults and vugs (Rockwater 2021).

Groundwater levels in the Woodie Woodie mine region have been heavily altered by pit dewatering over the years. While the watertable is more than 110 mbgl (metres below ground level) in the central area of the mine corridor, watertables as high as 4 mbgl have been recorded in regional areas (data from this survey). Similarly, aquifer thickness also varies substantially (Figure 3), with thickness >120 m to the south and east of Woodie Woodie, and thickness varying between 0 and 30 m in most central and northern areas of the Project (Rockwater 2021).

Aquifer recharge occurs via direct rainfall infiltration, with preferential recharge occurring along surface water drainage features, faults and lineaments (Rockwater 2021). Groundwater leaves the Project area to the north, and possibly discharges along watercourses in the Oakover River valley where groundwater is close to surface.

Groundwater in the region typically has salinity of less than 1000 mg/L total dissolved solids (TDS) (Rockwater 2021).



Bennelongia Environmental Consultants

GCS GDA 1994
Author: VMarques
Date: 27/05/2022

Figure 3: Aquifer thickness and sample effort in and around the Project area.

4. METHODS

Sampling was conducted according to the general principles laid out for subterranean fauna sampling by the Environmental Protection Authority (EPA) in *Environmental Factor Guideline – subterranean fauna* (EPA 2016b) and *Technical guidance – subterranean fauna survey* (EPA 2016c). Sampling also conforms with recommendations in the recent *Technical Guidance - subterranean fauna surveys for environmental impact assessment* (EPA 2021).

Sampling was conducted in a Survey Area comprising the Development Envelope and nearby areas where drill holes occurred. The locations making up the Survey Area were chosen in consultation with ConsMin and, in many cases, holes were drilled specifically for the purpose of subterranean fauna sampling (Figure 4).

4.1. Laboratory sampling techniques

4.1.1. Stygofauna

In addition to sampling of exploration drill holes, sampling for stygofauna was undertaken in existing monitoring bores throughout the area. Stygofauna were sampled at each hole using weighted plankton nets. Where possible, six hauls were taken at each site, three using a 50 µm mesh net and three with a 150 µm mesh net. The net was lowered to the bottom of the hole and jerked up and down briefly to agitate benthos (increasing the likelihood of collecting benthic species) and then slowly retrieved.

Contents of the net were transferred to a 125 ml polycarbonate vial after each haul, flushed with bore water to reduce fine sediment content, preserved in 100% ethanol and refrigerated at a constant 4 °C. Nets were washed between holes to minimise site-to-site contamination.

In situ water quality parameters – temperature, electrical conductance (EC) and pH – were measured at each site. Standing water level was also measured using a Solinst water level meter.

4.1.2. Troglofauna

Exploration drill holes were also sampled for troglofauna. When calculating sampling effort, each unit of troglofauna sampling effort consisted of two different, complementary sampling techniques: scraping and trapping. Previous studies have shown that use of both techniques yields a greater diversity of troglofauna than either technique alone. Furthermore, troglofauna generally occur at low abundance and yields, therefore the use of two techniques contributes significantly to obtaining a representative sample of the troglofauna community in a sampling area (Halse and Pearson 2014):

1. *Scraping* is undertaken prior to setting traps. In each scraping event, a troglofauna net is prepared with a weighted ring net of 150 µm mesh, and a diameter closely matched to 60% of the bore diameter. This net is lowered to the bottom of a bore or to the water table, and subsequently scraped back to the surface at least four times. In each of these scrapes a different section of the wall of the hole is targeted (e.g., north, south) to maximize the organisms retrieved. The contents of each scrape are immediately transferred to a 125 ml vial with 100% ethanol for preservation of the sample and its DNA.

2. *Trapping* uses traps of cylindrical PVC (270 x 70 mm) with holes drilled on the side and top to function as entrances and a bait of microwaved leaf litter. Traps are lowered on nylon cord to the end of the bore, or to a few metres above the water table. For most holes, one trap was set near the bottom of the drill hole or just above the water table, which varied between 2 and 52 m. At about one-quarter of holes, a second trap was set approximately halfway between the surface and the first trap. Traps were then left inside bores for approximately 8 weeks, allowing troglofauna enough time to colonize them. During that period, the bores were sealed to minimise movement of surface animals into the troglofauna traps. When traps were

retrieved, their contents were transferred to a zip-lock bag and transported alive to the laboratory in Perth.

4.2. Sample Effort

Sampling for subterranean fauna conducted by Bennelongia consisted of five rounds of sampling each for stygofauna and troglofauna between July 2020 and March 2022. Samples collected by MBS Environmental during a baseline stygofauna survey undertaken in May 2019 were also included in this report. A total of 163 stygofauna samples and 153 troglofauna samples were collected across the entire period (Table 1).

Table 1: Subterranean fauna sampling effort at Woodie Woodie.

Date	Stygofauna	Troglofauna*
May 2019	7	-
July 2020	18	18
May/June/July 2021	34	29
August 2021	-	39
October 2021	34	28
December 2021	38	-
January 2022	-	39
March 2022	32	-
TOTAL	**163**	**153**

*Note: each unit of troglofaunal sampling effort consisted of trapping and scraping

Within the Survey Area, samples were taken in locations proposed to be impacted by mining (Indicative Disturbance Area) or groundwater drawdown and in proposed undisturbed areas (outside the Development Envelope or areas within it that will not be mined or abstracted) (Figure 4). Modelled groundwater drawdown of ≥2 m above current conditions was considered to be an impact detrimental to stygofauna.

In total, 96 impact and 67 reference stygofauna samples were collected (Table 2). There were fewer impact troglofauna samples, with 53 impact (in proposed mine pits) and 100 reference troglofauna samples were collected (Table 3).

Table 2: Impact and reference stygofauna samples collected at Woodie Woodie.

Date	Stygofauna	
	Impact	Reference
May 2019	5	2
July 2020	17	1
May/June/July 2021	33	1
October 2021	33	1
December 2021	8	30
March 2022	-	32
Subtotal	**96**	**67**
TOTAL	**163**	

Table 3: Impact and reference troglofauna samples collected at Woodie Woodie.

Date	Troglofauna	
	Impact	Reference
July 2020	4	14
June/July 2021	7	22
August 2021	-	39
October 2021	7	21
March 2022	35	4
Subtotal	**53**	**100**
TOTAL	**153**	

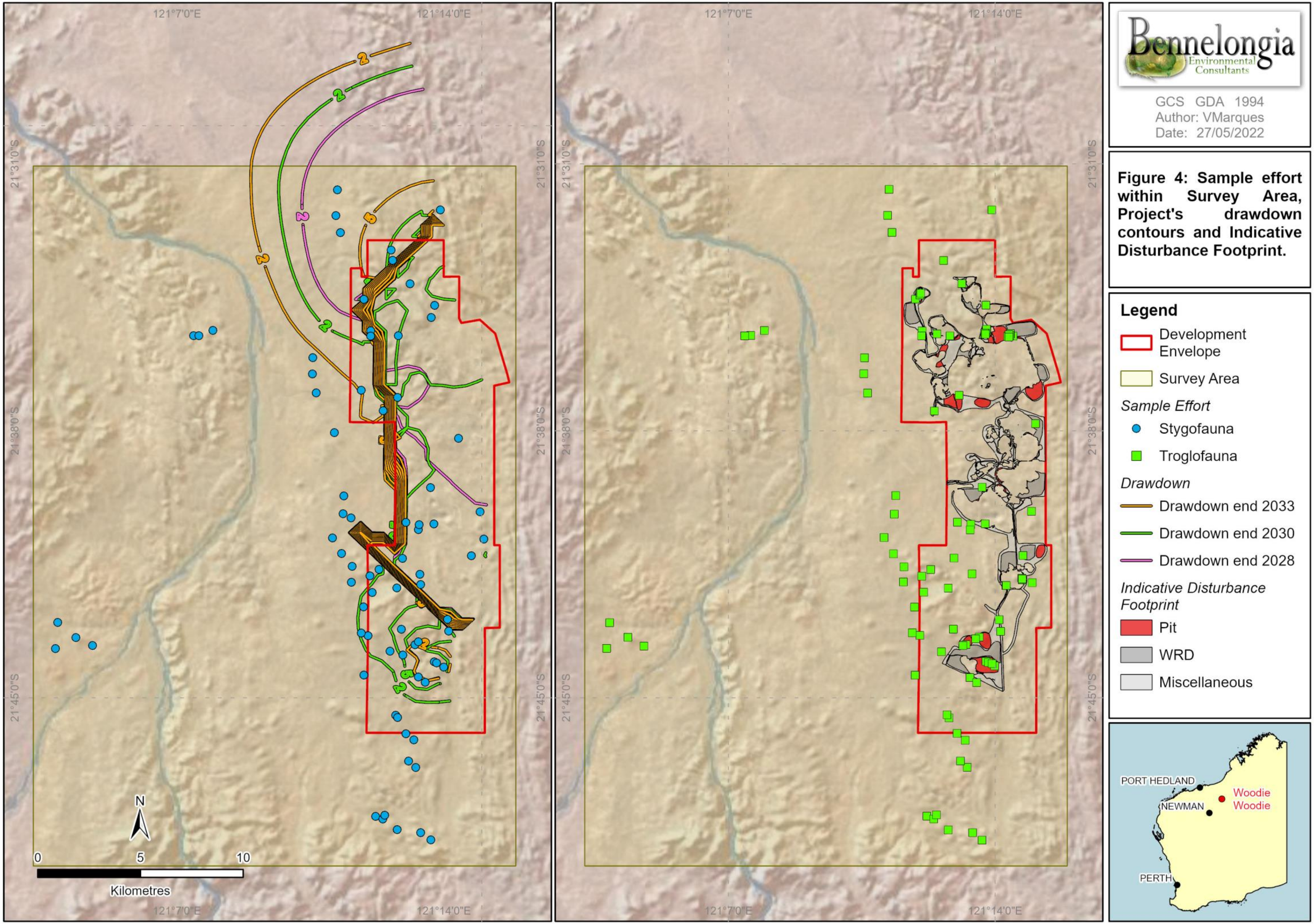


Figure 4: Sample effort within Survey Area, Project's drawdown contours and Indicative Disturbance Footprint.

4.4 Laboratory Processing

All subterranean fauna samples were sorted in the laboratory. Leaf litter retrieved from troglofauna traps was processed in Berlese funnels under halogen lamps for 72 hours, during which time the light and heat drives animals downwards and towards a vial containing 100% ethanol as a preservative. Litter was quickly checked after removal from the funnels to ensure no invertebrates remained. Samples in ethanol from the Berlese funnels were carefully screened under a dissecting microscope to pick out troglofaunal animals.

Troglofauna scrape samples and stygofauna net samples were elutriated to separate animals from sediment and put through sieves to fractionate the contents according to size (53, 90 and 250 µm) to improve searching efficiency prior to screening under a dissecting microscope. All potential subterranean animals were removed from samples during screening for later species or morpho-species level identification. Surface animals were identified to Order level.

Troglofauna and stygofauna identification were made using published, unpublished and informal taxonomic keys, as well as species descriptions in the scientific literature. Morphospecies were established using the characters of existing species keys, and the lowest level of identification possible was reached given the constraints of sex, maturity of the specimens (juveniles and females are often impossible to identity to species level) and possible damage to body parts. During the final phase of identification, dissecting and compound microscopes were used, with the process often requiring dissection of specimens.

4.3. Molecular analyses

DNA sequencing was completed on 12 specimens (from seven different species) from the study area (Appendix 3). Depending on the size of the specimens, legs or whole animals were used for DNA extractions using a Qiagen DNeasy Blood & Tissue kit (Qiagen 2006). Elute volumes varied from 30 µL to 40 µL depending on the quantity of material. Primer combinations used for PCR amplifications were LCO1490:HCO2198, C1J1718:HC02198, and LCO1490:HCOoutout for the MT-CO1 gene (Folmer *et al.* 1994; Simon *et al.* 1994). Next, dual-direction, sanger sequencing was undertaken for PCR products by the Australian Genome Research Facility (AGRF). Sequences returned were aligned in Geneious and genetic distances (using the Tamura-Nei method) between sequences were measured as uncorrected p-distances (total percentage of nucleotide differences between sequences). Sequences on GenBank and in available literature were included in phylogenetic analysis to provide a framework for assessing intra- and interspecific variation, as well as to document the levels of intraspecific differentiation in described species across their geographic ranges.

4.4. Survey Limitations

There was minor loss of troglofauna traps but it was insufficient to affect assessment in any way.

PVC collars are commonly installed during the drilling process to prevent the walls of drill holes to collapse. As this is considered more likely to occur in the Project area due to local geological profile, the collars of many drill holes at Woodie Woodie are rather deep (18 m in some places). Consequently, this impacted troglofauna sampling during the survey. Troglofauna habitat was very limited in some drill holes because the end of collar was only 1 m above the water table. In other bores, habitat was completely inaccessible, and no sample could be taken as the collar was deeper than the groundwater level.

Unexpected disturbances were also encountered during the survey. While retrieving the troglofauna traps, one of the drill holes was uncovered and the trap was found on the ground, still attached to its string. The cause for this was believed to be cattle interference. In addition, two traps were lost in the drill holes due to disturbance cause by rehabilitation work near those bores.

Heavy rain events also affected the trap collection during the last round of troglofauna sampling. Some of the drill holes uncovered prior to sampling were angled and without a collar above the ground level. Water had flowed in to one side of the angled bore and deposited a great amount of mud over some troglofauna traps. On one occasion, the walls of the bore possibly collapsed above the trap, which got stuck at the bottom and could not be retrieved.

4.5. Personnel

The field survey was undertaken by Bruno Buzatto, Louis Masarei, Vitor Marques and William Fleming, assisted by the Environmental Department of CML. Laboratory sorting of samples and species identifications were completed by Jane McRae, Jim Cocking, Heather McLetchie, Melanie Fulcher, Melita Pennifold, Mike Scanlon, Monique Moroney, Sam Chidgzey, Vitor Marques and William Fleming. Genetic analyses were completed by Melanie Fulcher. GIS and mapping, and report writing were completed by Vitor Marques.

5. RESULTS

5.1. Stygofauna

The survey resulted in collection of 943 stygofauna specimens belonging to at least 26 species (Table 4). The community included at least nine species of copepod, five species of worm, four species of amphipod, four species of syncarid, two species of ostracod, one species of isopod and one species of netamode worm (nematodes are not assessed as part of the EIA process).

Twelve of these species are known to date only from the Survey Area and one species, for which there is very little distributional information, may also be known only from this area. These 13 species comprise four copepods, four amphipods, four syncarids and one isopod. Five species were collected solely within the impact (groundwater drawdown) area, namely the syncarids Bathynellidae sp., *Billibathynella* \`BSY192\` and *Billibathynella* \`BSY230\`, and the copepods *Dussartstenocaris* \`BHA324\` and *Parastenocaris* \`BHA311\`. The ranges of these species is discussed in Section 6.1.

5.2. Troglofauna

The survey collected 108 troglofauna specimens belonging to at least 24 species (Table 5), namely five species of dipluran, three species each of pseudoscorpion and isopod, two species each of spider, silverfish and pauropod, and one species of palpigrade, cockroach, beetle, dipteran, centipede, millipede and symphylan. With the exception of the dipteran *Allopnyxia* sp. B01, most species were collected in low abundance, with many species known from single holes and usually only one animal.

One of the species recorded is cosmopolitan, two occur throughout the Pilbara, 15 species are known only from the Survey Area and six species could not have their distribution assessed because they are higher order identifications. Four of the species known only from the Survey Area were collected only within proposed pit boundaries and are discussed in more detail in Section 6.2. The species are the pseudoscorpions *Tyrannochthonius* \`BPS398\` and *Tyrannochthonius* \`BPS434\`, the isopod *Troglarmadillo* \`BIS474\` and the dipluran Projapygidae \`BDP209\`.

5.3. Listed Species and Threatened/Priority Communities

There are no subterranean invertebrate species listed under the WC Act in the Project Survey Area. Furthermore, there are no Priority Ecological Communities (PECs) or Threatened Ecological Communities (TECs) for subterranean fauna listed in the vicinity of Woodie Woodie.

Table 4: Stygofauna species collected during the subterranean fauna survey a Woodie Woodie.
Grey highlight denotes higher order identifications recorded in the area but not included in species count.
* Higher order identifications included in species count.

Higher Order ID	Lowest Identification	Specimens (No. of sites)		Taxonomy and Distribution	Comments
		Impact	Reference		
Annelida					
Clitellata					
Enchytraeida					
Enchytraeidae	Enchytraeidae `2 bundle` s.l. (long thin 2 per seg)	8 (1)	-	Known throughout the Pilbara	
	Enchytraeidae `3 bundle` s.l. (short sclero)	5 (1)	3 (1)	Widespread in WA	
Haplotaxida					
Phreodrilidae	Phreodrilidae sp. AP SVC s.l.	1 (1)	2 (1)	Known throughout the Pilbara	
Tubificidae	*Monopylephorus* sp. nov. WA29 (ex *Pristina* WA3) (PSS)	-	12 (1)	Known throughout the Pilbara	
Polychaeta					
Phyllodocida					
Nereididae	*Namanereis pilbarensis*	1 (1)	-	Known throughout the Pilbara	
Arthropoda					
Crustacea					
Malacostraca					
Amphipoda					
Bogidiellidae	*Bogidiella* `BAM206`	1 (1)	1 (1)	Known only from Survey Area	Linear range 21.3 km
Paramelitidae	*Maarrka* `BAM212`	-	1 (1)	Known only from Survey Area	Singleton
	Pilbarus `BAM156`	18 (4)	38 (4)	Known only from Survey Area	Linear range 18 km
	Pilbarus `BAM207`	8 (3)	19 (5)	Known only from Survey Area	Linear range 28 km
Isopoda					
Microcerberidae	Microcerberidae sp.*	-	4 (3)	Higher order identification Potentially known only from Survey Area	Linear range 17.2 km
Syncarida					
Bathynellidae	Bathynellidae sp.*	18 (1)	-	Higher order identification **Known only from within 2m drawdown contours**	
Parabathynellidae	*Billibathynella* `BSY192`	23 (2)	-	**Known only from within 2m drawdown contours**	Linear range 1.8 km
	Billibathynella `BSY224`	1 (1)	8 (3)	Known only from Survey Area	Linear range 20.6 km
	Billibathynella `BSY230`	2 (2)	-	**Known only from within 2m drawdown contours**	Collected from two bores on same drill pad
Maxillopoda					
Copepoda					
Cyclopoida					
Cyclopidae	*Diacyclops humphreysi* s.l.	2 (1)	-	Known throughout the Pilbara	
	Diacyclops scanloni	107 (8)	173 (6)	Known from Mulga Downs	

Higher Order ID	Lowest Identification	Specimens (No. of sites)		Taxonomy and Distribution	Comments
		Impact	Reference		
	Mesocyclops notius	3 (2)	85 (3)	Known throughout the Pilbara	
	Mesocyclops sp.	-	1 (1)	Unknown, higher order identification	Possibly represents *Mesocyclops notius*
	Thermocyclops \`BCY091\`	-	1 (1)	Known only from survey area	
Harpacticoida					
Ameiridae	*Abnitocrella* \`BHA258\`	84 (4)	28 (1)	Known only from survey area	Linear range 13.9 km
	Megastygonitocrella trispinosa	4 (2)	10 (2)	Known throughout the Pilbara	
Canthocamptidae	*Elaphoidella humphreysi* s.l.	2 (1)	116 (4)	Known throughout the Pilbara	
Parastenocarididae	*Dussartstenocaris* \`BHA324\`	4 (1)	-	**Known only from within 2m drawdown contours**	
	Parastenocaris \`BHA311\`	36 (3)	-	**Known only from within 2m drawdown contours**	
Unknown order	Copepoda sp.	-	1 (1)	Unknown, higher order identification	Very small juvenile, possibly represents *Elaphoidella humphreysi* s.l.; collected from same bore
Ostracoda					
Podocopida					
Candonidae	*Humphreyscandona capillus*	19 (1)	-	Known throughout the Pilbara	
Cyprididae	*Cypretta* sp.*	1 (1)	-	Unknown, higher order identification	Stygal *Cypretta* species are usually widespread
Nematoda					
	Nematoda spp.	90 (5)	2 (1)	Unknown, higher order identification	Not assessed as part of the EIA process
Grand Total		**943**			

Table 5: Troglofauna species collected during the subterranean fauna survey at Woodie Woodie.
Grey highlight denotes higher order identifications recorded in the area but not included in species count.
* High order identifications included in species count.

Higher Order ID	Lowest Identification	Specimens (No. of sites)		Taxonomy and Distribution	Comments
		Impact	Reference		
Arthropoda					
Chelicerata					
Arachnida					
Araneae					
Gnaphosidae	nr *Encoptarthria* sp.*	-	1 (1)	Higher order identification Potentially known only from Survey Area	Singleton
Oonopidae	*Prethopalpus* sp.*	-	1 (1)	Higher order identification Potentially known only from Survey Area	Singleton
Palpigradi					
Eukoeneniidae	*Eukoenenia* sp.*	-	1 (1)	Higher order identification Potentially known only from Survey Area	Singleton

Higher Order ID	Lowest Identification	Specimens (No. of sites)		Taxonomy and Distribution	Comments
		Impact	Reference		
Pseudoscorpiones					
Chthoniidae	*Tyrannochthonius* `BPS382`	-	1 (1)	Known only from Survey Area	Singleton
	Tyrannochthonius `BPS398`	1 (1)	-	**Known only from Indicative Disturbance Footprint**	Singleton
	Tyrannochthonius `BPS434`	1 (1)	-	**Known only from Indicative Disturbance Footprint**	Singleton
Crustacea					
Malacostraca					
Isopoda					
Armadillidae	Armadillidae `BIS466`	-	1 (1)	Known only from Survey Area	Singleton
	Troglarmadillo `BIS443`	1 (1)	1 (1)	Known only from Survey Area	Linear range 6.2 km
	Troglarmadillo `BIS474`	2 (1)	-	**Known only from Indicative Disturbance Footprint**	Potentially a troglophile
Hexapoda					
Entognatha					
Diplura					
Parajapygidae	Parajapygidae `BDP196`	-	2 (2)	Known only from Survey Area	Linear range 12.9 km
	Parajapygidae `BDP201`	-	1 (1)	Known only from Survey Area	Singleton
	Parajapygidae `BDP202`	-	1 (1)	Known only from Survey Area	Singleton
	Parajapygidae `BDP203`	-	1 (1)	Known only from Survey Area	Singleton
Projapygidae	Projapygidae `BDP209`	1 (1)	-	**Known only from Indicative Disturbance Footprint**	Singleton
Insecta					
Blattodea					
Nocticolidae	*Nocticola* sp.*	-	1 (1)	Higher order identification Potentially known only from Survey Area	Singleton
Coleoptera					
Carabidae	*Gracilanillus* `BCO236`	-	2 (1)	Known only from Survey Area	
Diptera					
Sciaridae	*Allopnyxia* sp. B01	11 (1)	50 (1)	Known throughout the Pilbara	
Zygentoma					
Nicoletiidae	*Dodecastyla* sp.*	-	1 (1)	Higher order identification Potentially known only from Survey Area	Singleton
	Trinemura sp.*	-	2 (2)	Higher order identification Potentially known only from Survey Area	Linear range 3.9 km
Myriapoda					
Chilopoda					

Higher Order ID	Lowest Identification	Specimens (No. of sites)		Taxonomy and Distribution	Comments
		Impact	Reference		
Scolopendrida					
Cryptopidae	*Cryptops* `BSCOL080`	-	2 (2)	Known only from Survey Area	Linear range 5.5 km
Unknown order	Chilopoda sp.	-	1 (1)	Unknown, higher order identification	Possibly *Cryptops* `BSCOL080`
Diplopoda					
Polyxenida					
Lophoproctidae	*Lophoturus madecassus*	-	8 (2)	Cosmopolitan	
Pauropoda					
Tetramerocerata					
Pauropodidae	Pauropodidae `BPU104`	-	1 (1)	Known only from Survey Area	Singleton
	Pauropodidae sp. B01 s.l.	-	11 (1)	Known throughout the Pilbara	
Symphyla					
Cephalostigmata					
Scolopendrellidae	*Symphylella* `BSYM105`	-	1 (1)	Known only from Survey Area	Singleton
Grand Total		**108**			

6. DISCUSSION

The geology of the Project and surrounding areas is considered prospective for subterranean fauna, particularly due to the presence of vuggy lithologies across most of the area. The 163 stygofauna samples collected during the survey yielded 943 specimens of at least 26 species (Table 4). Additionally, the 108 troglofauna specimens of at least 24 species (Table 5) were collected from 153 samples.

When considering species ranges and the likelihood of restricted distributions, it is common to take into account whether potentially restricted species are short-range endemic (SRE) species as defined by Harvey (2002). However, being an SRE species (the criterion for this is a range of <10,000 km^2) provides very little guidance as to whether the species is likely to be impacted by project development and so SRE status is not taken into account other than identifying widespread species. The important issue is whether species with an apparently local distributions are likely to be restricted to the Development Envelope (approximately 120 km^2) or, more particularly, the Indicative Impact Footprint that consists of multiple small areas within the Development Envelope.

6.1. Stygofauna

Of the 26 stygofauna species recorded at Woodie Woodie, 13 species are potentially known only from the survey area. At least five of these species currently show restricted occurrences within the drawdown boundaries of the Project. These species are the syncarids Bathynellidae sp., *Billibathynella* `BSY192` and *Billibathynella* `BSY230`, and the harpacticoid copepods *Dussartstenocaris* `BHA324` and *Parastenocaris* `BHA311`.

Syncarids

Syncarids are small crustaceans found worldwide that almost exclusively inhabit groundwater. The syncarid fauna is significantly diverse in Western Australia and most species are undescribed (Guzik *et al.* 2008; Perina *et al.* 2018). Many species have small ranges and are restricted to sections of regional aquifers (Guzik *et al.* 2008). Many syncarid species are endemic to individual calcrete aquifers in palaeodrainages; species are also well adapted to life in the interstitial spaces of alluvium and colluvium due to morphological adaptations such as small size, elongate body and reduced appendages (Cho *et al.* 2006). When interstitial spaces fill up with materials such as clays, movement of syncarids can become restricted (Guzik *et al.* 2008).

Initially, three species of syncarids were identified in the Development Envelope and surroundings, two species from the family Parabathynellidae and one species from the family Bathynellidae. Due to the potentially restricted status of some of these species, sequencing of the CO1 gene was attempted for six specimens to confirm the identifications and provide distributional information. However, one of the six specimens failed to return a sequence for CO1.

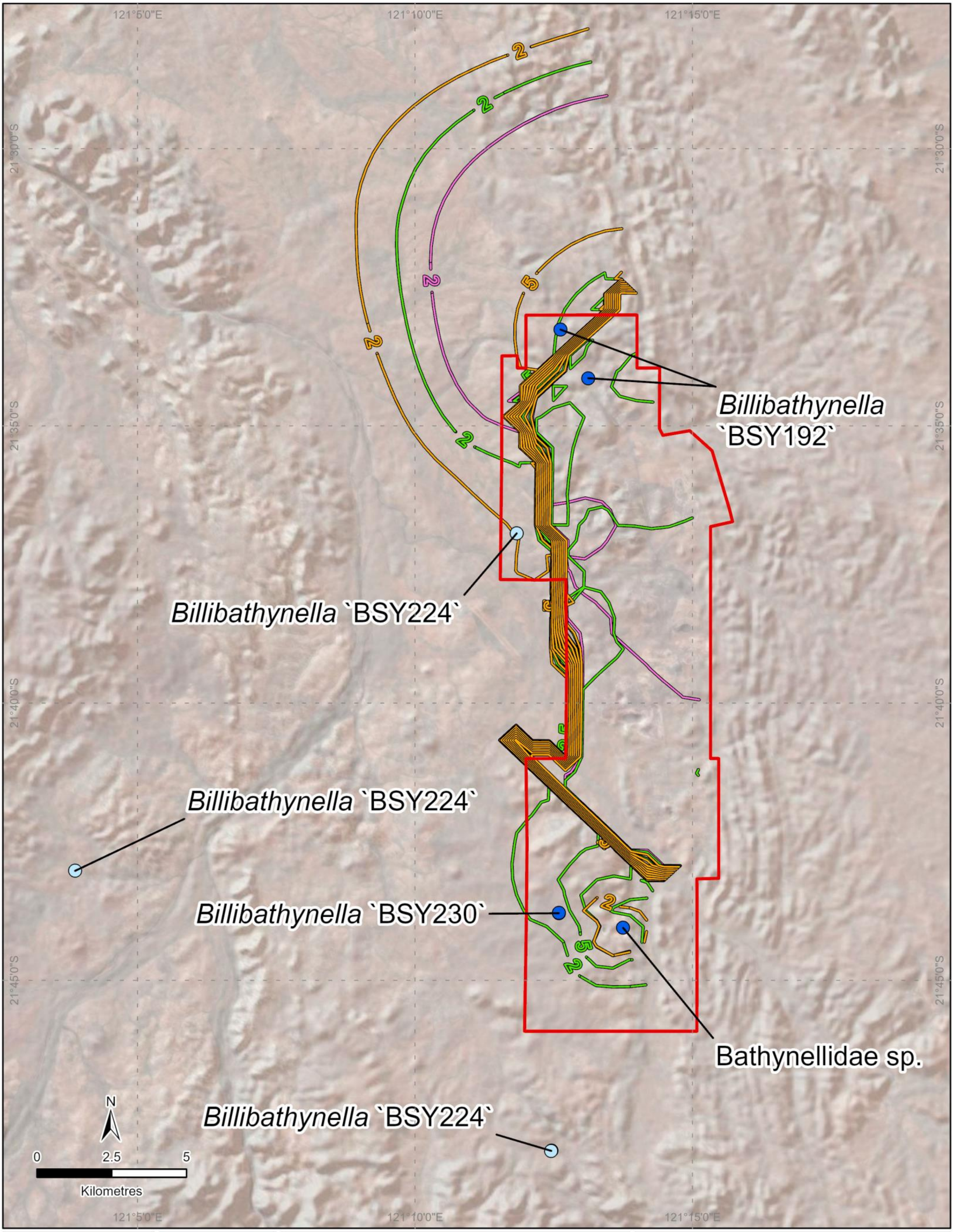
Bathynellidae sp.
A total of 18 specimens of Bathynellidae sp. were recorded from a single bore (STYP021_S) in dolomite within a proposed pit (Figure 5). The current depth to the water table at this hole is 20 m and future drawdown appears to reach at least 10 m by the end of 2030 (Figure 5). There is about 70 m of dolomite aquifer in this area (Figure 3). The one animal on which sequencing was attempted did not yield a sequence but, irrespective of whether the species has a wider distribution, there appears to be high probability Bathynellidae sp. can persist in situ because of the large depth of uniform aquifer and small drawdown. The threat to the species is minor. In this report minor threat means there may be little or no reduction in the size of the species populations and no threat to the conservation status of the species.

Billibathynella \`BSY192\`
A total of 23 specimens of what was called *Billibathynella* \`BSY192\` prior to sequencing were collected from two bores in the northern area of the Development Envelope, while two bores near the southern end of the Development Envelope yielded one specimen each. All bores were within the area of drawdown with a linear range of 19.4 km. Molecular analysis showed a divergence of 22.7% in CO1 sequences between the northern and southern records. Therefore, only the specimens from the two northern bores (REF_IMP_27S and WWMB011), with a linear range of 1.8 km, are treated as *Billibathynella* \`BSY192\` (see below).

The drawdown is expected to reach 80 m around the bore REF_IMP_27S, which lies in an aquifer thickness of 10-20 m. WWMB011, however, is located north of the main drawdown area, where the drawdown is projected to reach a maximum of 5-10 m in 2030 and 2033 and aquifer thickness is 70-80 m (Figure 3 and Figure 5). There appears to be high probability that *Billibathynella* \`BSY192\` can persist in situ because of the large depth of uniform aquifer and future small drawdown. The threat to *Billibathynella* \`BSY192\` from Project development appears to be minor.

Billibathynella \`BSY230\`
The specimens recorded from the southern bores discussed above are treated as *Billibathynella* \`BSY230\`. When the sequences of both *Billibathynella* \`BSY192\` and \`BSY230\` were compared with others of the genus on Genbank and in the Bennelongia database, the closest match was Parabathynellidae sp. (sequenced by the Western Australian Museum), which was 19.8% divergent from *Billibathynella* \`BSY230\`. The sequence data suggests that neither *Billibathynella* \`BSY230\` or "BSY192' is currently known from outside drawdown.

Billibathynella \`BSY230\` was collected from REF_IMP_05S and REF_IMP_05T and is represented by two individuals, a singleton from a net sample and a singleton from a scrape sample. The modelled drawdown at these bores is 2-5 m and aquifer thickness is more than 120 m. Irrespective of the wider distribution of *Billibathynella* \`BSY230\`, the species is likely to persist in situ and the threat from Project development is minor.



Bennelongia Environmental Consultants

GCS GDA 1994
Author: VMarques
Date: 26/05/2022

Legend

Development Envelope

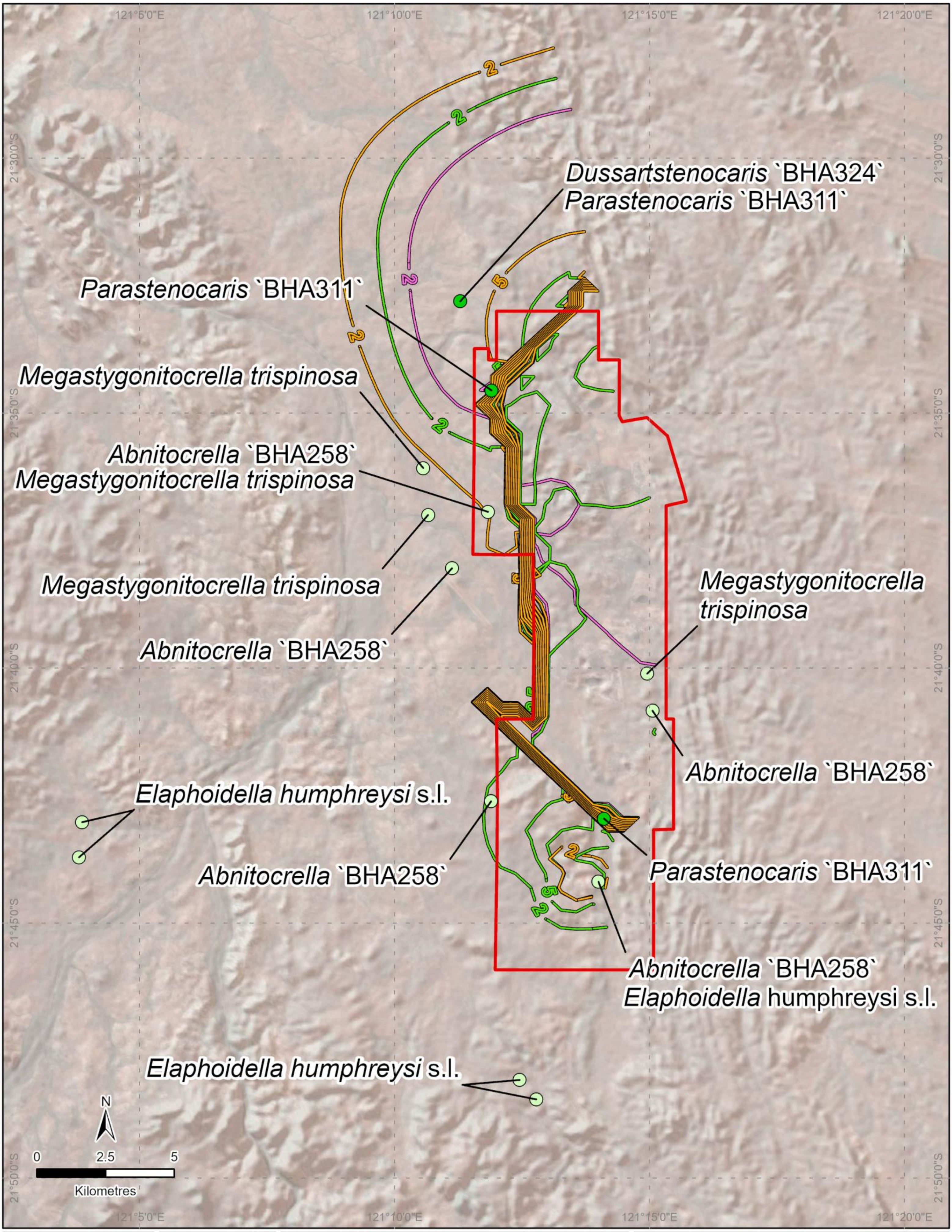
Drawdown

- Drawdown end 2033
- Drawdown end 2030
- Drawdown end 2028

Syncarids

- Restricted species
- Other species

Figure 5: Syncarids recorded during survey and drawdown modelling in the Project area and surroundings.



Bennelongia Environmental Consultants

GCS GDA 1994
Author: VMarques
Date: 26/05/2022

Legend

Development Envelope

Drawdown
- Drawdown end 2033
- Drawdown end 2030
- Drawdown end 2028

Harpacticoids
- Restricted species
- Other species

Figure 6: Harpacticoids recorded during survey and drawdown modelling in the Project area and surroundings.

Copepods
Copepods are tiny stygofaunal crustaceans and are very diverse in the Pilbara and in groundwater worldwide. A substantial proportion of the cyclopoid copepod species in the Pilbara are stygophiles that occur widely in groundwaters of this region (although is some cases genetic analysis suggests morphological species comprise clusters of genetic lineages), while harpacticoid copepods are usually stygobites with small ranges. Both species known only from within the Project drawdown contours are harpacticoid copepods.

Dussartstenocaris `BHA324`
Four specimens of this species were collected from one bore (STYP054_S2) within the 2-5 m drawdown area in the northern part of the Project (Figure 6). The aquifer has a thickness of more than 90 m. This site is outside the Development Envelope at the Project, although within the drawdown area. Irrespective of the wider distribution of *Dussartstenocaris* `BHA324`, the species is likely to persist in situ and the threat from Project development is minor.

Parastenocaris `BHA311`
This species was collected from 3 bores (REF_IMP_26S, REF_IMP_10T, and STYP054_S2) at the Northern and Southern end of the Project (Figure 6). Prior to molecular sequencing, *Parastenocaris* `BHA311` was known from two bores at the northern end of the Development Envelope, showing a linear range of 3 km. Following barcoding analysis, it was confirmed that other specimens identified morphologically as *Parastenocaris* sp. are also *Parastenocaris* `BHA311` (CO1 sequence variation of 0.2-4.5%), which extended the species linear range to 20 km along the length of the Project. The most northern occurrence of the species is in an area of predicted 2-5 m drawdown and it should persist in situ here. Populations in the other two bores are unlikely to persist. The threat to *Parastenocaris* `BHA311` is most likely minor but would be moderate if most of the species' distribution is in areas of large drawdown. Moderate threats are likely only to reduce species population size and, in the unlikely event of species distributions being very tightly restricted (and hence conservation status being threatened), the threats can be managed to mitigate the possibility of significant impact.

6.2. Troglofauna
Of the 24 troglofauna species recorded at Woodie Woodie, two species are known to occur throughout the Pilbara, one is cosmopolitan and the remaining 21 species are potentially known only from the survey area. Four of these species currently show restricted occurrences within impact areas of the Indicative Disturbance Footprint. The species are the pseudoscorpions *Tyrannochthonius* `BPS398` and *Tyrannochthonius* `BPS434`, the isopod *Troglarmadillo* `BIS474` and the dipluran Projapygidae `BDP209`. Their likely ranges are discussed with reference to the available habitat information and the distribution of any possible surrogate species. Surrogate species are related species collected in similar geologies and locations.

Pseudoscorpions
There are currently 22 described species of *Tyrannochthonius* in Australia, and most of them are only known from one or few locations (ALA 2022), although a few are much more widespread (for example, *T. aridus* in the Pilbara). At Woodie Woodie, two pseudoscorpion species were collected from sites only within impact areas of the Indicative Disturbance Footprint (Figure 7). *Tyrannochthonius* `BPS398` is a singleton collected from a troglofauna trap set at 43 m below ground level at site REF_IMP_16T towards the centre of the Development Envelope. *Tyrannochthonius* `BPS434` is a singleton specimen collected from a troglofauna trap set at 5 m at GU21001 at the southern end of the Development Envelope.

It was considered possible, based on morphology, that *Tyrannochthonius* `BPS382`, which was collected outside the Development Envelope, may be conspecific with (and demonstrate wider range for)

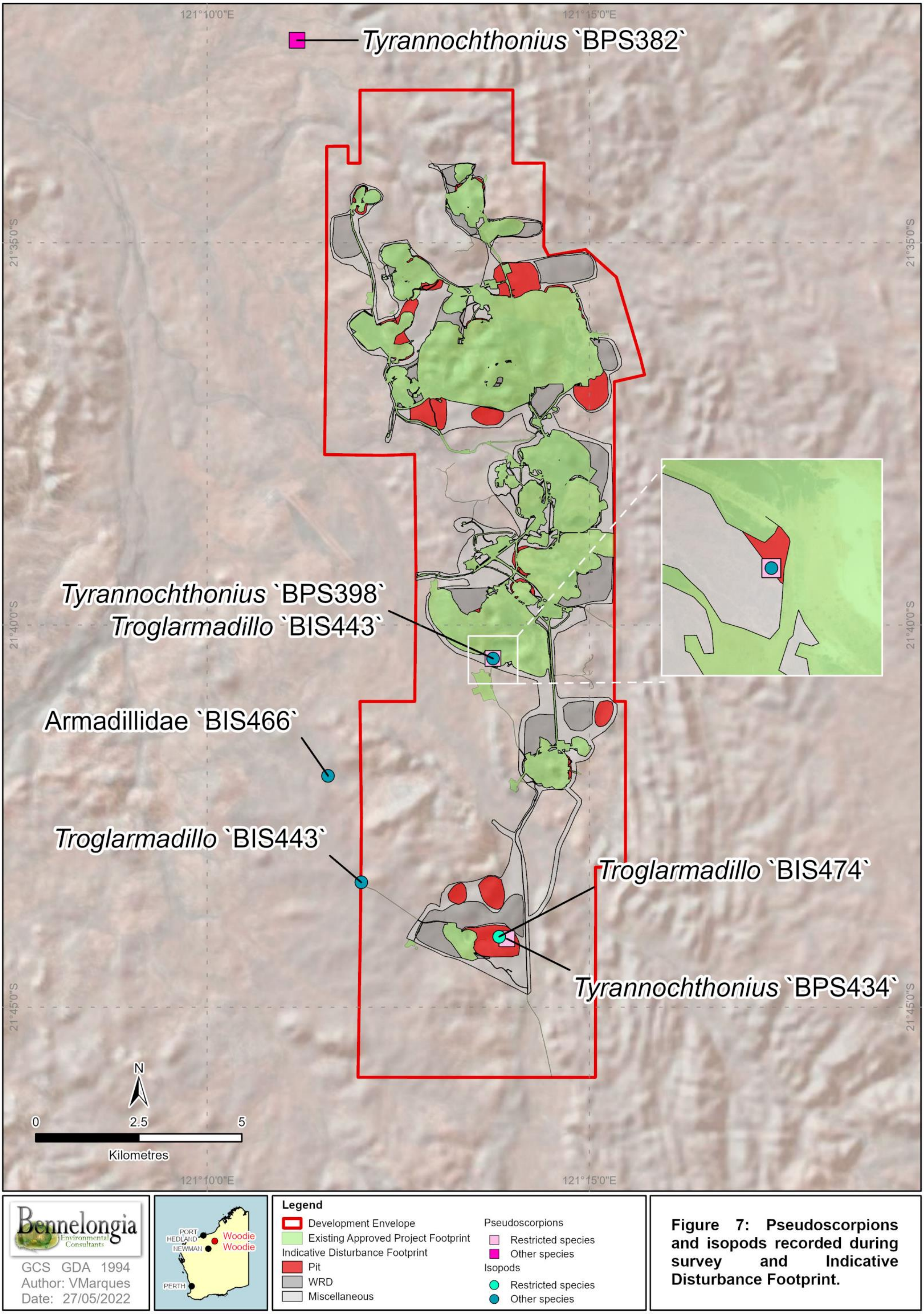
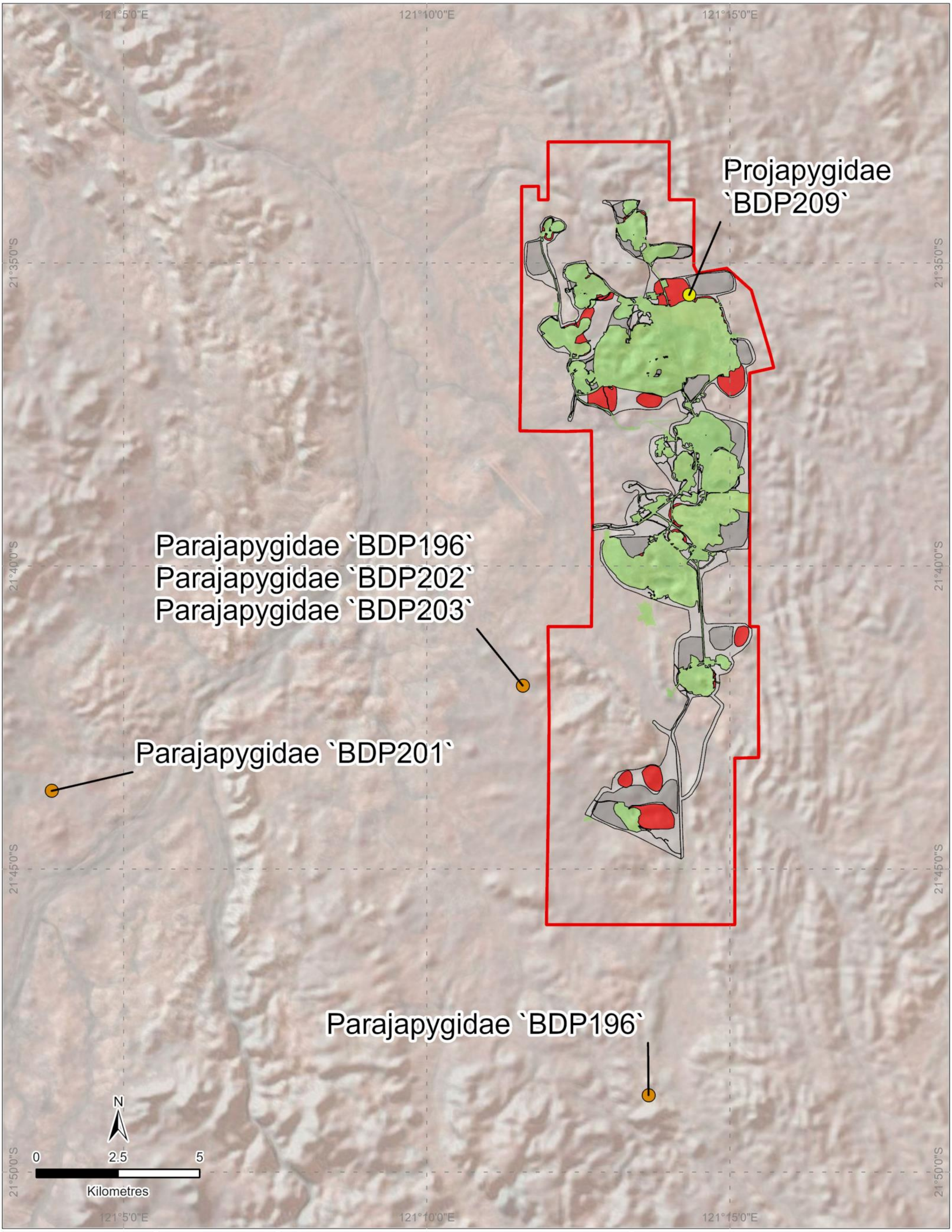


Figure 7: Pseudoscorpions and isopods recorded during survey and Indicative Disturbance Footprint.



Bennelongia Environmental Consultants

GCS GDA 1994
Author: VMarques
Date: 27/05/2022

PORT HEDLAND
NEWMAN
PERTH
Woodie Woodie

Legend

- Development Envelope
- Existing Approved Project Footprint

Indicative Disturbance Footprint

- Pit
- WRD
- Miscellaneous

Diplurans

- Restricted species
- Other species

Figure 8: Diplurans recorded during survey and Indicative Disturbance Footprint.

Tyrannochthonius `BPS398`. However, sequencing attempts on *Tyrannochthonius* `BPS382` failed for all three CO1 primers. The animal may have been dead when collected and was subsequently in too poor condition to yield informative molecular sequences. An informative molecular sequence was obtained from *Tyrannochthonius* `BPS398` but the nearest match was 15.8% divergent and treated as a different species. Thus, both *Tyrannochthonius* species are regarded as known only from the Survey Area.

Tyrannochthonius `BPS434' is known only from a proposed mine pit (Figure 7). The likelihood of being restricted to that pit is low but the species may possibly be restricted to the Development Envelope, including areas that will not be developed. A parsimonious assessment is that the level of threat to *Tyrannochthonius* `BPS434' is moderate. *Tyrannochthonius* `BPS398` is known only from a proposed pit cutback (Figure 7) and the level of threat to this species is also moderate.

Isopods
Isopods (slaters) are typical constituents of most troglofauna communities in Western Australia and are often very diverse at the species level. At Woodie Woodie, *Troglarmadillo* `BPS474` was collected from a single site from a troglofaunal trap set 14 m below ground level at site STYP022_T within a proposed mine pit. *Troglarmadillo* `BPS474` may be a troglophile because it had small eyes and faint pigment. However, a subterranean environment is essential for at least most of the species' life stages. A possible surrogate for the distribution of *Troglarmadillo* `BPS474`, a troglobite with all of its life cycle below ground, is provided by the related *Troglarmadillo* `BIS443`, which was found both inside and outside of the Indicative Disturbance Footprint over a linear range of 6 km in Pinjian Chert Breccia and in Quaternary unconsolidated deposits respectively (Figure 7). *Troglarmadillo* `BIS474` was collected from Pinjian Chert Breccia but, like *Troglarmadillo* `BIS443`, may exist in Quaternary unconsolidated deposits to the west of the development footprint. If *Troglarmadillo* ` BPS474` is a troglophile it is likely to have a large range. Accordingly, the threat from Project development is either moderate if it is a troglobite (for reasons already discussed) or minor if it is a troglophile.

Diplurans
Diplurans are essentially primitive insects. The average linear range of troglofaunal species in the Pilbara with multiple records is approximately 5 km (Halse and Pearson 2014). One of the five species of dipluran at Woodie Woodie was found only within the Indicative Disturbance Footprint. This was the Projapygidae `BDP209`, collected from a troglofauna trap set at 20 m at site ME21004 within a proposed mine pit (Figure 8). The species was collected from within the most widespread and connected type of geology in the area, Quaternary unconsolidated deposits (Figure 2). When the small size of the mine pits is taken into account, Projapygidae `BDP209` undoubtedly occurs in areas of no disturbance even if restricted to the Development Envelope. Accordingly, the threat to Projapygidae `BDP209` is considered to be only moderate.

7. CONCLUSION

Based on the results of the field survey, it is evident that moderately rich troglofauna and stygofauna communities occur at, and in the vicinity of, the Project. The vuggy porosity and permeability of the geology and lithology in the area is highly prospective for subterranean fauna, as was shown by the survey results. In total, 163 stygofauna samples collected yielded 943 specimens of at least 26 species. Additionally, 108 troglofauna specimens of at least 24 species were yielded from 153 samples despite survey limitations.

Of the 26 stygofauna species collected, 13 species are potentially known only from the survey area, and five of these species currently show restricted occurrences within the drawdown boundaries of the Project. These species are the syncarids Bathynellidae sp., *Billibathynella* `BSY192` and *Billibathynella* `BSY230`, and the harpacticoid copepods *Dussartstenocaris* `BHA324` and *Parastenocaris* `BHA311`. For four species, the threat from Project development is minor, while for *Parastenocaris* 'BHA311' it is either minor or moderate.

Of the 24 troglofauna species recorded at Woodie Woodie, 21 species are potentially known only from the survey area. Four of these species currently show restricted occurrences within impact areas of the Indicative Disturbance Footprint. These species are the pseudoscorpions *Tyrannochthonius* \`BPS398\` and *Tyrannochthonius* \`BPS434\`, the isopod *Troglarmadillo* \`BIS474\` and the dipluran Projapygidae \`BDP209\`. The threat to *Troglarmadillo* \`BIS474\` is either minor or moderate, while the threat to the other three species is moderate. Moderate threats are likely only to reduce species population size and, in the unlikely event of species distributions being very tightly restricted, can be managed to mitigate the possibility of significant impact.

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Appendix 1 – Sites sampled and subterranean fauna collected at Woodie Woodie

Hole ID	Latitude	Longitude	Target Fauna	Subterranean Species Collected
CRRC05v2	-21.61782	121.21757	Troglofauna	
FN21001	-21.72346	121.22636	Troglofauna	
FN21002	-21.72426	121.22478	Troglofauna	
GE21001	-21.72719	121.21925	Troglofauna	
GN20023	-21.6302	121.251	Troglofauna	
GU21001	-21.73508	121.23201	Troglofauna	*Allopnyxia* sp. B01 Enchytraeidae `3 bundle` s.l. (short sclero) *Tyrannochthonius* `BPS434`
GU21002	-21.73607	121.23312	Troglofauna	
HA21003	-21.69845	121.24513	Troglofauna	
HA21004	-21.69808	121.24515	Troglofauna	
HA21005	-21.69771	121.24503	Troglofauna	
LM21005	-21.58892	121.22955	Troglofauna	
LM21006	-21.58893	121.22975	Troglofauna	
LM21010	-21.58955	121.22934	Troglofauna	
LM21011	-21.58956	121.22973	Troglofauna	
LM21013	-21.59066	121.22874	Troglofauna	
LM21014	-21.59066	121.22912	Troglofauna	
LM21015	-21.59089	121.22893	Troglofauna	
LM21016	-21.59109	121.22913	Troglofauna	
LM21017	-21.59107	121.22875	Troglofauna	
ME21002	-21.5919	121.24116	Troglofauna	
ME21004	-21.59213	121.2388	Troglofauna	Projapygidae `BDP209`
ME21005	-21.59233	121.23937	Troglofauna	
ME21006	-21.59134	121.23935	Troglofauna	
ME21007	-21.59165	121.23978	Troglofauna	
ME21010	-21.59085	121.24005	Troglofauna	
REF_IMP_05S	-21.72966	121.20991	Stygofauna	*Billibathynella* `BSY192` *Diacyclops scanloni* s.l. *Pilbarus* `BAM156`
REF_IMP_05T	-21.72983	121.20986	Troglofauna	*Billibathynella* `BSY192` *Diacyclops scanloni* s.l. *Pilbarus* `BAM156`
REF_IMP_07S	-21.72278	121.20028	Stygofauna	*Troglarmadillo* `BIS443`
REF_IMP_07T	-21.72272	121.20044	Troglofauna	
REF_IMP_08S	-21.7209	121.23558	Stygofauna	
REF_IMP_08T	-21.72095	121.23572	Troglofauna	Chilopoda sp. *Cryptops* `BSCOL080` *Dodecastyla* sp.
REF_IMP_09S	-21.72	121.2149	Stygofauna	*Nocticola* sp.
REF_IMP_09T	-21.71996	121.21503	Troglofauna	
REF_IMP_10S	-21.71579	121.23499	Stygofauna	
REF_IMP_10T	-21.71587	121.23513	Troglofauna	*Parastenocaris* sp. *Trinemura* sp.
REF_IMP_11S	-21.70096	121.23804	Troglofauna	

Hole ID	Latitude	Longitude	Target Fauna	Subterranean Species Collected
REF_IMP_11T	-21.70093	121.23818	Troglofauna	Nematoda spp.
REF_IMP_12T	-21.69968	121.24955	Troglofauna	
REF_IMP_13S	-21.696	121.223	Stygofauna	
REF_IMP_13T	-21.69584	121.22325	Troglofauna	
REF_IMP_14S	-21.68906	121.21536	Stygofauna	
REF_IMP_14T	-21.68892	121.21535	Troglofauna	
REF_IMP_15S	-21.68794	121.2455	Stygofauna	
REF_IMP_15T	-21.68779	121.24553	Troglofauna	
REF_IMP_16S	-21.67399	121.22908	Stygofauna	
REF_IMP_16T	-21.67396	121.22898	Troglofauna	*Troglarmadillo* `BIS443` *Tyrannochthonius* `BPS398`
REF_IMP_19S	-21.62454	121.20679	Stygofauna	
REF_IMP_19T	-21.62464	121.20673	Troglofauna	
REF_IMP_22S	-21.59176	121.21352	Stygofauna	
REF_IMP_22T	-21.59185	121.21357	Troglofauna	
REF_IMP_23T	-21.59017	121.22944	Troglofauna	
REF_IMP_25S	-21.57847	121.22942	Stygofauna	Nematoda spp.
REF_IMP_25T	-21.57842	121.22931	Troglofauna	
REF_IMP_26S	-21.57592	121.19837	Stygofauna	*Parastenocaris* `BHA311`
REF_IMP_26T	-21.57581	121.19845	Troglofauna	
REF_IMP_27S	-21.569	121.21869	Stygofauna	*Billibathynella* `BSY192` *Diacyclops humphreysi* s.l.
REF_IMP_27T	-21.569	121.21878	Troglofauna	
SD21016	-21.59095	121.20787	Troglofauna	
STYP001_S	-21.55882	121.21098	Stygofauna	
STYP001_T	-21.55887	121.21078	Troglofauna	
STYP005_S	-21.58956	121.20147	Stygofauna	
STYP005_T	-21.58968	121.20141	Troglofauna	
STYP006_S	-21.59188	121.20133	Stygofauna	
STYP006_T	-21.59181	121.20117	Troglofauna	
STYP009_S	-21.61866	121.21309	Stygofauna	
STYP012_S	-21.63656	121.23981	Stygofauna	Nematoda spp.
STYP013_S	-21.65812	121.2276	Stygofauna	Nematoda spp.
STYP013_T	-21.65798	121.22768	Troglofauna	
STYP014_S	-21.66863	121.24919	Stygofauna	
STYP014_T	-21.6685	121.24924	Troglofauna	*Allopnyxia* sp. B01 *Megastygonitocrella trispinosa*
STYP015_S	-21.67331	121.2168	Stygofauna	
STYP015_T	-21.67328	121.21684	Troglofauna	
STYP016_S	-21.67429	121.22263	Stygofauna	
STYP016_T	-21.67415	121.22272	Troglofauna	
STYP017_S	-21.67643	121.22232	Stygofauna	*Cypretta* sp. Enchytraeidae `2 bundle` s.l. (long thin 2 per seg)
STYP017_T	-21.6766	121.22243	Troglofauna	
STYP018_S	-21.70043	121.22331	Stygofauna	
STYP019_S	-21.72544	121.22224	Stygofauna	

Hole ID	Latitude	Longitude	Target Fauna	Subterranean Species Collected
STYP019_T	-21.72544	121.22247	Troglofauna	
STYP020_S	-21.72681	121.22071	Stygofauna	
STYP020_T	-21.72674	121.22061	Troglofauna	
STYP021_S	-21.73421	121.22917	Stygofauna	Bathynellidae sp. *Diacyclops scanloni* s.l.
STYP021_T	-21.7341	121.22929	Troglofauna	
STYP022_S	-21.73468	121.23027	Stygofauna	
STYP022_T	-21.73461	121.23037	Troglofauna	*Troglarmadillo* `BIS474`
STYP023_S	-21.74092	121.22229	Stygofauna	
STYP023_T	-21.74114	121.22231	Troglofauna	
STYP024_S	-21.74323	121.22518	Stygofauna	
STYP024_T	-21.74333	121.22524	Troglofauna	*Prethopalpus* sp.
STYP025_S	-21.80893	121.2233	Stygofauna	
STYP025_T	-21.80894	121.22347	Troglofauna	
STYP026_S	-21.81207	121.22775	Stygofauna	
STYP026_T	-21.81218	121.22763	Troglofauna	Parajapygidae `BDP196`
STYP027_S	-21.80179	121.20355	Stygofauna	
STYP027_T	-21.8017	121.20345	Troglofauna	
STYP028_S	-21.80295	121.20672	Stygofauna	
STYP028_T	-21.80295	121.20648	Troglofauna	
STYP029_S	-21.80128	121.20758	Stygofauna	*Billibathynella* `BSY224` *Diacyclops scanloni* s.l. *Elaphoidella humphreysi* s.l.
STYP029_T	-21.80114	121.20766	Troglofauna	*Billibathynella* `BSY224` *Diacyclops scanloni* s.l.
STYP030_S	-21.80764	121.213	Stygofauna	
STYP030_T	-21.80774	121.21281	Troglofauna	
STYP031_S	-21.78048	121.22103	Stygofauna	*Bogidiella* `BAM206` Copepoda sp. *Elaphoidella humphreysi* s.l. *Pilbarus* `BAM207`
STYP031_T	-21.78035	121.22108	Troglofauna	
STYP032_S	-21.77767	121.218	Stygofauna	Nematoda spp.
STYP032_T	-21.7776	121.21818	Troglofauna	
STYP033_S	-21.75763	121.21233	Stygofauna	
STYP033_T	-21.75743	121.21228	Troglofauna	
STYP034_S	-21.75856	121.21316	Stygofauna	
STYP034_T	-21.75875	121.21315	Troglofauna	*Eukoenenia* sp.
STYP035_S	-21.76564	121.21677	Stygofauna	
STYP035_T	-21.76552	121.21669	Troglofauna	
STYP036_S	-21.76839	121.22024	Stygofauna	
STYP036_T	-21.76854	121.22026	Troglofauna	*Cryptops* `BSCOL080`
STYP037_S	-21.74011	121.1985	Stygofauna	
STYP037_T	-21.7401	121.19832	Troglofauna	
STYP038_S	-21.72172	121.19723	Stygofauna	
STYP038_T	-21.72156	121.1971	Troglofauna	
STYP039_S	-21.71024	121.19823	Stygofauna	*Abnitocrella* `BHA258` *Diacyclops scanloni* s.l.

Hole ID	Latitude	Longitude	Target Fauna	Subterranean Species Collected
				Pilbarus \`BAM156\`
STYP039_T	-21.71036	121.19806	Troglofauna	
STYP040_S	-21.69955	121.19305	Stygofauna	Armadillidae \`BIS466\` *Gracilanillus* \`BCO236\` *Mesocyclops notius* Parajapygidae \`BDP196\` Parajapygidae \`BDP202\` Parajapygidae \`BDP203\` *Pilbarus* \`BAM156\`
STYP040_T	-21.69939	121.19319	Troglofauna	*Mesocyclops notius*
STYP041_S	-21.69386	121.20498	Stygofauna	*Mesocyclops notius*
STYP041_T	-21.69393	121.20515	Troglofauna	Pauropodidae sp. B01 s.l. *Trinemura* sp.
STYP042_S	-21.70194	121.21291	Stygofauna	
STYP042_T	-21.70209	121.2128	Troglofauna	*Lophoturus madecassus*
STYP043_S	-21.68693	121.18868	Stygofauna	
STYP043_T	-21.68706	121.18884	Troglofauna	
STYP044_S	-21.704	121.20213	Stygofauna	
STYP044_T	-21.70384	121.20208	Troglofauna	*Lophoturus madecassus*
STYP045_S	-21.69676	121.20111	Stygofauna	*Diacyclops scanloni* s.l. *Pilbarus* \`BAM156\`
STYP045_T	-21.69683	121.20123	Troglofauna	
STYP046_S	-21.69263	121.19326	Stygofauna	*Pilbarus* \`BAM156\`
STYP046_T	-21.69273	121.19347	Troglofauna	*Mesocyclops* sp.
STYP047_S	-21.68012	121.18466	Stygofauna	
STYP047_T	-21.67994	121.18476	Troglofauna	
STYP048_S	-21.66954	121.18937	Stygofauna	
STYP048_T	-21.66973	121.18924	Troglofauna	
STYP049_S	-21.66182	121.1897	Stygofauna	
STYP049_T	-21.6616	121.18985	Troglofauna	
STYP050_S	-21.60133	121.17604	Stygofauna	*Diacyclops scanloni* s.l. *Megastygonitocrella trispinosa* Microcerberidae sp. Phreodrilidae sp. AP SVC s.l. *Pilbarus* \`BAM207\`
STYP050_T	-21.6014	121.1762	Troglofauna	
STYP051_S	-21.60842	121.17599	Stygofauna	
STYP051_T	-21.60836	121.17588	Troglofauna	
STYP052_S	-21.61666	121.17762	Stygofauna	*Diacyclops scanloni* s.l. *Megastygonitocrella trispinosa* Microcerberidae sp. *Monopylephorus* sp. nov. WA29 (ex Pristina WA3) (PSS) *Pilbarus* \`BAM207\`
STYP052_T	-21.61683	121.17752	Troglofauna	
STYP053_S	-21.52794	121.18683	Stygofauna	
STYP053_T	-21.5278	121.18692	Troglofauna	*Mesocyclops notius*
STYP054_S2	-21.54679	121.18816	Stygofauna	*Dussartstenocaris* \`BHA324\` *Parastenocaris* \`BHA311\`
STYP054_T	-21.54664	121.18823	Troglofauna	*Symphylella* \`BSYM105\`
STYP055_S	-21.53925	121.18622	Stygofauna	
STYP055_T	-21.53917	121.18628	Troglofauna	*Mesocyclops notius* nr *Encoptarthria* sp.

Hole ID	Latitude	Longitude	Target Fauna	Subterranean Species Collected
				Tyrannochthonius `BPS382`
STYP056_S	-21.53684	121.23188	Stygofauna	
STYP056_T	-21.53678	121.2319	Troglofauna	Pauropodidae `BPU104`
STYP057_S	-21.72721	121.07975	Stygofauna	*Pilbarus* `BAM207` *Thermocyclops* `BCY091`
STYP057_T	-21.72737	121.07973	Troglofauna	
STYP058_S	-21.7236	121.07245	Stygofauna	
STYP058_T	-21.72354	121.07268	Troglofauna	
STYP059_S	-21.71705	121.06457	Stygofauna	*Billibathynella* `BSY224` *Diacyclops scanloni* s.l. *Elaphoidella humphreysi* s.l. *Maarrka* `BAM212` Microcerberidae sp. *Pilbarus* `BAM207`
STYP059_T	-21.71716	121.06472	Troglofauna	
STYP060_S	-21.72851	121.06355	Stygofauna	*Elaphoidella humphreysi* s.l. Parajapygidae `BDP201`
STYP060_T	-21.72838	121.06341	Troglofauna	
STYP061_S	-21.5917	121.12389	Stygofauna	*Pilbarus* `BAM156`
STYP061_T	-21.59182	121.12379	Troglofauna	
STYP062_S	-21.5918	121.12631	Stygofauna	
STYP062_T	-21.59167	121.12644	Troglofauna	
STYP063_S	-21.58934	121.13231	Stygofauna	
STYP063_T	-21.58947	121.13242	Troglofauna	
WD21003	-21.57318	121.20076	Troglofauna	
WD21005	-21.57374	121.20053	Troglofauna	
WD21008	-21.57399	121.20045	Troglofauna	
WMMB015	-21.58373	121.22787	Stygofauna	Nematoda spp.
WWMB010	-21.73651	121.23333	Stygofauna	*Abnitocrella* `BHA258` *Diacyclops scanloni* s.l. *Elaphoidella humphreysi* s.l. *Humphreyscandona capillus* *Pilbarus* `BAM207`
WWMB011	-21.55439	121.21037	Stygofauna	*Billibathynella* `BSY192` *Pilbarus* `BAM207`
WWMB014	-21.6806	121.25097	Stygofauna	*Abnitocrella* `BHA258` *Diacyclops scanloni* s.l.
WWMB04	-21.61562	121.19724	Stygofauna	*Abnitocrella* `BHA258` *Billibathynella* `BSY224` *Bogidiella* `BAM206` *Diacyclops scanloni* s.l. *Megastygonitocrella trispinosa* *Namanereis pilbarensis* Phreodrilidae sp. AP SVC s.l. *Pilbarus* `BAM207`
WWMB07	-21.63407	121.18546	Stygofauna	*Abnitocrella* `BHA258`
WWMB09	-21.67141	121.19277	Stygofauna	
WWMB17	-21.73131	121.21553	Stygofauna	*Diacyclops scanloni* s.l. *Pilbarus* `BAM156`

Appendix 2 – Specimens sequenced for the CO1 gene and taxonomic conclusions

Cap	Hole ID	Morphology	DNA comments	Results	Updated identification?
1	WWMB04	Bogidiella `BAM206`	3 body segs, 2C	Failed	Failed
2	STYP030_S	Bogidiella `BAM206`	3 body segs, 2C	Closest match is Bogidiella `BAM179` collected from Kutayi which is 13.5% different. Keeps BAM206 species code.	None
3	REF_IMP_26S	Parastenocaris `BHA311`	2DD, whole animals soaked in ATL over 24 hours	Cap 3 & 4 are the same. There is 4.2% divergence between them. No blast or BEC DB matches.	None
4	REF_IMP_10T	Parastenocaris sp.	Whole, 2DD, soaked in ATL over 24 hours	Cap 3 & 4 are the same. There is 4.2% divergence between them. No blast or BEC DB matches.	Parastenocaris `BHA311`
5	STYP055_T	Tyrannochthonius `BPS382`	Whole squished animal v bad condition, 3C, soaked in ATL over 24 hours	Failed - specimen in poor condition	Failed - poor condition
6	REF_IMP_16T	Tyrannochthonius `BPS398`	Abdomen & legs, 2C, soaked in ATL over 24 hours	Keeps new B number. Closest match was from a blast search - Tyrannochthonius sp. WAM (Accession code MT044580). They are 15.8% different.	None
7	STYP021_S	Bathynellidae sp.	Whole, 2C, ethanol full of little white bits, soaked in ATL over 24 hours	Failed - specimen in poor condition	Failed - poor condition
8	REF_IMP_27S	Billibathynella `BSY192`	Whole , 2C, soaked in ATL over 24 hours	New species, no blast or benne database matches. Closest match: 18.7% divergent Billibathynella `BSY224`	None
9	REF_IMP_05S	Billibathynella `BSY192`	Whole, 2C, soaked in ATL over 24 hours	New species, not the same as cap 8. Closest match is blast match Parabathynellidae sp. (Accession code: MW911298) which is 19.8% different.	Billibathynella `BSY230`
10	WWMB04	Billibathynella `BSY224`	2D, whole, soaked in ATL over 24 hours	Same species cap 10, 11, 12? There is 13% to 13.7% divergence between these three specimens. In the past I have used 10% as a cut-off point but crustaceans can be difficult and often larger intraspecific variation is acceptable.	None
11	STYP029_T	Billibathynella `BSY224`	2D, whole, soaked in ATL over 24 hours	Same species cap 10, 11, 12? There is 13% to 13.7% divergence between these three specimens. In the past I have used 10% as a cut-off point but crustaceans can be difficult.	None
12	STYP059_S	Billibathynella `BSY224`	2D, whole, soaked in ATL over 24 hours	Same species cap 10, 11, 12? There is 13% to 13.7% divergence between these three specimens. In the past I have used 10% as a cut-off point but crustaceans can be difficult.	None