Bennelongia Environmental Consultants

Yandi Targeted Subterranean Fauna Survey Report

Prepared for:

BHP Western Australian Iron Ore

April 2025

Final Report

Short-Range Endemics I Subterranean Fauna

Waterbirds I Wetlands

Yandi Targeted Subterranean Fauna Survey Report

Bennelongia Pty Ltd
5 Bishop Street
Jolimont WA 6014

P: (08) 9285 8722
F: (08) 9285 8811
E: info@bennelongia.com.au

ABN: 55 124 110 167

Report Number: 694

Report Version	Prepared by	Reviewed by	Submitted to Client	
			Method	Date
Draft	Huon Clark	Vitor Marques	email	10 March 2025
Final	Stuart Halse		email	8 April 2025

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EXECUTIVE SUMMARY

BHP Western Australian Iron Ore (BHP WAIO) manages the iron ore mine known as Yandi Operations (the Project), which lies 100 km north-east of Newman in the Pilbara region of Western Australia. BHP WAIO proposes to expand mining at Yandi Operations to include the Yandi E8 pit area and other nearby developments and has commissioned numerous environmental studies at the Project, including studies for subterranean fauna. Bennelongia Environmental Consultants conducted a subterranean fauna between May 2022 and March 2023 (Bennelongia 2024), which resulted in the identification of five species of stygofauna and 13 species of troglofauna as new species known only from the Yandi Operations area.

Upon further investigation, BHP WAIO identified that two species of stygofauna and five species of troglofauna were of conservation significance and required further investigations. The stygofauna species are the harpacticoid copepods:

- *Elaphoidella* `BHA342`, and
- *Parastenocaris* `BHA343`.

The troglofauna identified by BHP WAIO are:

- The symphylan *Hanseniella* sp. indet.,
- The beetle *Hesperanillus* `BCO247`,
- The centipede *Cryptops* `BSCOL091`, and
- The millipedes Haplodesmidae `BDI080` and Trigoniulidae `BDI079`.

Bennelongia re-visted the Project area between 21st and March 28th 2024 (with trap collection occurring between May 27th and 28th 2024) to conduct a targeted survey for the seven identified species. A total of 39 stygofauna samples and 27 troglofauna samples were taken, resulting in the collection of 733 specimens belonging to 24 species of stygofauna and 334 specimens of at least 16 species of troglofauna.

The targeted survey and subsequent molecular work resulted in the additional collection and/or reclassification of three of the target species. *Elaphoidella* `BHA342` was collected 33 km from the original collection site. Trigoniulidae `BDI079` was collected 110 m from the original collection location. Finally, Haplodesmidae `BDI080` was recollected and then matched genetically to a widespread species. As a result, the name of this species has been updated to Haplodesmidae `Helix-DIHAP001` and it is considered to be a widespread species.

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1. INTRODUCTION

BHP Western Australian Iron Ore (BHP WAIO) manages the iron ore mine known as Yandi Operations (the Project), which lies 100 km north-east of Newman in the Pilbara region of Western Australia (Figure 1). BHP WAIO proposes to expand mining at Yandi Operations to include the Yandi E8 pit area and other nearby developments and has instigated numerous environmental studies to facilitate this. One such study was the subterranean fauna survey, conducted by Bennelongia Environmental Consultants (BEC) between May 2022 and March 2023. The subsequent report (Bennelongia 2024) identified five species of stygofauna and 13 species of troglofauna as new species known only from the Yandi Operations area.

Upon further investigations, BHP WAIO identified that two species of stygofauna and five species of troglofauna were of conservation significance and required further investigations. The stygofauna species are the harpacticoid copepods:

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- The millipedes Haplodesmidae \`BDI080\` and Trigoniulidae \`BDI079\`.

BHP WAIO commissioned BEC to conduct further sampling in an attempt to recollect these seven target species and this report discusses the results and subsequent findings of the targeted subterranean fauna survey.

1.1. Subterranean Fauna Framework

The term subterranean fauna refers to animals living essentially full-time underground. Subterranean animals are divided into two types: stygofauna are aquatic animals that live below ground in water, while troglofauna are air-breathing animals that live underground and require very high humidity (Gibson *et al.* 2019). Stygofauna inhabit vugs, fissures, and interstitial spaces in groundwater aquifers, especially those in alluvium and calcretes. Troglofauna inhabit similar (albeit slightly larger) spaces above the water table.

Subterranean species share several convergent adaptations to life underground where it is dark, and resources are limited. These include worm-shaped bodies, elongated chemosensory apparatus, loss of wings, transition towards K-selected breeding strategies, and the loss of skin colouration and eyes (Gibert and Deharveng 2002). Western Australia supports a particularly rich subterranean fauna outside caves, with estimates of more than 4,000 species of stygofauna and troglofauna, 90% of which remain to be described (Guzik *et al.* 2011; Halse 2018a). Almost all subterranean animals in Western Australia are invertebrates, but fishes (Whitely 1945) and one snake (Aplin 1998) have also been recorded. Most subterranean species are microscopic but contribute substantially to biodiversity and ecosystem function, for example by moderating groundwater quality (Hose and Stumpp 2019).

1.1.1. Distribution

Subterranean animals tend to have limited distributions. Most stygofauna species exhibit short range endemism (SRE), having substantially smaller ranges than Harvey's (2002) SRE criterion of 10,000 km^2 (Cooper *et al.* 2007; Cooper *et al.* 2002; Eberhard *et al.* 2009). The ranges of troglofauna have yet to be investigated in detail but are mostly even more restricted than those of stygofauna, with many species having linear ranges less than 10 km (Halse and Pearson 2014; Lamoreux 2004). Given that species with small ranges are more vulnerable to extinction following habitat degradation than wider ranging species, it follows that subterranean taxa are highly susceptible to anthropogenic threats, particularly large-scale excavation and groundwater abstraction (Halse 2018a; Ponder and Colgan 2002).

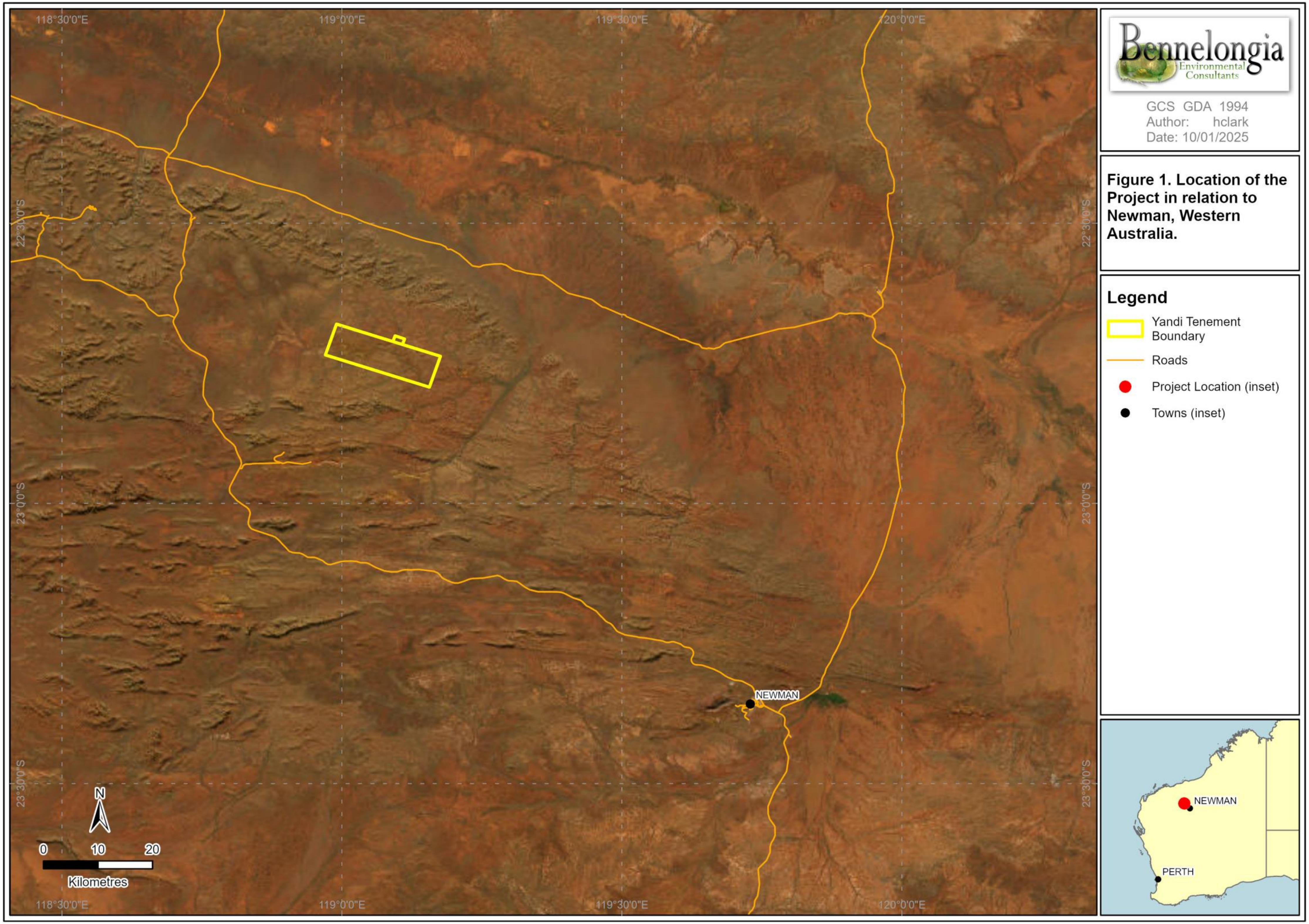

Figure 1. Location of the Project in relation to Newman, Western Australia.

The distribution of subterranean animals is largely determined by lithology. In most situations in Western Australia, subterranean animals probably occupy spaces only a few millimetres in width (Halse a, b, c). The key characteristics of the habitats used by subterranean species are the occurrence of suitable space spaces (e.g. interstices in alluvium, screen, and voids; vugs, cavities, and fissures in consolidated geologies) and that the spaces are well connected laterally and vertically. Lateral connectivity facilitates dispersal of animals, while vertical connectivity to the surface is crucial for delivering carbon and other nutrients to subterranean ecosystems (Korbel and Hose 2011). Connectivity may be disrupted by a range of factors, including dykes, fractures and folding, major landscape features, and unfavourable chemistry. Temporal variation in population density does not appear to be linked with either climate or weather (Halse 2018b, c; WABSI 2021).

1.1.2. Stygofauna

Most stygofauna species in Western Australia are crustaceans, particularly ostracods and copepods, although other groups such as worms and beetles are sometimes abundant (DEC 2009; DPAW 2022; Matthews *et al.* 2019). The most productive known stygofauna habitats are saturated alluvial and calcrete aquifers associated with palaeochannel deposits, but stygofauna also inhabit karstic limestones, hyporheic zones, groundwater-fed springs, and aquifers in some iron formations, especially channel iron deposits known as CID (Halse 2018c; Hyde *et al.* 2018). Stygofauna are rarely abundant where depth to the water table is more than 30 m below ground level (Halse 2018a). Aquifers with higher transmissivity are more likely to host stygofauna than aquifers with lower transmissivity (Maurice and Bloomfield 2012). Stygofauna mostly occur in fresh to hyposaline water (Halse *et al.* 2014; Humphreys *et al.* 2009), but can occur in higher salinities (Bennelongia 2016; Reeves *et al.* 2007; Watts and Humphreys 2006).

1.1.3. Troglofauna

Western Australia appears to be almost unique for its diverse and widespread troglofauna outside caves (Halse and Pearson 2014). The Western Australian troglofauna comprises mostly arthropods, with a variety of isopods, insects, spiders, pseudoscorpions, and millipedes, centipedes, and their allies also represented. Troglofauna are particularly likely to occur in weathered or mineralised iron formations, alluvium or colluvium in valley-fill areas (including areas of karstic calcrete), and fractured sandstone (Halse 2018a). Troglofauna typically require relative humidity close to 100% (Howarth 1983).

1.2. 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. At the national level, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna and ecological communities.

Both the EPBC and BC Acts provide frameworks for the protection of threatened ecological communities (TECs), where an ecological community is defined as a naturally occurring group of plants, animals and other organisms interacting in unique habitat (with the unique habitat created by the combination of the species and their landscape setting; DEC 2013). Communities occupying a small or threatened habitat are classified as threatened ecological communities (TECs) under the BC Act and the EPBC Act. 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.

2. PROJECT HISTORY

The planned expansions in the Yandi E8 deposit will result in excavation of the E8 pit and an extension of groundwater drawdowns. As a part of the environmental approvals process, BHP WAIO commissioned BEC to conduct a desktop and a three-phase subterranean fauna survey to bring sampling of the site in line with the most recent EPA Technical Guidance (EPA 2021).

The desktop assessment included reviewing historical subterranean survey reports in the immediate vicinity of Yandi to ensure historical data were captured and updated with the newest understanding of the taxonomy of the various groups. These historical reports included:

1. Bennelongia (2012), "Yandi stygofauna – continuation of monitoring program",
2. Biota (2015), "Yandi operations stygofauna data consolidation 2003-2014",
3. Bennelongia (2018), "Ministers North subterranean fauna survey", and
4. Bennelongia (2021), "Ministers North targeted troglofauna survey".

Bennelongia undertook sampling between May 2022 and March 2023 that resulted in the collection of 59 stygofauna samples and 60 troglofauna samples at the Yandi E8 area and surrounding landscape (Bennelongia 2024). A total of 1,171 specimens from 35 species of stygofauna were collected during the 2022/23 survey. Of these, five species of stygofauna were identified as being known only from the Yandi area. Additionally, 194 specimens from 33 species of troglofauna were collected during the 2022/23 survey program. Twelve of these species of troglofauna were considered restricted to the Yandi area at the time of reporting (Bennelongia 2024).

BHP WAIO conducted further analysis and narrowed the list of species of conservation concern to seven including two species of stygofauna and five species of troglofauna. The restricted stygofauna species are the harpacticoid copepods:

- *Elaphoidella* `BHA342`, and
- *Parastenocaris* `BHA343`.

The troglofauna identified by BHP WAIO are:

- The symphylan *Hanseniella* sp. indet.,
- The beetle *Hesperanillus* `BCO247`,
- The centipede *Cryptops* `BSCOL091`, and
- The millipedes Haplodesmidae `BDI080` and Trigoniulidae `BDI079`.

2.1. Target Stygofauna

Harpacticoid copepods in the Pilbara have been regarded as moderately widespread (Karanovic 2006). Harpacticoid copepods are among the most ubiquitous of major groups of stygofauna in WA and have been recorded in an array of geologies. Calcrete aquifers often harbour large numbers of harpacticoid species, and it is commonplace to record multiple species of a single genus. While a considerable number of stygal harpacticoid species have been described (e.g. Karanovic 2006, 2010; Karanovic and Cooper 2012; Karanovic and Hancock 2009; Karanovic and McRae 2013), many taxa previously recognised as monophyletic and widespread, actually comprise multiple, short-range species.

***Elaphoidella* `BHA342`**

Nineteen specimens of *Elaphoidella* `BHA342` were collected from two drill holes, YE2070R and HYE1511 (Figure 2). Site YE2070R was sampled three times between 2022 and 2023 and had a depth to groundwater ranging between 41.66 and 42.52 m bgl at the time of sampling. With an end of hole of 51 m bgl, this provides a collection range of approximately 9 m. YE2070R contains fresh water (between 380 and 805 µS/cm) with a neutral pH (6.66 to 6.94) and 16 specimens of *Elaphoidella* `BHA342` have been collected from there.

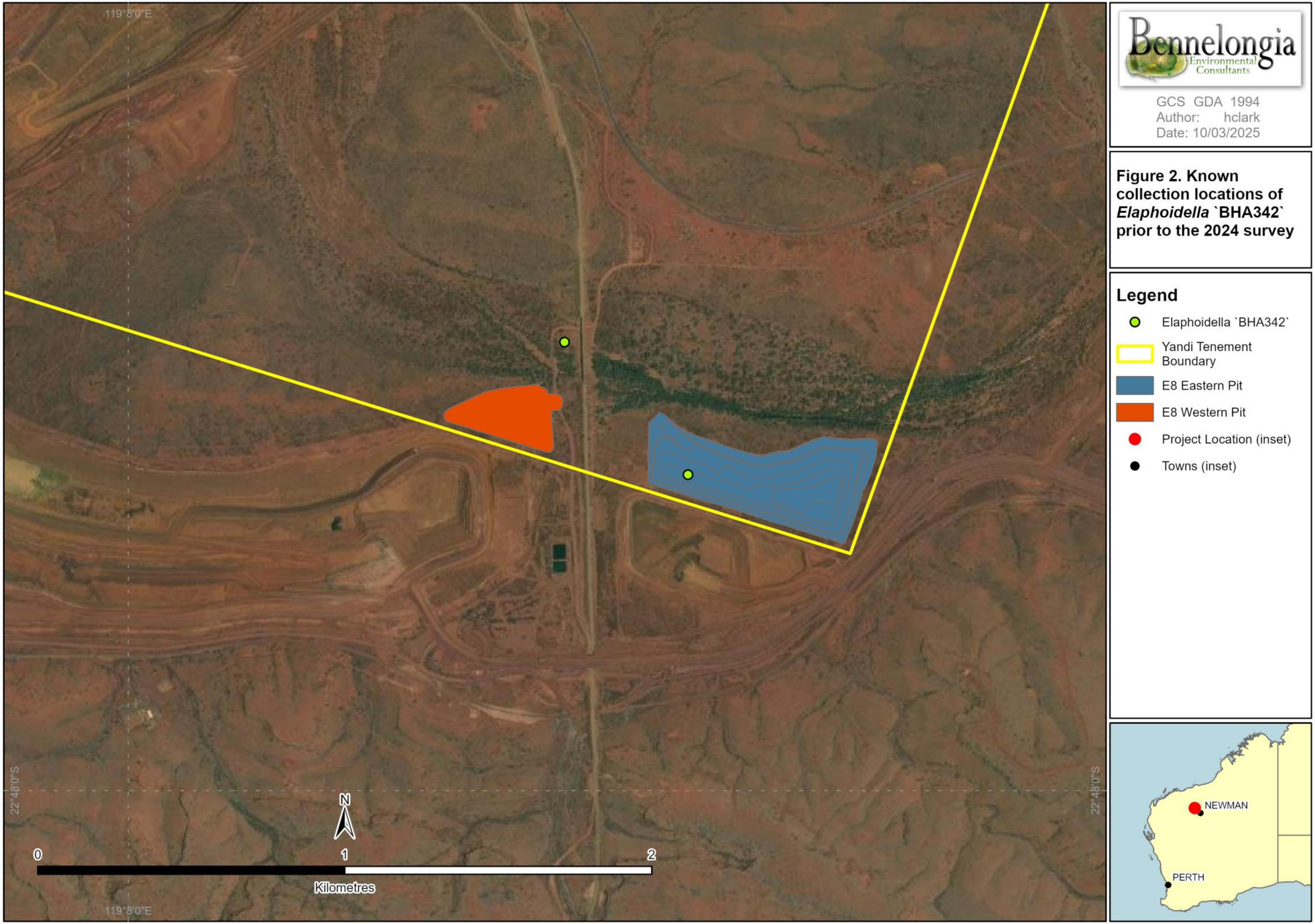

Figure 2. Known collection locations of *Elaphoidella* `BHA342` prior to the 2024 survey

The remaining three specimens of *Elaphoidella* `BHA342` were collected from site HYE1511 in 2023 which had a depth to water of 6.03 m bgl, an EC reading of 1128 µS/cm and a pH reading of 7.05.

The two locations are 600 m apart and are situated on either side of the main channel of Marillana Creek (Figure 2). Linear ranges for species of *Elaphoidella* in the Pilbara with at least three records vary from Pilbara-wide (*E. humphreysi*) to 13 km (*E.* sp. 'B05').

***Parastenocaris* `BHA343`**

Parastenocaris `BHA343` was collected as a singleton in 2022 from bore YE2070R. On the day of collection, depth to water was 42.52 m bgl and the end of hole was 51 m bgl providing a range of collection of 8.5 m. The water at the time of sampling was fresh (379.5 µS/cm) and pH neutral (6.94). This site is located to the south of Marillana Creek and the Yandicoogina Palaeovalley is also present at this location (Figure 3).

Other than *Parastenocaris jane*, most species of *Parastenocaris* in the Pilbara have small linear ranges (varying from 0.2 to 24 km for species collected from three or more holes).

2.2. Target Troglofauna

***Hanseniella* sp. indet.**

Hanseniella sp. indet. was collected as a singleton in a scrape from drill hole YE2061R (Figure 4). This specimen was collected in poor condition, which resulted in the inability to identify the species beyond genus using morphology. Genetic analysis was attempted on this individual but unfortunately did not return a successful sequence due to the condition of the material. As a result, this specimen has been left as a higher order identification at the genus level, *Hanseniella* sp. indet. The depth to water at site YE061R was 37 m bgl at the time of sampling providing a lower limit to the collection depth.

The current record lies within the range of the widespread *Hanseniella* sp. B14, which appears to be a troglophile (known linear range of 42 km). It is possible that *Hanseniella* sp. indet. is a new species, but three other *Hanseniella* species, *H.* B14, *H.* B42 and *H.* B43, occur in the area and *Hanseniella* sp. indet. May also be one of these species.

***Hesperanillus* `BCO247`**

When collected, coleopteran beetles are often found within mineralised rock and detritals and have a calculated median linear range of 8.7 km (Halse 2018b). Beetles of the genus *Hesperanillus* are rare with only five species recorded in the Bennelongia database, including three described species (Baehr and Main 2016). Each of the five species is known from only two or fewer specimens, further confirming their rarity in the collections.

Hesperanillus `BCO247` was collected as a singleton in a scrape sample from drill hole YE2045R (Figure 5). Due to the nature of scrape samples, a collection depth could not be determined, however the standing water level at this site was 41 m bgl providing a lower limit for collection.

This specimen was in poor condition and dead upon collection. Molecular sequencing of the specimen was, as a result, unsuccessful and identification was based on morphology alone.

***Cryptops* `BSCOL091`**

Subterranean centipedes are known to inhabit mineralised rock and detritals including calcretes (Halse 2018b). The BEC database contains 140 known species of subterranean centipede and, in 2018, Halse calculated this group to have a known median linear range of 6.2 km. Of the 140 known species, 68 are of the genus *Cryptops*, making them by far the most common genus of subterranean centipede in the BEC database.

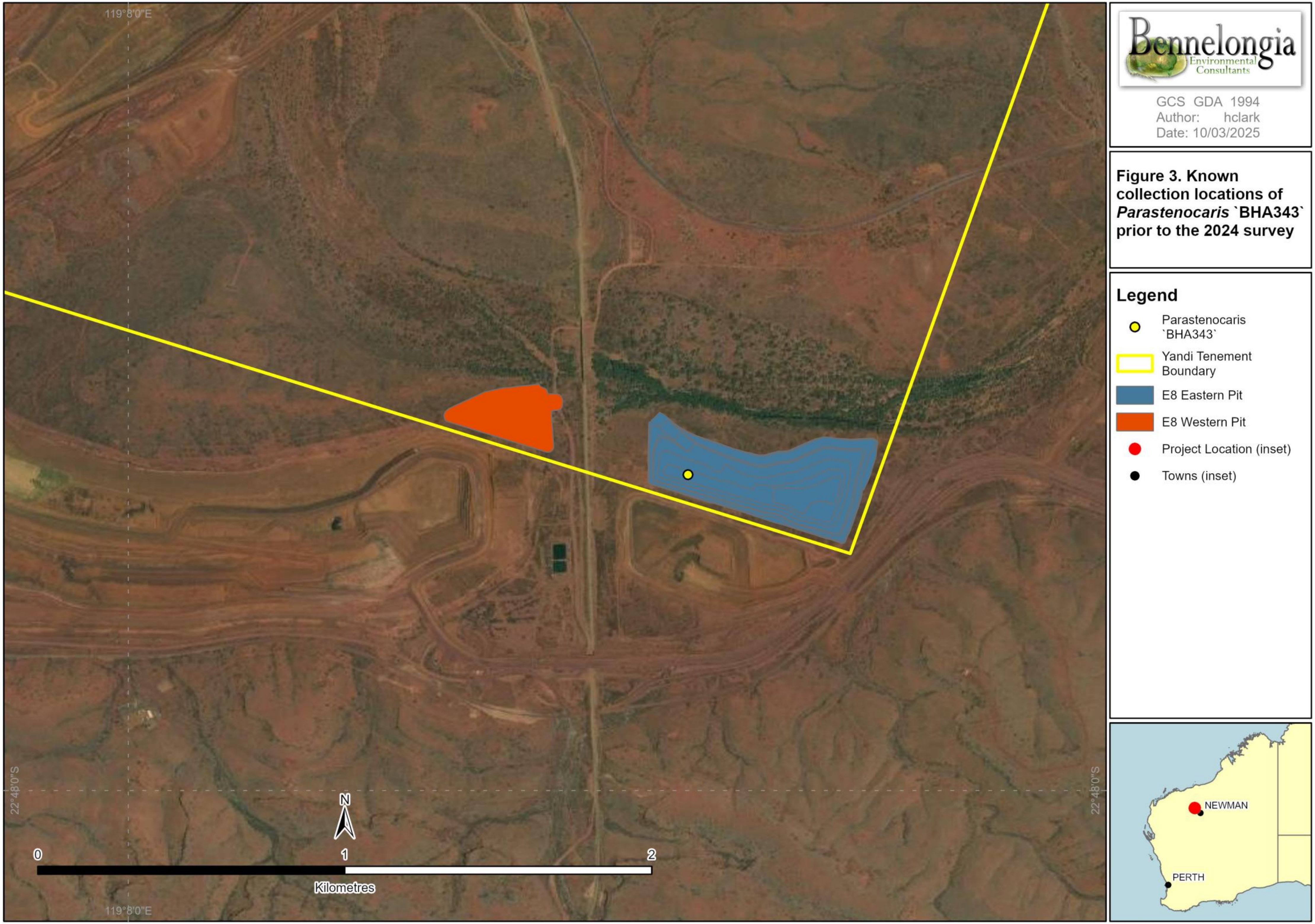

Figure 3. Known collection locations of *Parastenocaris* `BHA343` prior to the 2024 survey

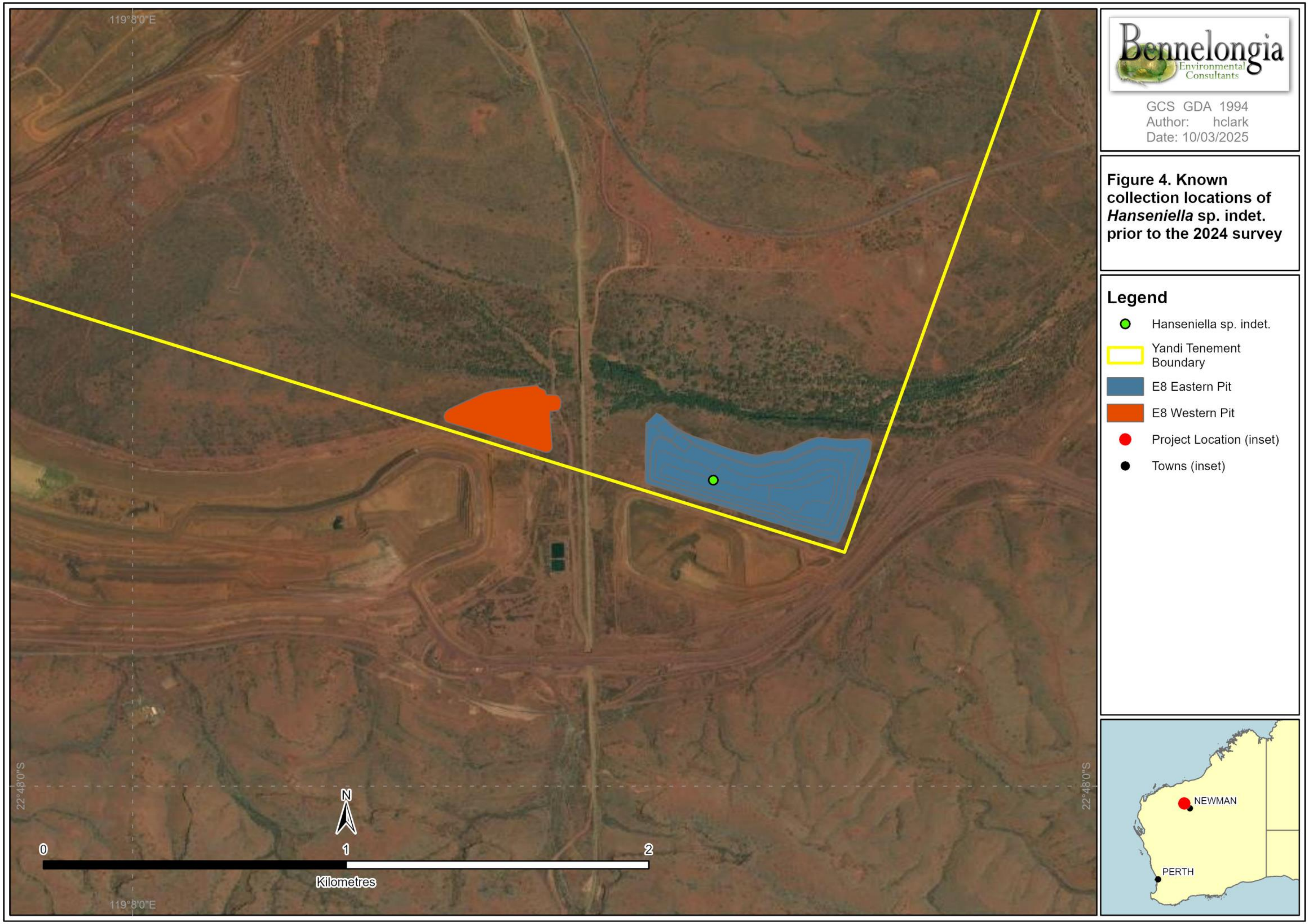

Figure 4. Known collection locations of *Hanseniella* sp. indet. prior to the 2024 survey

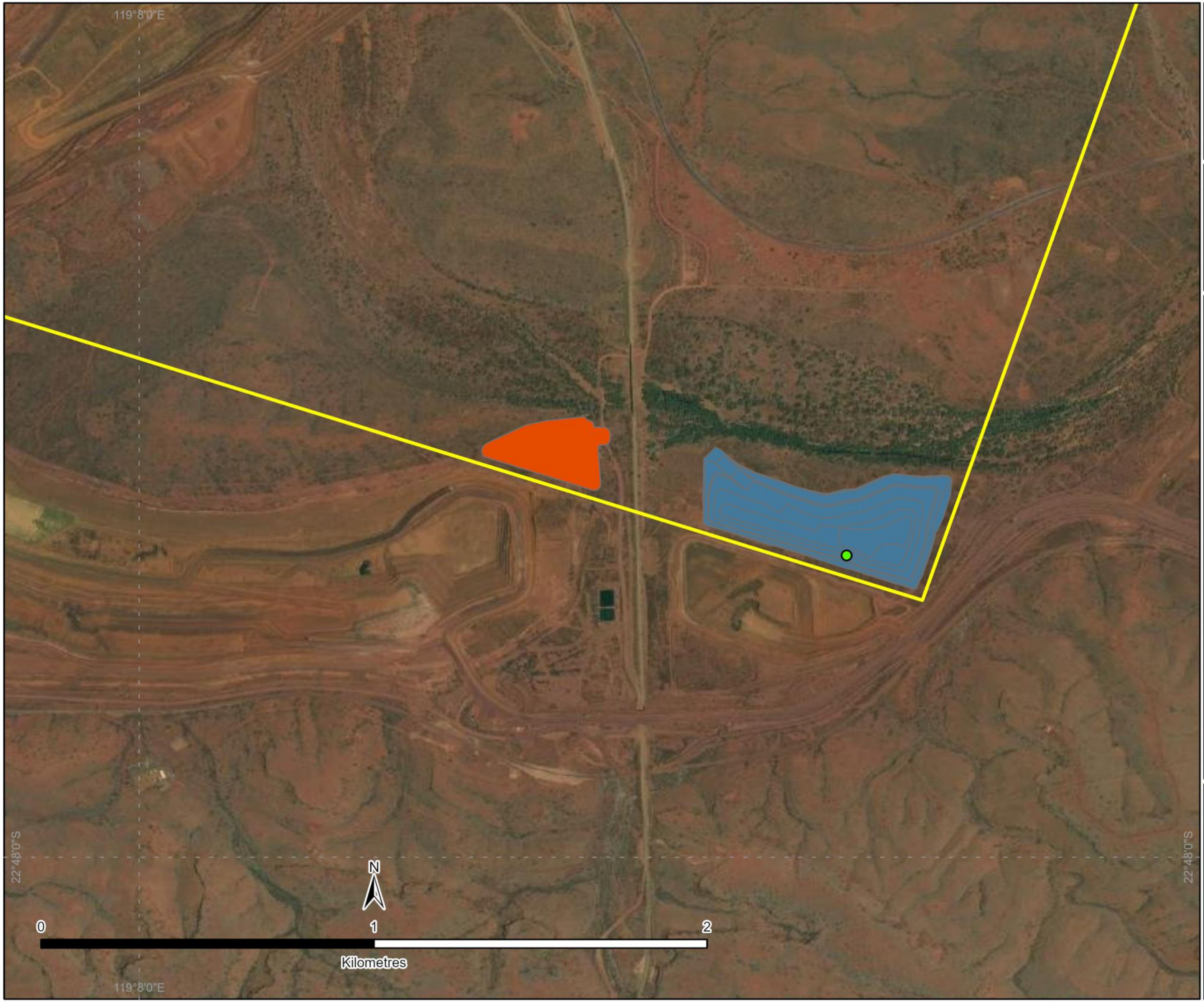

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Figure 5. Known collection locations of *Hesperanillus* `BCO247` prior to the 2024 survey

Legend

- Hesperanillus `BCO247`
- Yandi Tenement Boundary
- E8 Eastern Pit
- E8 Western Pit
- Project Location (inset)
- Towns (inset)

Two specimens of *Cryptops* `BSCOL091` were collected as bycatch during stygofauna net hauling from two drill holes, YE2029R and YE2033R, 600 m apart, located on the southern side of Marillana Creek (Figure 6). Due to the collection method, a collection depth could not be established for either of these individuals, however the standing water level at each of these sites were 21.16 and 36.52 m bgl respectively. Sequencing confirmed that both specimens belong to the same species, and they are both morphologically and genetically distinct from all other known species (Bennelongia 2024).

Haplodesmidae `BDI080`

Similar to centipedes, millipedes are known to inhabit weathered mineralised rock, and detritals including calcrete (Halse 2018b). Millipedes make up 3.5% of the species of troglofauna known from the Pilbara and have a mean linear range of 4.5 km, although this is likely heavily skewed due to the regular collection of the circumtropical troglophilic *Lophoturus madecassus* (Car *et al.* 2013; Halse 2018b).

Haplodesmidae `DBI080` was collected in 2023 as a singleton in a trap set at 5 m bgl at site YE2020R. This site is located south of Marillana Creek (Figure 7). It is possible that this species is a synonym with Haplodesmidae `Helix-DIHAP001` which is widespread throughout the Pilbara, however genetic work is required to confirm this. Molecular sequencing of this specimen was attempted but was unsuccessful (Bennelongia 2024), so identification was based on morphology only.

Trigoniulidae `BDI079`

A single specimen of Trigoniulidae `BDI079` was collected as bycatch during stygofauna net hauling from site YE2033R (Figure 8). Due to the nature of the collection method, determining a collection depth is challenging although at the time of sampling the depth to water at YE2033R was 36.52 m bgl. This individual was sequenced in an attempt to find a genetic match with individuals held at Bennelongia and in the public domain. Molecular sequencing was successful; however no match was identified and, as a result, this individual retains its species code.

3. CHARACTERISTICS OF THE PROJECT AREA

3.1. IBRA Region

The Project Area falls within the Hamersley subregion of the Pilbara bioregion, according to the recognised bioregionalisation of Australia (Figure 9; DCCEEW 2021). The Hamersley subregion is characterised as mountainous, comprising Proterozoic sedimentary ranges and plateaus, with gorges of basalt, shale, and dolerite.

3.2. Climate

The climate in the Central Pilbara is semi-arid to arid with a hot summer from October-April and a mild winter from May-September (Bureau of Meteorology 2023). Mean monthly maxima and minima are highest in January (39.0°C and 25.3°C respectively) and lowest in July (22.3°C and 8.1°C respectively). Monthly rainfall peaks in February (80.1 mm) and is lowest in October (3.9 mm). Evaporation (3000 mm/yr) greatly exceeds rainfall (300 mm/yr), with groundwater recharge mostly associated with cyclonic rainfall (Johnson and Wright 2001).

3.3. Topography

Relatively steep ranges lie north and south of the Project Area, running approximately east-west with complex topology (ranging from 700-1000 mAHD). Terrain is relatively flat in the Project Area itself, with elevation ranging from 550 mAHD in the southeast to 650 mAHD in the northwest. Most of the Project Area falls between 550-600 mAHD.

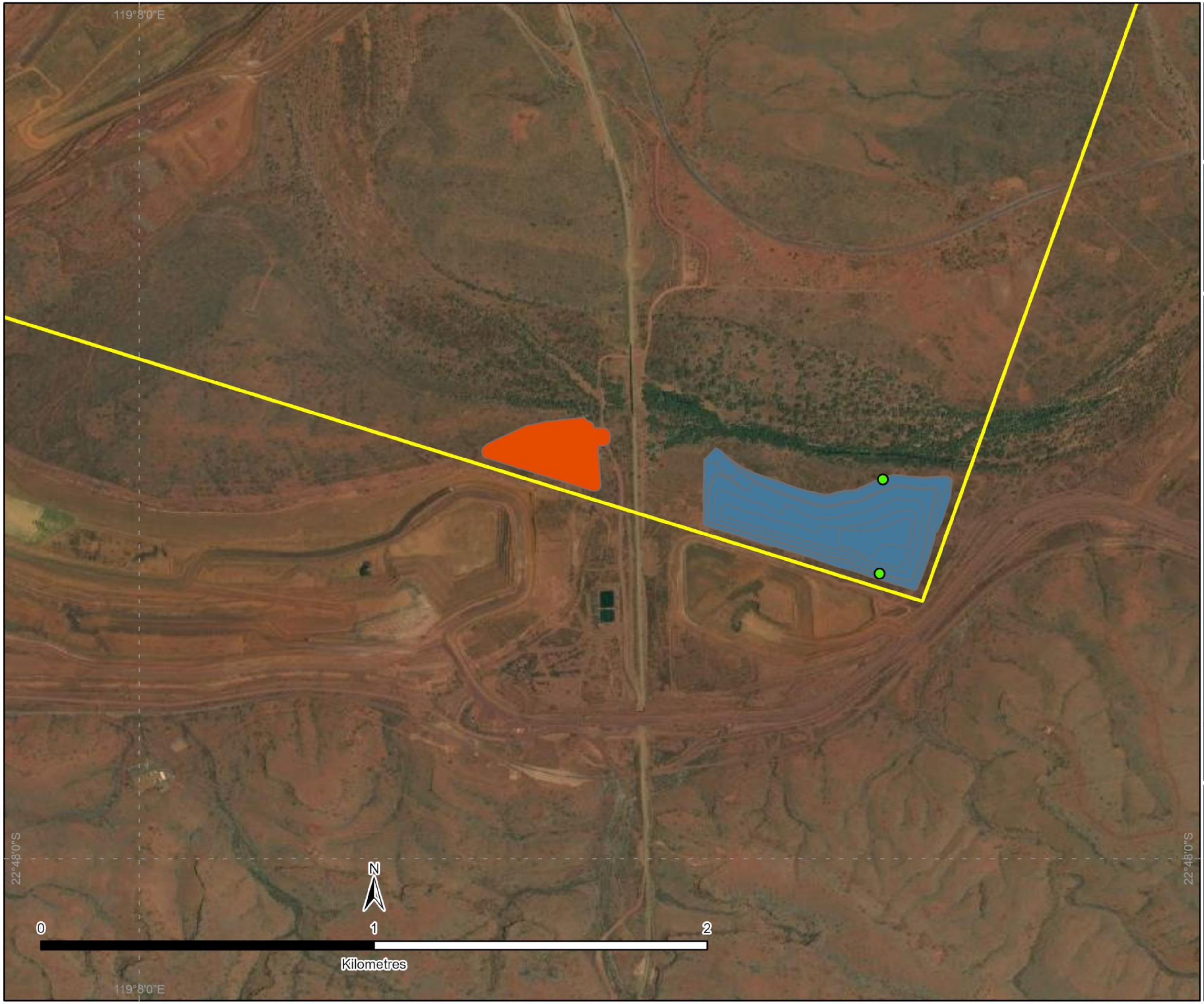

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Figure 6. Known collection locations of *Cryptops* `BSCOL091` prior to the 2024 survey

Legend

- Cryptops `BSCOL091`
- Yandi Tenement Boundary
- E8 Eastern Pit
- E8 Western Pit
- Project Location (inset)
- Towns (inset)

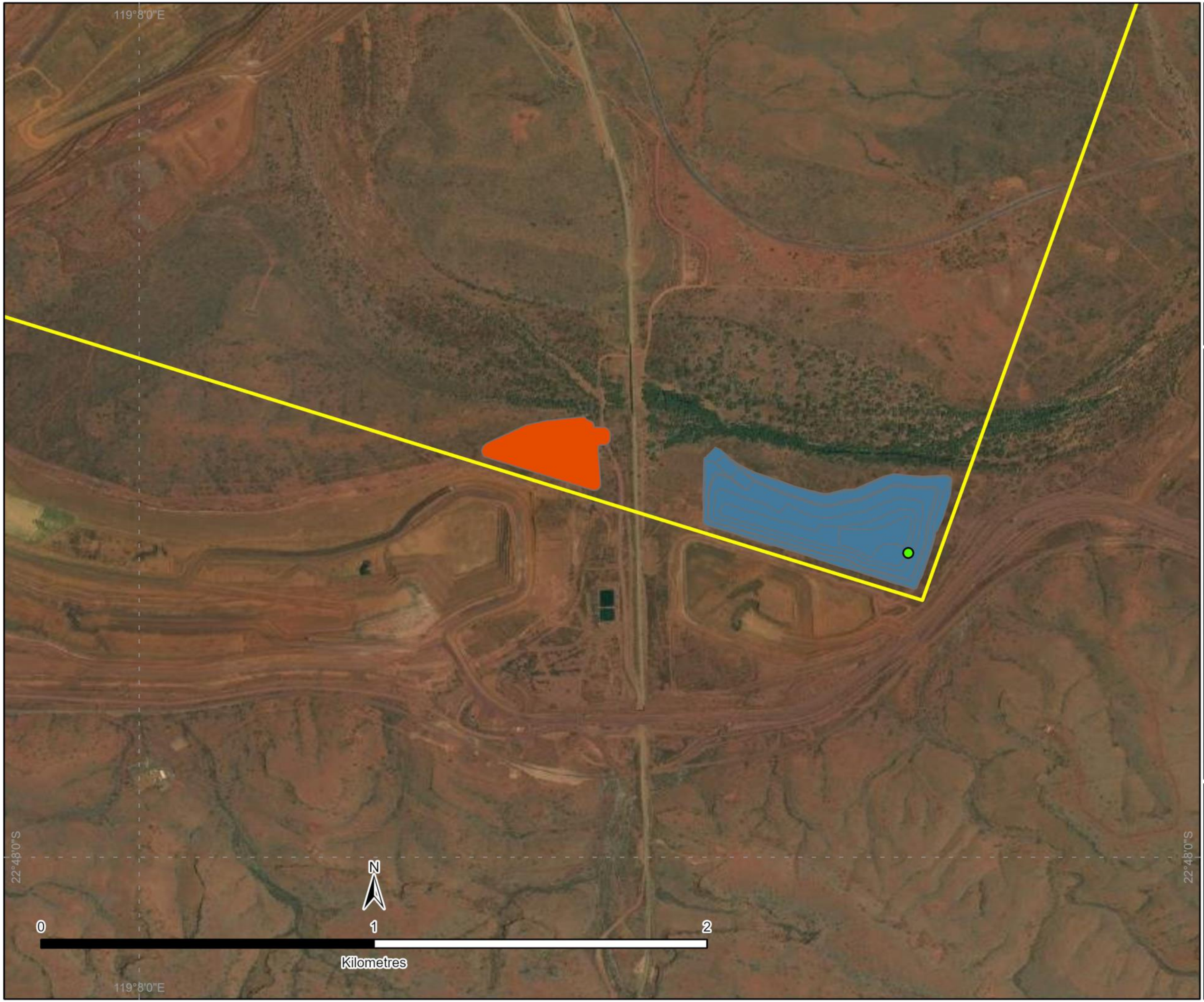

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Figure 7. Known collection locations of Haplodesmidae `BDIL080` prior to the 2024 survey

Legend

- Haplodesmidae `BDI080`
- Yandi Tenement Boundary
- E8 Eastern Pit
- E8 Western Pit
- Project Location (inset)
- Towns (inset)

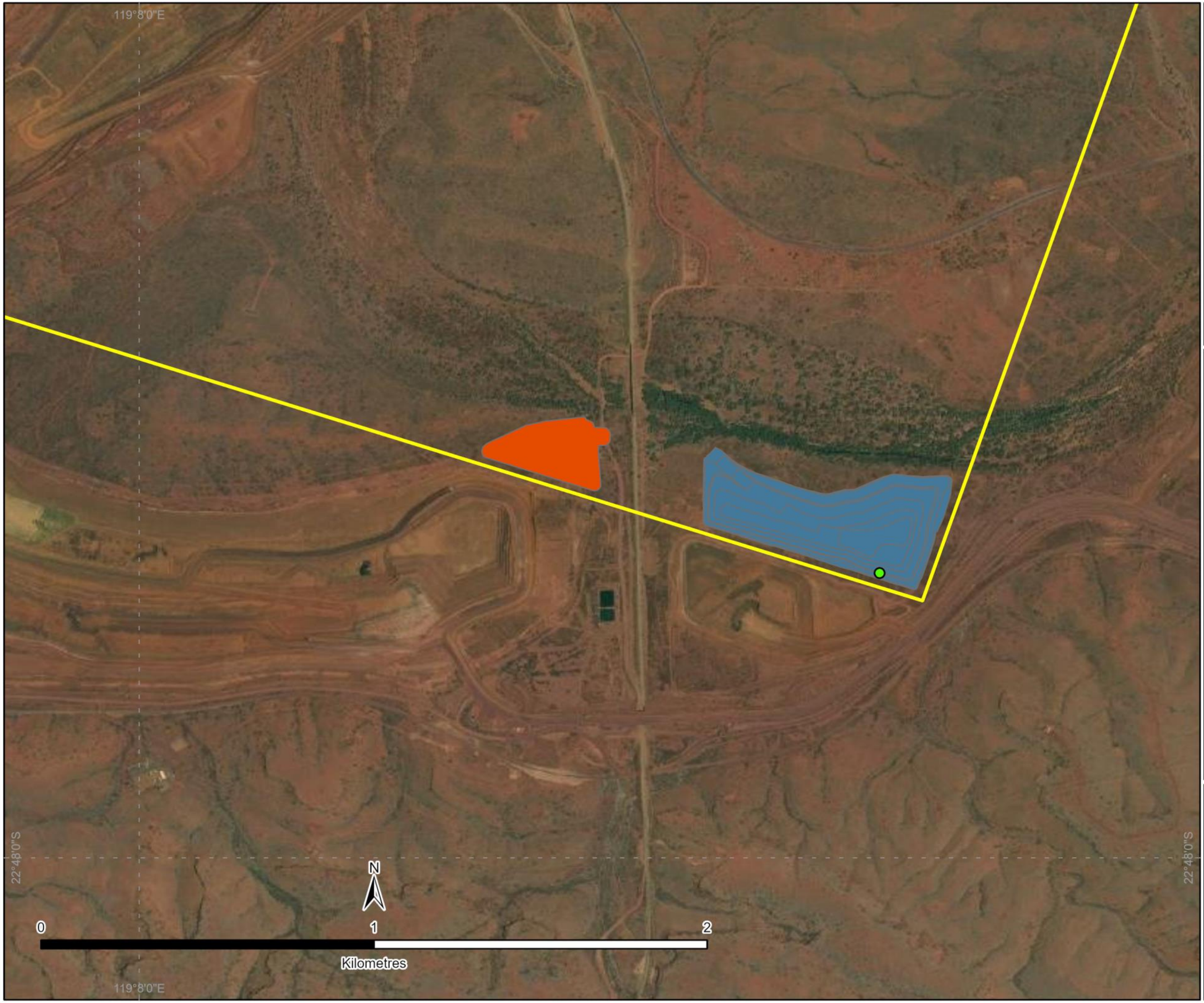

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Figure 8. Known collection locations of Trigoniulidae `BDIL079` prior to the 2024 survey

Legend

- Trigoniulidae `BDI079`
- Yandi Tenement Boundary
- E8 Eastern Pit
- E8 Western Pit
- Project Location (inset)
- Towns (inset)

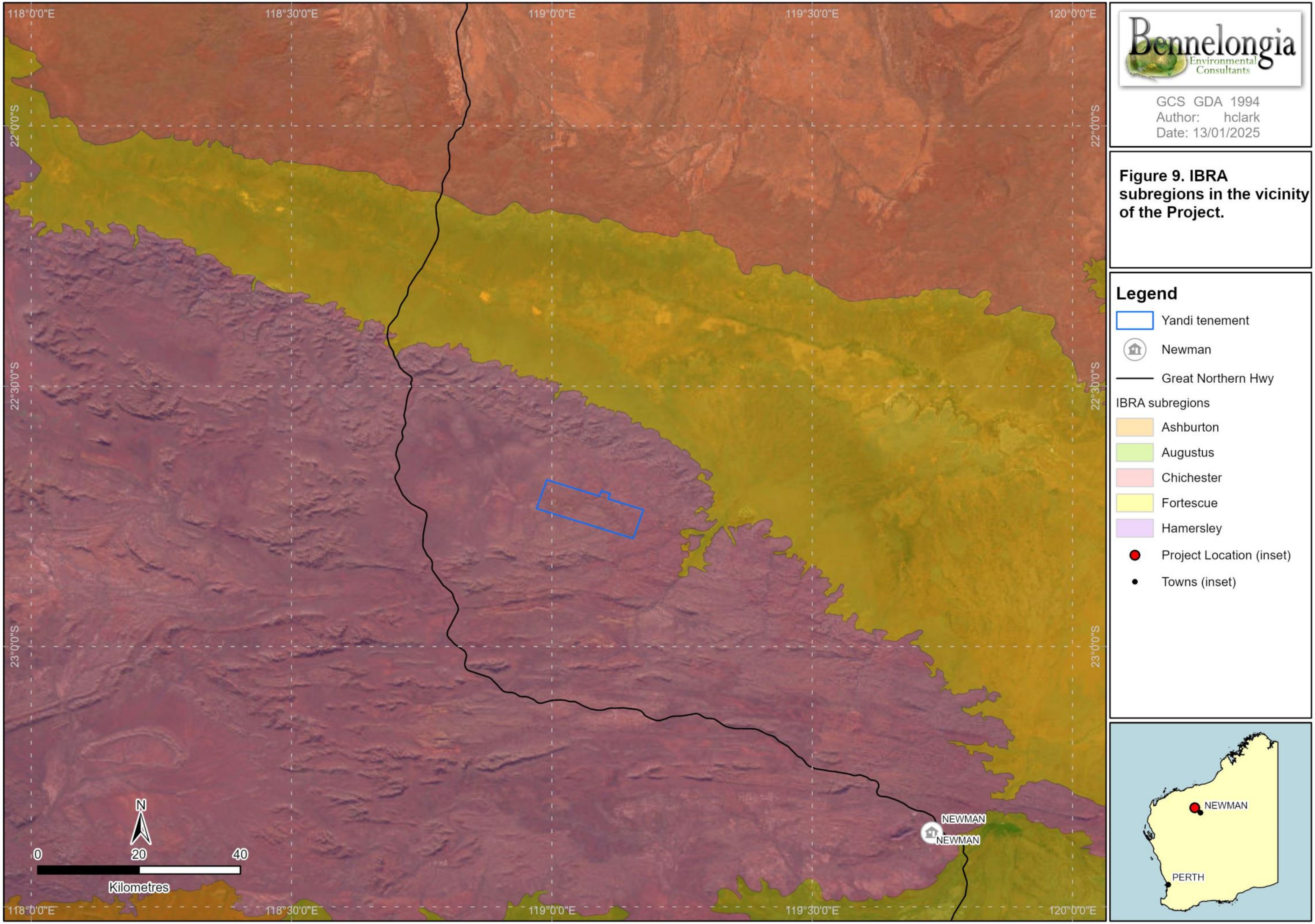

Figure 9. IBRA subregions in the vicinity of the Project.

3.4. Geology

The Project Area lies entirely within the upper Hamersley Group (Figure 10), a metamorphic formation dominated by banded iron formation (BIF), with chert, mudstone, siltstone, rhyolite, and numerous dolerite sills also present (Johnson and Wright 2001). Surface geology comprises primarily exposed rock, with alluvium and colluvium along drainage lines (Figure 11). The Yandicoogina Palaeovalley overlaps with several parts of the Project Area (Figure 11) and connects to the north-east with the much larger Robe Palaeovalley.

3.5. Surface Hydrology

Surface water at the Project Area drains to Marillana Creek (Golder 2015), which empties into Weeli Wolli Creek and then into the Fortescue Valley. Occurrence of surface water is dependent on rainfall, and flow in Marillana Creek is ephemeral (Golder 2015). The Yandicoogina Palaeovalley, which underlies much of the Project Area, is mostly remote from Marillana Creek (Golder 2015). While there is a broad correlation in the Pilbara between drainage systems and shallow groundwater (Mokany *et al.* 2017), the water resources of streambeds and regional aquifers are usually poorly connected. This is reflected in the minimal overlap of stygofauna species in the communities inhabiting streambeds and adjacent aquifers (Halse *et al.* 2002).

3.6. Hydrogeology

Three types of aquifer occur in the Central Pilbara: unconsolidated sedimentary aquifers, fractured-rock aquifers, and chemically deposited aquifers (Johnson and Wright 2001). Unconsolidated sedimentary aquifers of alluvium and/or colluvium in palaeovalleys are up to 200 m thick and comprise interbedded sequences of clay, sand, and gravel.

Chemically deposited aquifers of calcrete and pisolitic limonite occur within palaeodrainages; calcrete aquifers are more karstic than pisolitic limonite aquifers in CID, which nevertheless have well developed porosity. Water in chemically deposited aquifers is typically fresh to brackish (Johnson and Wright 2001). The pisolitic limonite aquifer in the Project Area is >80 km long, 50 m wide, and up to 90 m thick (Gardiner 2003; Johnson and Wright 2001). Throughflow in the aquifer is estimated at 2.5-3 ML/d, and salinity is fresh, ranging from 380-920 µS/cm (Gardiner 2003; Johnson and Wright 2001). Depth to groundwater in the Project Area ranges from 4-53 m, with a mean of 33.1 m.

4. METHODS

A single round of survey was conducted between March 21st and March 28th 2024, with trap collection occurring between May 27th and 28th 2024. Sampling was conducted in accordance with the guidelines provided by the EPA (2016a, 2016b, 2021) and under animal collection licence number BA27000108-6 issued to Mike Scanlon. A total of 39 stygofauna (Table 1, Figure 12) samples and 27 troglofauna samples (Table 1, Figure 13) were collected during the 2024 targeted subterranean fauna survey. Survey sites were selected based on the collection locations of target species and in collaboration with BHP WAIO. Details of holes sampled are provided in Appendix 1.

Table 1: Sample effort for the targeted subterranean fauna survey at Yandi in 2024.

<table>
<tr><th>Sample Type</th><th>March</th><th>May</th><th>Total</th></tr>
<tr><td>Net (stygofauna)</td><td>39</td><td></td><td>39</td></tr>
<tr><td>Scrape (troglofauna)</td><td>27</td><td></td><td rowspan="2">27</td></tr>
<tr><td>Double Trap (troglofauna)</td><td></td><td>27</td></tr>
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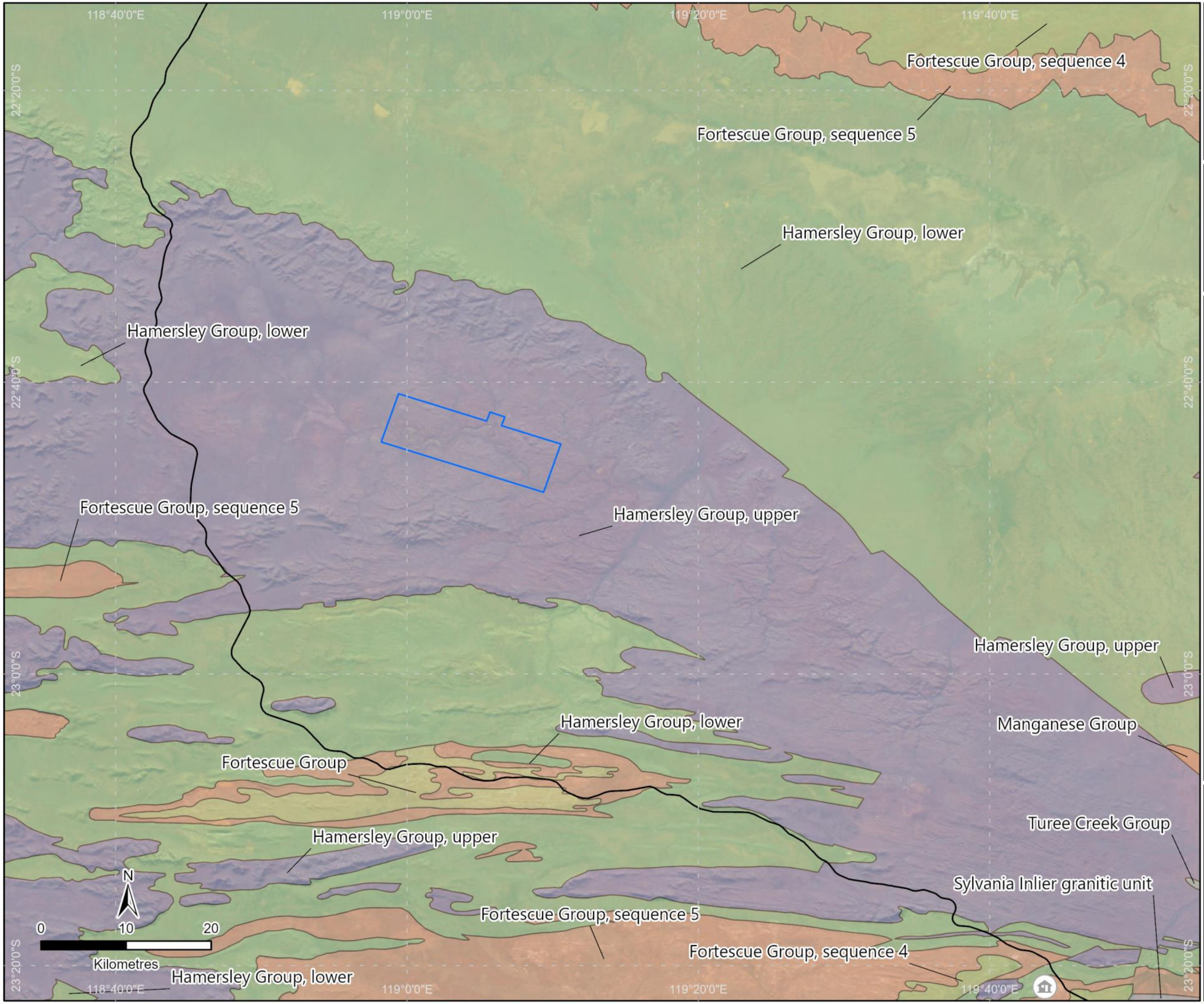
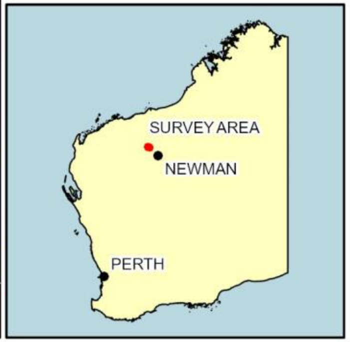
Date: 13/01/2025

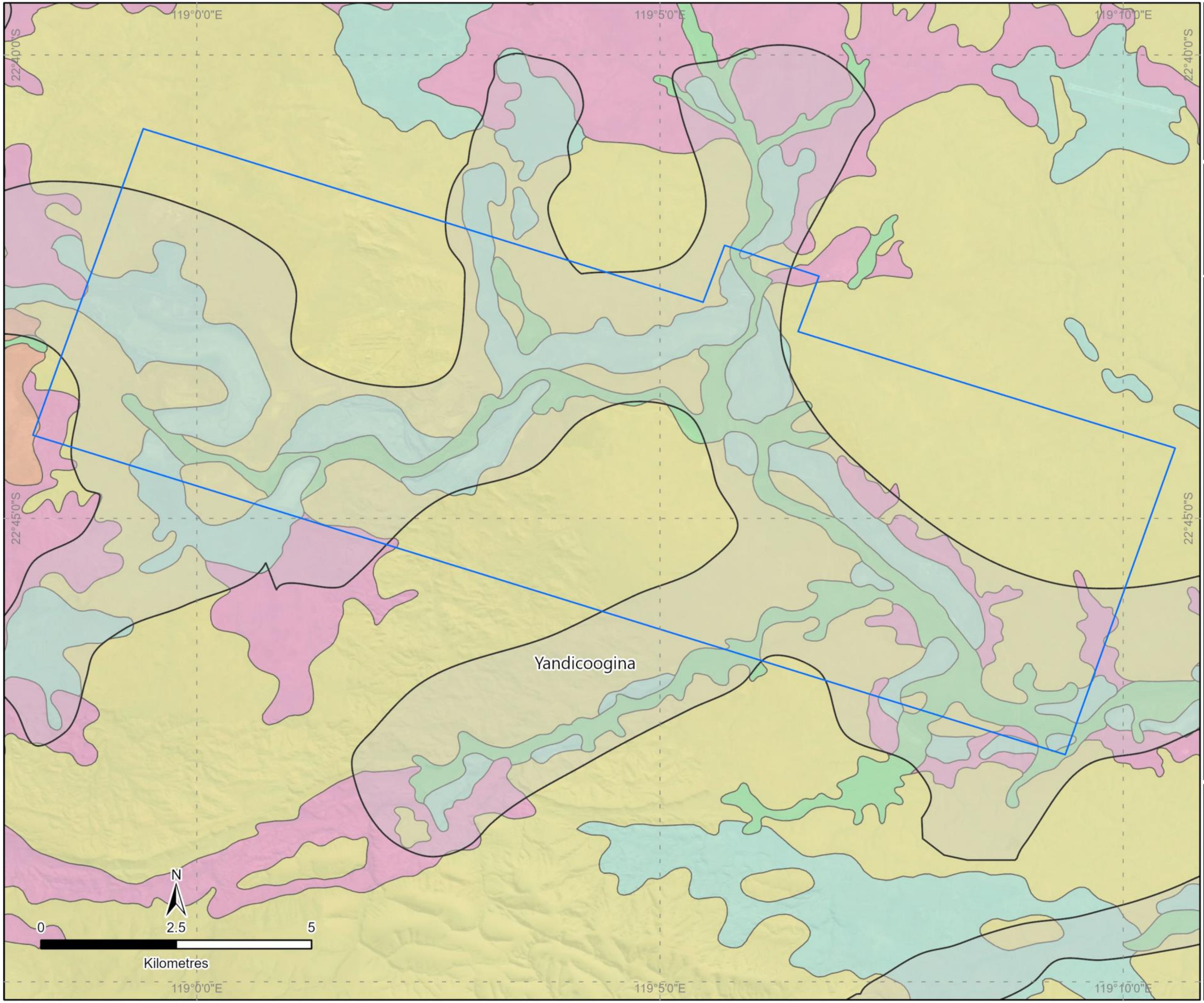
Figure 10. Bedrock geology around the Project.



Legend

- Yandi tenement
- Great Northern Hwy
- Newman
- Project Location (inset)
- Towns (inset)





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Date: 13/01/2025

Figure 11. Detailed overview of surface geology around the Project

Legend

- Yandi tenement
- Palaeovalleys

Surface geology

- Alluvium
- Calcrete
- Colluvium
- Exposed
- Residual
- Project Location (inset)
- Towns (inset)

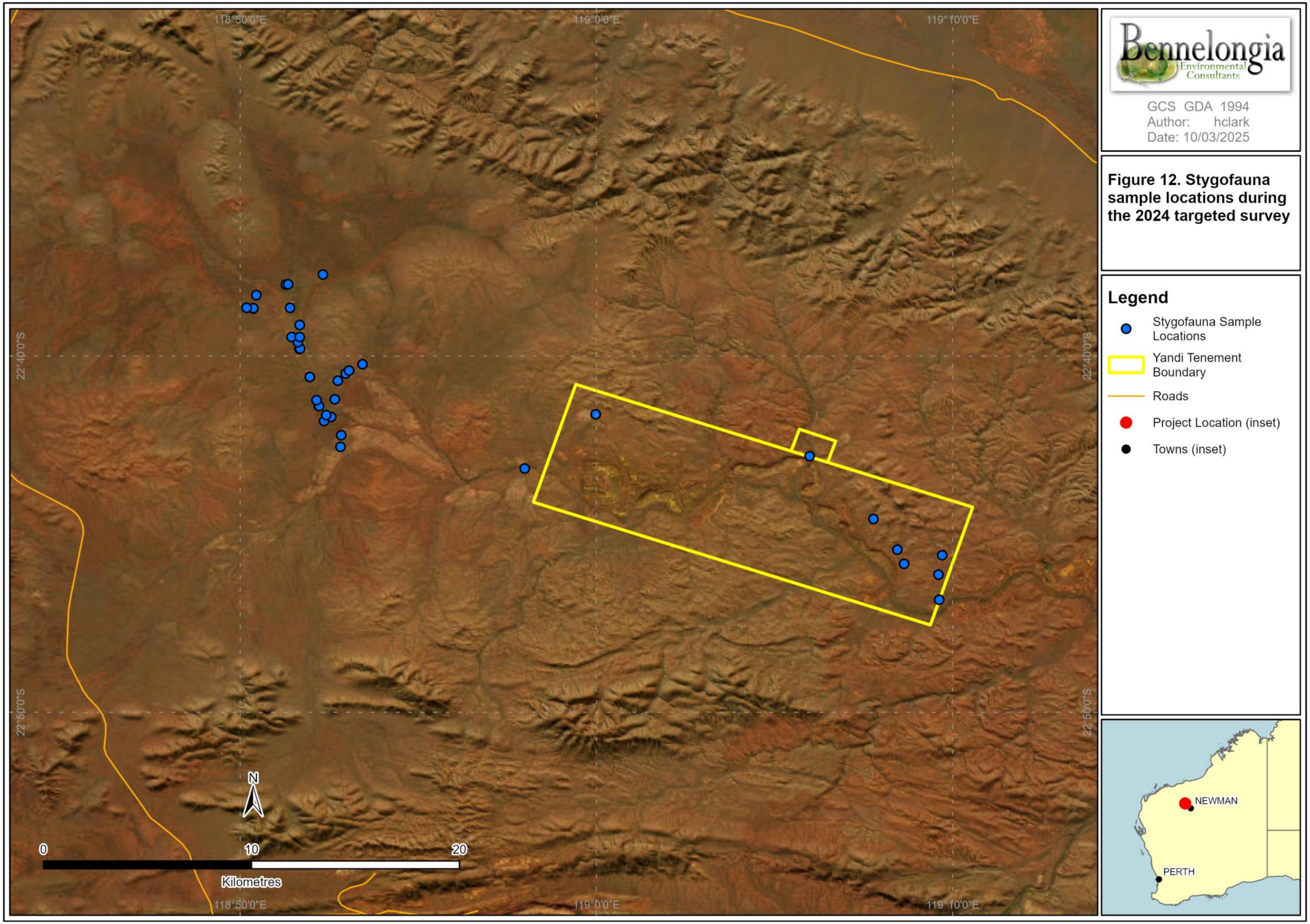


Figure 12. Stygofauna sample locations during the 2024 targeted survey

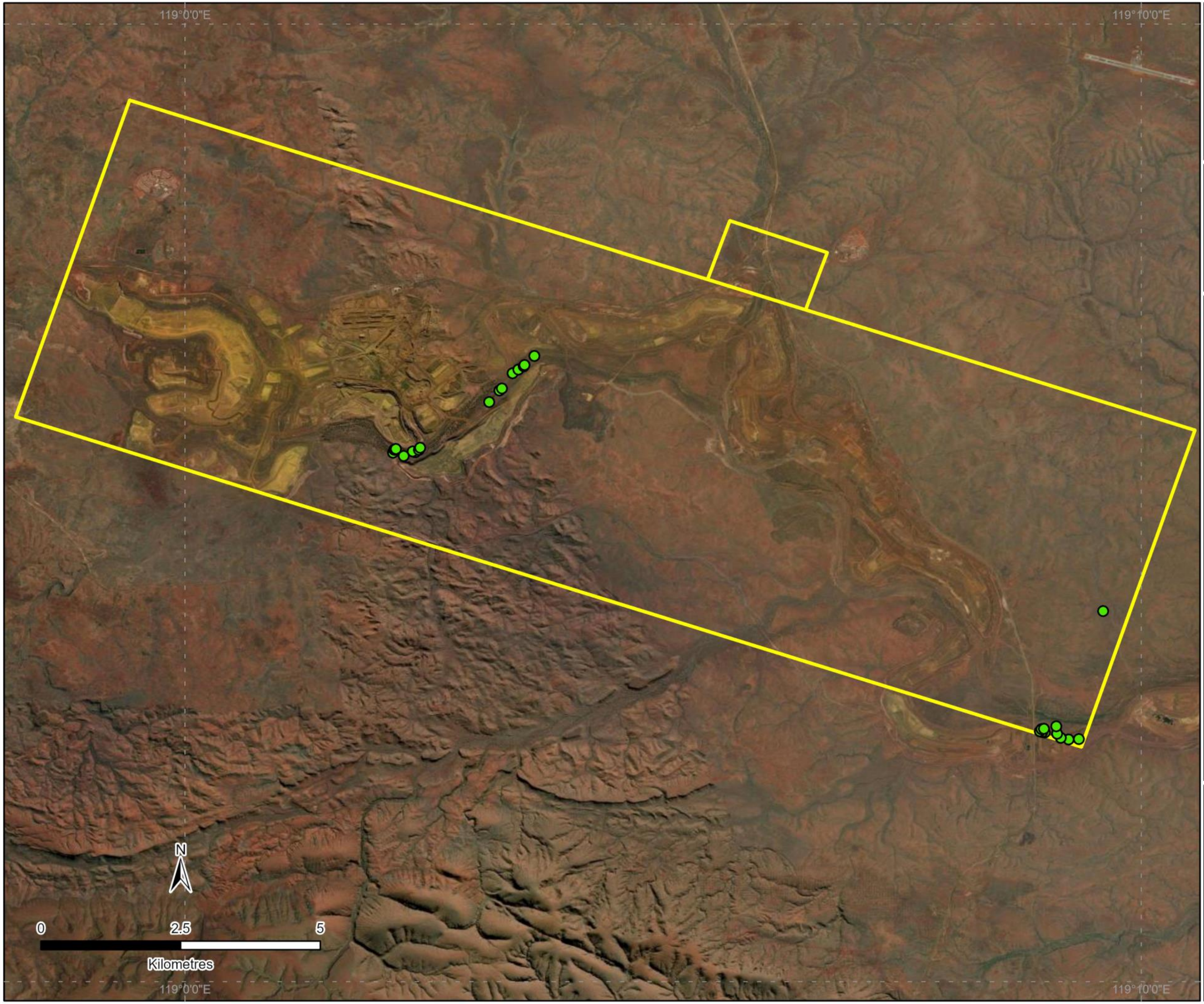


Figure 13. Troglofauna sample locations during the 2024 targeted survey

4.1. Stygofauna Sampling

Each stygofauna sample comprised six hauls using a weighted plankton net, three using 50 µm mesh and three using 150 µm mesh. During each haul, the net was lowered to the bottom of the hole and oscillated vertically to agitate the 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 4°C. Nets were washed between holes to prevent site-to-site contamination.

In situ water quality parameters (temperature, electrical conductivity, and pH) were measured in each bore using a WP 81 field meter. Standing water level and total depth of hole were also measured using a Solinst water level meter. Contents of the net hauls were returned to the laboratory in Perth for processing.

4.2. Troglofauna Sampling

Troglofauna sampling typically used two complementary techniques: scraping and trapping (Halse and Pearson 2014). In this case, one scrape and two traps were collected from each hole. When calculating troglofauna sampling effort, scraping and trapping each represent 0.5 of a sample irrespective of the number of traps used. The reason for treating scraping and trapping as sub-samples is that troglofauna yields are low and diverse methods are required to collect a moderately comprehensive sample (Halse and Pearson 2014).

Scraping uses a weighted net with an upper diameter approximately 60% of the drill hole diameter to scrape troglofauna from the wall of the drill hole. The net of 150 µm mesh is lowered to the bottom of the hole or to the water table and then scraped back to the surface at least four times. In each of these scrapes, where possible, a different section of the wall of the hole is targeted (e.g., north, south, east and west) to maximise the number of animals collected. After each haul, net contents are transferred to a 125 ml vial with 100% ethanol to preserve the sample and refrigerated at a 4°C. Samples are returned to the laboratory in Perth for processing.

After scraping has been completed at a drill hole, two traps are set at different depths, one deep (near the bottom of the hole) and one midway between the bottom trap and surface. Trapping uses cylindrical PVC tubes (270 mm x 70 mm) with holes on the sides to allow troglofauna to enter traps baited with microwaved leaf litter. Traps were lowered on nylon cord into the hole. Traps are left in place for approximately eight weeks for troglofauna to colonise them. During this period, the holes are sealed off at the surface to minimise entry of surface animals into the traps. After retrieving the traps, the bait and the animals present were transferred to a zip-lock bag and transported to the laboratory in Perth for processing.

4.3. Laboratory Processing

In the laboratory, samples were elutriated to separate out heavy sediment particles and sieved into size fractions using 250, 90, and 53 µm screens. Samples were sorted under a dissecting microscope, targeting specimens that could be members of target species. Where necessary, animals were dissected and examined under a differential interference contrast compound microscope for comparison with target species. Specimens were initially identified to species level, where possible, through morphology and supported with genetic analysis if necessary. Morphological identifications used available keys, and the characters typically viewed as important in the relevant taxonomic group. Most subterranean species in Western Australia remain undescribed and undescribed species were assigned unique 'B codes' by Bennelongia staff (e.g. *Cryptops* `BSCOL091`). When specimens were badly damaged, juvenile, or of the nondiagnostic sex and could not be identified to species they were classified to the lowest level possible. These specimens carry the miscellaneous designation 'sp.'

4.4. Molecular Methods

Three specimens from the survey were sequenced to further taxonomic investigation. For all samples, DNA was extracted using a Qiagen DNeasy Blood & Tissue kit (Qiagen 2006). For smaller animals, such as copepods, whole animals were used for DNA extraction. For larger animals, such as diplurans, legs and or body parts (e.g. sections of the abdomen) were used for DNA extraction. Elute volumes varied from 50 µL to 100 µL depending on the age, condition, and quantity of material available.

Polymerase chain reaction was done on the extracted DNA of the three survey specimens and, in addition, on the DNA of a fourth specimen (*Hanseniella* sp. indet.) that was extracted as part of a previous project (Bennelongia 2024). Primer combinations used for PCR amplifications were LCO1490:HCO2198 (Folmer *et al.* 1994), jgLCO1490:jgHCO2198 (Geller *et al.* 2013) and III_B_F: jgHCO2198 (Shokralla *et al.* 2015), targeting the COI region of the mitochondrial genome. PCR products were sequenced using dual-direction Sanger sequencing carried out by the Australian Genome Research Facility (AGRF). The returned sequences were edited and aligned manually in Geneious version 2022.2.2 (https://www.geneious.com).

Genetic analysis was conducted on the four sequences generated here. Additionally, a fifth sequence, generated in 2023 (Bennelongia 2024), was reanalysed as a part of this process. Pairwise genetic distances to related sequences in the Bennelongia database were calculated as uncorrected p-distances (total percentage of nucleotide differences between sequences). To visualise genetic distances and phylogenetic relationships between taxa, distance based phylogenetic trees using the Tamura-Nei genetic distance were generated, also in Geneious v2022.2.2. Sequences on GenBank and in grey literature were included in the phylogenetic analysis to provide a framework for assessing intra- and interspecific variation.

4.5. Personnel and Survey Limitations

Personnel involved in all stages of the survey are listed in Table 2. No limitations to this survey were recorded.

5. RESULTS

5.1. Water Chemistry

At each of the 39 sites where stygofauna sampling occurred, water quality was recorded including the standing water level (SWL: m), temperature (°C), electrical conductivity (EC: µS/cm), pH, dissolved oxygen (DO: mg/L) and oxidation-reduction potential (ORP: mV). For a complete list of water quality recording at each of the sites sampled for stygofauna, please refer to Appendix 1.

Standing Water Levels

The depth to water can provide information about the stygofauna community and the geology from which it was collected. For example, stygofauna can only occur in geologies with appropriate vugs and voids that hold suitable water and yields of stygofauna are often lower when depth to water reaches >30 m (Halse *et al.* 2014). The depth to water during the 2024 survey ranged from 4.69 m bgl to 56.74 m bgl with the deeper SWL values being recorded at the eastern end of the Project Area (Appendix 1).

Temperature

Groundwater temperatures in underground environments tend to remain much more stable than surface temperatures (Moldovan *et al.* 2018), providing more consistent conditions for subterranean animals to live and evolve. Of course, factors such as depth to water may influence these values but during the 2024 survey, groundwater temperatures were recorded between 22.5 and 28°C (Appendix 1).

Table 2: Personnel involved in the survey and the generation of this report.

Role	Name	Qualifications/Experience
Fieldwork	Jim Cocking (lead; all)	B.Sc., Grad. Dip. Sc. Over 25 years of experience conducting field survey of subterranean and other invertebrate animals.
	Jaxon Haines (stygo net haul, trog scrape and trap set)	B.Sc. Three years experience.
	Ethan Lamont (trog trap collection)	B.Sc. One years experience.
Sample sorting	Ella Carstens	B.Sc.
	Ashley Browse	B.Sc., M.Sc.
	Will Baxter	B.Sc.
	Jaxon Haines	B.Sc.
	Oscar Garswood	B.Sc
	Melita Pennifold	BSc. (Hons). Over 25 years of research and taxonomic identification experience.
Species identification	Jane McRae	Over 30 years of identification experience at the Australian Museum, British Museum, DBCA, and Bennelongia. Author of 14 taxonomic papers and 9 papers on species inventory/ecology.
	Ella Carstens	B.Sc.
	Ana Vasconcelos	B.Sc., M.Sc., Ph.D
Molecular identification	Heather McLetchie (extraction of molecular material)	B.Sc. (Hons). Over 15 years of experience extracting and analysis molecular information from invertebrate animals.
	Veera Haslam (extraction of molecular material and analysis of sequences)	B.Sc. (Hons). Ph.D.
	Daniel White (analysis of sequences)	B.Sc. (Hons), M.Sc., Ph.D.
Mapping	Huon Clark	B.Sc. (Hons), Ph.D.
Reporting	Huon Clark (drafting)	B.Sc. (Hons), Ph.D.
	Vitor Marques	B.Sc.

Electrical Conductivity

Electrical Conductivity is the measurement of the water's ability to conduct electrical charge. Naturally occurring substances (i.e. salts), have the ability to conduct electrical current and EC values essential reflect water salinity. EC values recorded during the survey ranged from 359.3 to 2193 µS/cm (Appendix 1), all within the natural variation of Pilbara groundwater.

pH

pH is the measurement of how acidic or alkaline a water body is. Acidic waters can increase dissolved concentrations of heavy metals. The pH range recorded during the survey was between 5.76 and 8.1 (Appendix 1), which is within the habitable range for stygofauna.

Dissolved Oxygen

Dissolved oxygen is a measurement of oxygen available to aquatic life for respiration in a waterbody. If too low, aquatic animals will not survive. Despite this, it is common for groundwaters to have low concentrations of DO (Halse *et al.* 2014; Malard and Hervant 1999). Malard and Hervant (1999) define three levels of DO concentrations in groundwater, suboxic (<0.3 mg/L), dysoxic (0.3-3.0 mg/L) and oxic (>3.0 mg/L: but see also Tyson and Pearson 1991). Additionally, Malard and Hervant (1999) discuss behavioural, respiratory responses and adaptations of groundwater animals to low oxygen concentrations (see Malard and Hervant 1999 and references within).

The DO values recorded during the survey ranged from 1.49 mg/L to 6.94 mg/L (Appendix 1). Only eight sites recorded values below 3.0 mg/L placing them in the dysoxic category defined by Malard and Hervant (1999), the rest were considered to be oxic, as they had DO values greater than 3.0 mg/L.

Oxidation-Reduction Potential

Oxidation-reduction potential (ORP) is a measure of the oxidising or reducing potential of water and is used as an indication of the waterbodies ability to breakdown contaminants and support biological processes (Račys *et al.* 2010; YSI Inc. 2025). It is often difficult to interpret ORF without information about other physico-chemical parameters and the history of the waterbody being measured. High ORP values tend to be associated with healthy, oxygenated ecosystems (YSI Inc. 2025) and groundwater ORP values normally range between -400 mV and 800 mV (Račys *et al.* 2010). ORP readings from the survey ranged from -190.2 mV to 115.7 mV (Appendix 1).

5.2. Sequencing

The three specimens selected for genetic analysis from the 2024 targeted survey all returned sequences and were successfully analysed (Table 3). These included the original specimen of Haplodesmidae `BDI080` collected in March 2023, as well as a new specimen of the same species and one of Trigoniulidae `BDI079`, both collected in 2024. The original specimen of Haplodesmidae `BDI080` was sequenced for the original report (Bennelongia 2024), however failed to return a successful sequence and as a result was re-run here.

Table 3: Genetic analysis conducted on specimens from Yandi.

Original ID	Date Collected	Reason For Sequenced	Result	Final ID
Haplodesmidae `BDI080`	1/05/2023	To confirm ID and compare to widespread species	Close match to widespread species held at WAM	Haplodesmidae `Helix-DIHAP001`
Haplodesmidae `BDI080`	27/05/2024	To confirm ID and compare to widespread species	Close match to widespread species held at WAM	Haplodesmidae `Helix-DIHAP001`
Trigoniulidae `BDI079`	27/05/2024	To compare to original collection of Trigoniulidae `BDI079`	Matched original specimen of Trigoniulidae `BDI079`	Trigoniulidae `BDI079`

The two specimens originally referred to as Haplodesmidae `BDI080` matched each other but also matched a number of sequences of the widespread species Haplodesmidae `Helix-DIHAP001` (Table 3). As a result, Haplodesmidae `BDI080` has now been updated to Haplodesmidae `Helix-DIHAP001` and is considered to be widespread throughout the Pilbara. It should be noted that these sequences also matched to, and are therefore considered to be, a synonym of an individual known as Haplodesmidae sp. DNA02. Genetic analysis has also confirmed the recollection of Trigoniulidae `BDI079` in 2024 and has extended the known linear distribution of this species to 110 m.

The additional two sequences that failed in the 2023 analysis (Bennelongia 2024) but were re-run here returned mixed results. *Hanseniella* sp. indet., collected from bore YE2061R failed once again, and this species remains as a higher order identification from the genus *Hanseniella* (Table 4). The reanalysis of the *Symphylella* sp. indet. sequence was successful but did not match any available sequences and could not be compared to *Hanseniella* sp. indet. because it failed. As a result, this specimen, has been given a new species code, *Symphylella* `BSYM139`.

Table 4: Past sequences re-analysed.

Original ID	Date Collected	Reason For Re-analysis	Result	Final ID
Hanseniella sp. indet.	7/03/2023	To determine a species identification	Fail	*Hanseniella* sp. indet.
Symphylella sp. indet.	8/03/2023	To compare to *Hanseniella* sp.	No close matches. New species code	*Symphylella* \`BSYM139\`

5.3. Stygofauna

The 2024 targeted subterranean fauna survey collected a total of 733 specimens of stygofauna belonging to at least 24 species (Table 5). Groups collected included amphipods (five species), annelid worms (four species), ostracods (four species), cyclopoid copepods (three species), harpacticoid copepods (three species), syncarids (two species), isopods (two species), and nematode worms (one species: Not assessed as a part of the EIA process).

5.3.1. Target Stygofauna

Of the two target stygofauna species, *Elaphoidella* \`BHA342\`, was not recollected meaning this species remains known from 19 individuals in two bores 600 m apart (Figure 2). The second target stygofauna species, *Parastenocaris* \`BHA343\`, was collected during this survey, with nine further specimens being collected from bore HMJ0027 approximately 33 km from the original collection location (Table 5 and Figure 14). *Parastenocaris* \`BHA343\` is now known from 10 individuals with a known linear range of 33 km.

5.3.2. Other Stygofauna of Interest

Two new species of ostracod were collected during the targeted subterranean fauna survey, these were *Meridiescandona* \`BOS1739\` and *Notacandona* \`BOS1900\`. *Meridiescandona* \`BOS1739\` was represented by five specimens from two bores during the 2024 survey (Table 5 and Figure 15). Four specimens were collected at site HYX0016 while a single specimen was collected at site HMJ0048, giving a total known linear distribution of 35 km (Table 5 and Figure 15).

Fourteen specimens of *Notacandona* \`BOS1900\` were collected in 2024 and represent the first known occurrences of this species. Collected at six different locations, all located to the north west of the Yandi Operations (Table 5 and Figure 15), this species has a known linear range of 7 km.

Table 5: Stygofauna specimens and species collected during the 2024 targeted subterranean fauna survey.
NB: Orange indicates targeted species

Higher Order Identification	Lowest Identification	Number of Specimens	Collected Bore	Distribution	Animal Comment
Nematoda	Nematoda spp.	3	HMJ0005, HMJ0001	Not assessed as part of the EIA process	
Annelida					
Aphanoneura					
Aeolosomatidae	*Aeolosoma* sp.	2	HMJ0048	Unknown	Poor taxonomic framework and likely locally widespread
Clitellata					
Enchytraeida					
Enchytraeidae	Enchytraeidae `2 bundle` s.l. (short sclero 4 per seg)	15	HMJ0048, YE2064RE and YWUNK01	Unknown	Enchytraeid worms are often locally widespread
	Enchytraeidae `3 bundle` s.l. (short sclero)	12	YW3763RD, YE2045R, YWUNK01 and YE2061R	Unknown	Enchytraeid worms are often locally widespread
Haplotaxida					
Phreodrilidae	Phreodrilidae sp. AP DVC s.l.	2	WW18	Unknown	Phreodrillid worms are often locally widespread
Ostracoda					
Podocopida					
Candonidae	*Deminutiocandona murrayi*	109	HMJ0022, HMJ0009, HMJ0008, HMJ0005, HMJ0020, HMJ0036, HMJ0001, HMJ0027, HMJ0026, HMJ0016 and HMJ0003	350 km	
	Meridiescandona `BOS1739`	5	HMJ0048 and HYX0016	35 km	New species
	Meridiescandona lucerna	121	HYX0017, HMJ0027, YM0121, HYX0009 and HMJ0026	220 km	
	Notacandona `BOS1900`	14	HMJ0003, HMJ0044, HMJ0004, HMJ0026, HMJ0016 and HMJ0022	7 km	New species

Higher Order Identification	Lowest Identification	Number of Specimens	Collected Bore	Distribution	Animal Comment
Maxillopoda					
Cyclopoida					
Cyclopidae	Cyclopidae sp.	1	YWUNK01	Unknown	Very juvenile. Most likely a member of any of the cyclopoid copepod species collected in the area
	Diacyclops `BCY059` (*humphreysi* s.l.)	88	YE2061R, YE2088R, HYX0017, HMJ0004, HMJ0009, HYX0016, HYX0009, HMJ0006, HMJ0005, WW18, HMJ0001, HMJ0026 and HMJ0007	48 km	
	Diacyclops cockingi	102	HMJ0003, HMJ0027, YM0121, HMJ0008, HMJ0002, HMJ0026, HMJ0047, HMJ0007, HMJ0016 and WW18	Widespread	
	Diacyclops sp.	3	HMJ0022 and HMJ0012	Unknown	Juveniles. Likely *D.* `BCY059` (*humphreysi* s.l.) or *D. cockingi*
	Microcyclops varicans	28	YW3909D, HMJ0048 and YC3601R	Widespread	
Harpacticoida					
Ameiridae	*Gordanitocrella trajani*	24	HMJ0009, HMJ0008, HMJ0049, HMJ0026, HMJ0016 and HMJ0027	50 km	
Parastenocarididae	*Parastenocaris* `BHA343`	9	HMJ0027	33 km	
	Parastenocaris jane s.l.	1	HMJ0027	Widespread	
Arthropoda					
Malacostraca					
Syncarida					
Bathynellidae	*Pilbaranella* `BSY372`	5	YC3601R	Single Site	

Higher Order Identification	Lowest Identification	Number of Specimens	Collected Bore	Distribution	Animal Comment
	Pilbaranella sp.	1	YWUNK01	Unknown	Cryptic species difficult to ID through morphology. *P.* `BSY372` collected 7km away within the same drainage system
Parabathynellidae	*Atopobathynella* sp. B07	41	YE2020R, YC3601R and YWUNK01	28 km	
Amphipoda					
Neoniphargidae	Neoniphargidae sp. B03	44	HMJ0003, HMJ0027, HMJ0002 and HMJ0009	3 km	
Paramelitidae	*Chydaekata* sp. MJ1-UM1	35	HMJ0048, HMJ0002, HMJ0005, HMJ0026, HMJ0016, MJ1138R and HMJ0001	28 km	
	Maarrka weeliwollii	7	HMJ0003, HMJ0009 and HMJ0027	92 km	
	Paramelitidae Genus 2 sp. B02	30	HMJ0044, HMJ0027, HMJ0008, WW18, HMJ0007, HMJ0014, HMJ0002, HMJ0001, HMJ0009, HMJ0005 and HMJ0016	80 km	
	Paramelitidae sp. B26 (Helix-AMP018)	26	HMJ0002	67 km	
Isopoda					
Tainisopidae	*Pygolabis* sp. B06 (=BIOTA yandi sp. 1)	4	HMJ0009, HMJ0026, HMJ0044 and HMJ0001	130 km	
	Pygolabis weeliwolli	1	HMJ0050	270 km	
Grand Total		**733**			

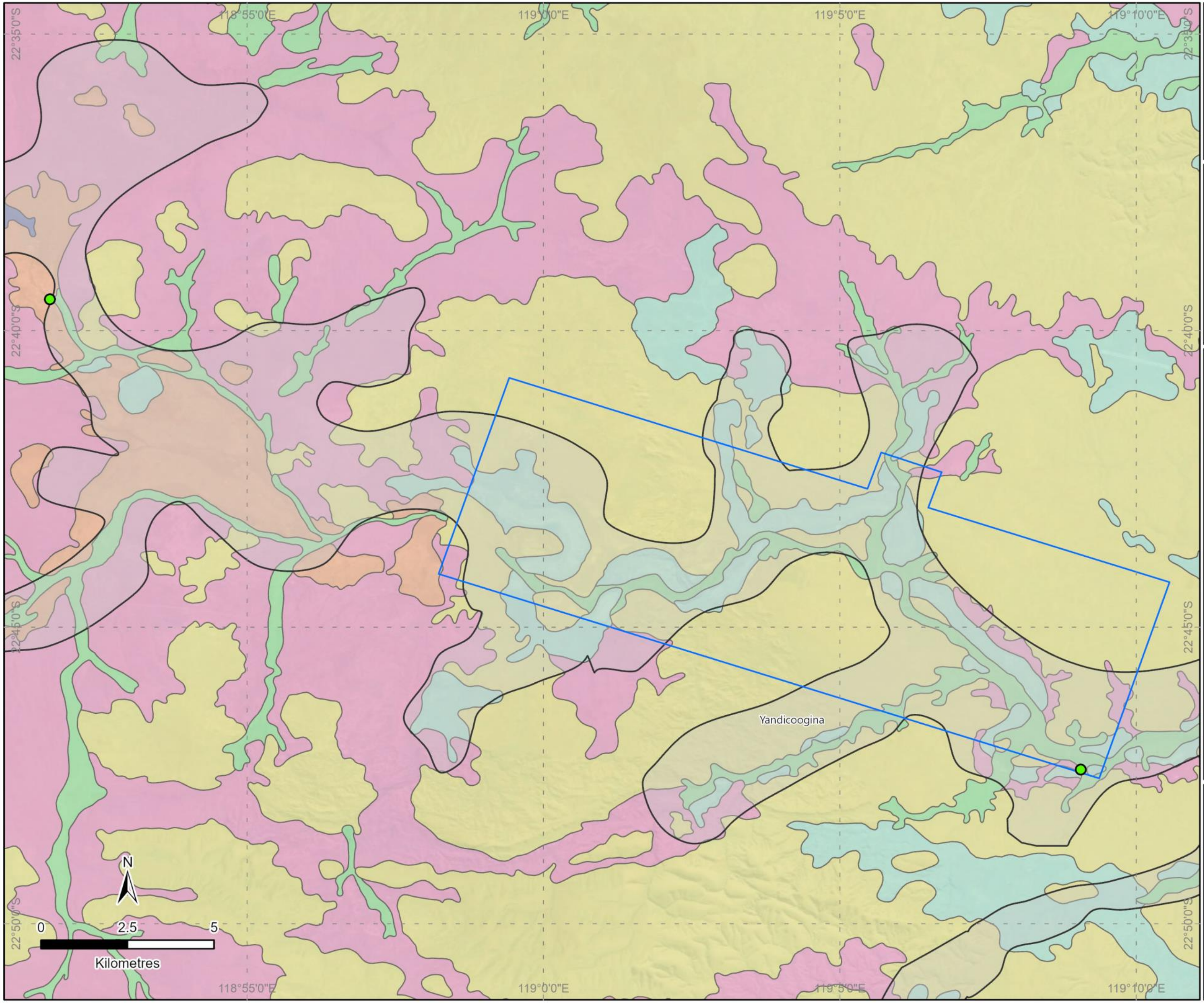
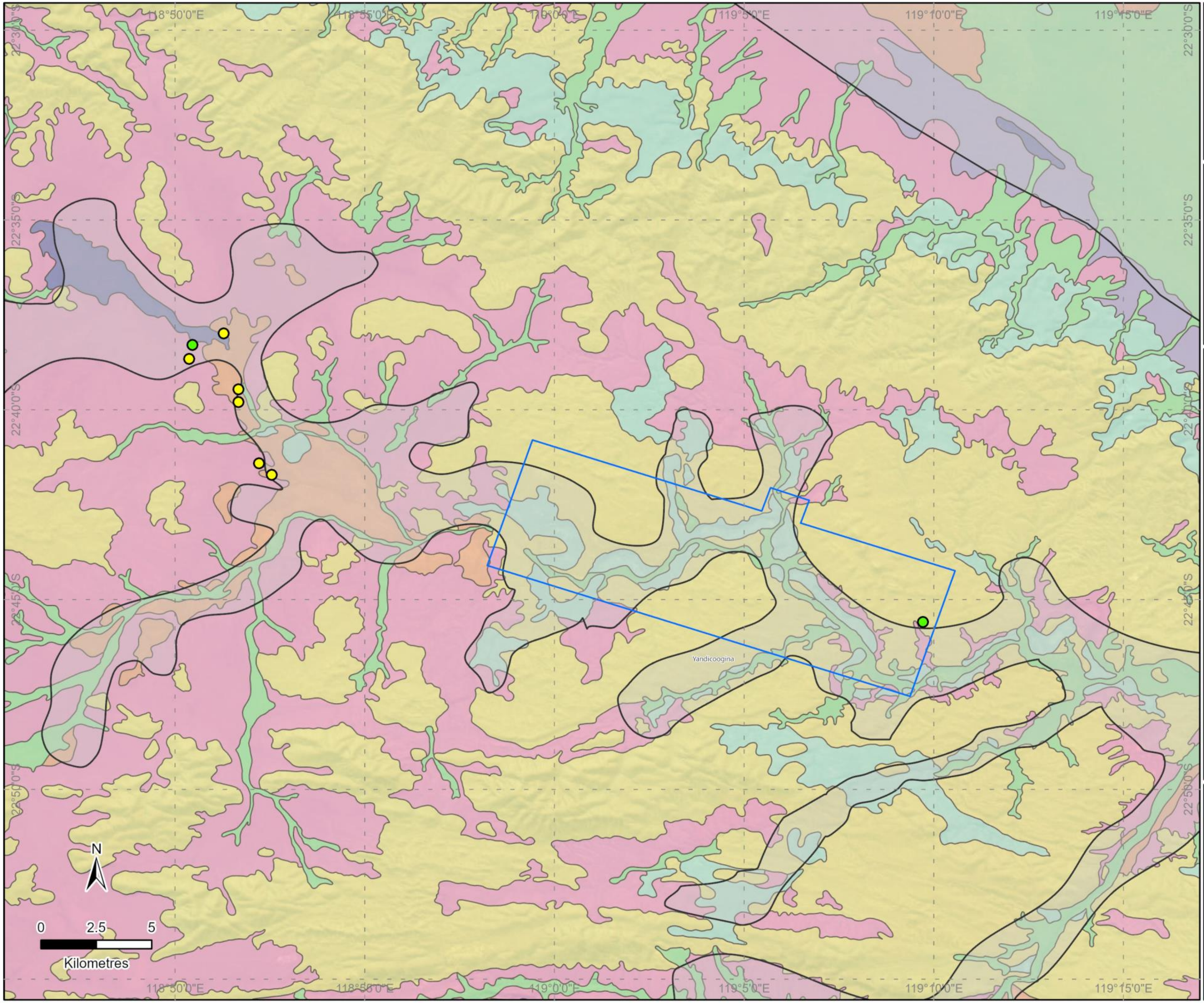


Figure 14. Updated distribution of *Parastenocaris* `BHA343` after the 2024 targeted survey



Bennelongia Environmental Consultants

GCS GDA 1994
Author: hclark
Date: 14/01/2025

Figure 15. Two new Ostracod species collected for the first time in 2024

Legend

New stygofauna species
- Meridiescandona `BOS1739`
- Notacandona `BOS1900`
- Yandi tenement
- Palaeovalleys

Surface geology
- Alluvium
- Calcrete
- Colluvium
- Exposed
- Lacustrine
- Residual
- Sandplain
- Project Location (inset)
- Towns (inset)

5.4. Troglofauna

A total of 334 specimens belonging to at least 16 species of troglofauna were collected during the 2024 targeted subterranean fauna survey (Table 6). These were beetles (four species), millipedes (three species), true bugs (two species), pseudoscorpions (one species), schizomids (one species), spiders (one species), diplurans (one species), silverfish (one species), cockroaches (one species), and flies (one species).

5.4.1. Target Troglofauna

Of the five target troglofauna species, three (*Hanseniella* sp. indet., *Hesperanillus* \`BCO247\` and *Cryptops* \`BSCOL091\`) were not recollected, resulting in them having the same known distributions as when originally reported (Bennelongia 2024). The millipede Haplodesmidae sp. DNA02 (formally Haplodesmidae 'BDI080') was recollected from the original collection location (bore YE2020R) and was successfully sequenced, which resulted in its known distribution being upgraded to widespread throughout the Pilbara (Table 6). The fifth species, the millipede *Trigoniulidae* \`BDI079\` was collected from bore YE2020R (Table 6) located 110 m from the original collection location. This was confirmed through both morphology and genetic sequencing, resulting in this species now being known from two individuals with a known linear range of 110 m (Figure 16).

5.4.2. Other Troglofauna of Interest

The 2024 targeted survey collected a further two new species of troglofauna, the pseudoscorpion *Lagynochthonius* \`BPS601\` and the silverfish *Trinemura* \`BZY117\` (Table 6). *L.* \`BPS601\` was collected at a single site (YW3955DG) and is represented by two individuals (Table 6 and Figure 17). One specimen was collected by scrape sampling, while the second was collected in a trap that was set at 16 m bgl. Site YW3955DG is located within Marillana Creek on the southern side of the Yandi Operations between two active mining pits.

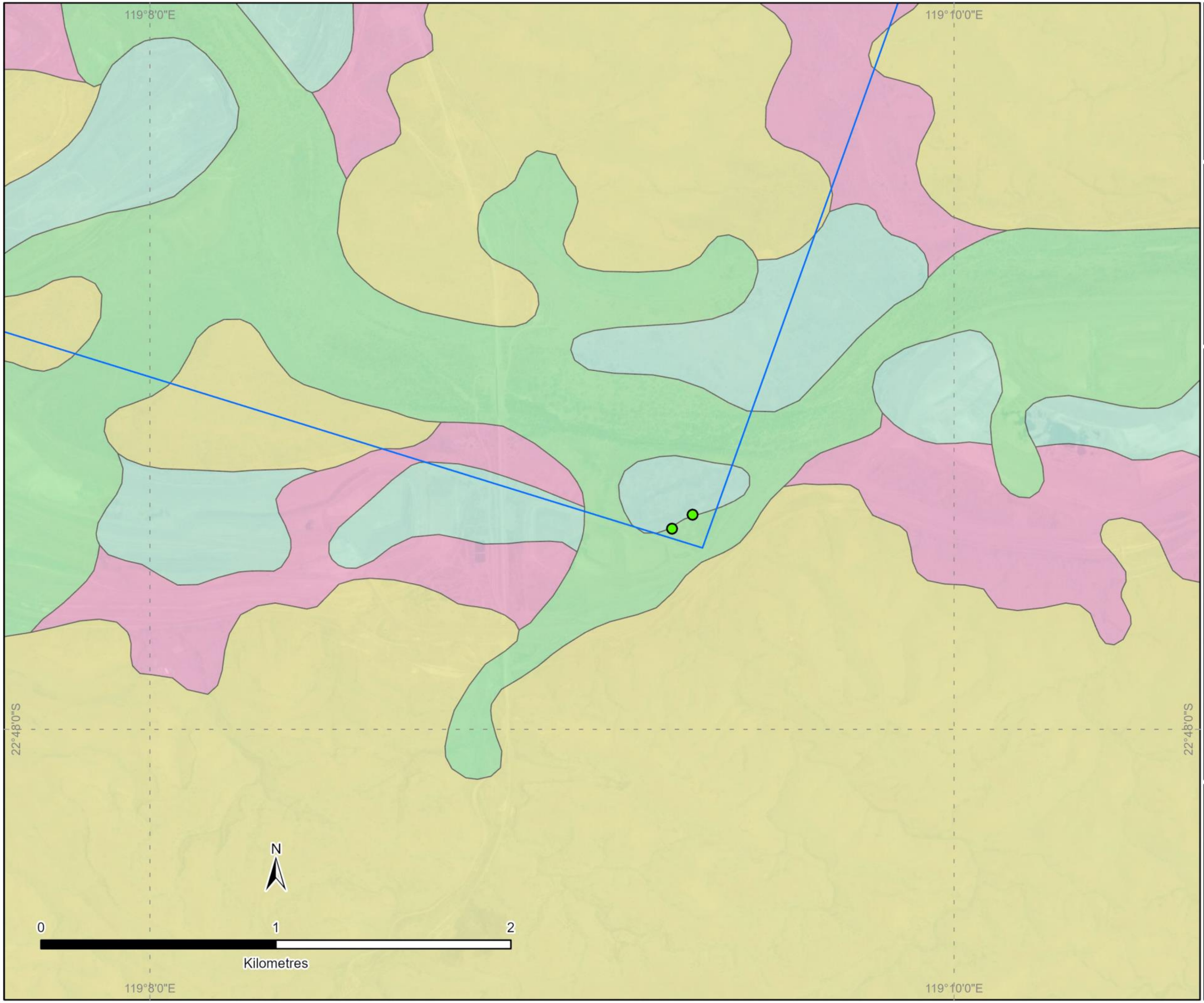
Seven specimens of *Trinemura* \`BZY117\` were collected from a single site (YX0030R) in a trap set at 15 m bgl (Table 6 and Figure 17). *T.* \`BZY117\` has some morphological features on the males that make them distinct from other species in the area: they are small and have stout spines on segments 1 to 4 of the outer cerci, which also has anemone organs. These features rule out the possibility of these specimens being synonymous with *T.* \`BZY112\` or *T.* B32. Another species, *T.* \`BZY105\` is represented in Bennelongia's collection by two juvenile specimens with DNA sequences available. Unfortunately, due to their life stage, these species cannot effectively be compared morphologically with 100% certainty.

The re-analysed *Symphylella* sp. indet, now known as *Symphylella* \`BSYM139\`, was collected from site YW3951DG (Figure 18). This sequence was compared to all other available symphylan sequences in the area and was not matched to anything. Consequently, this individual is currently considered a singleton and no further information is available regarding its possible distribution.

Table 6: Troglofauna specimens and species collected during the 2024 targeted subterranean fauna survey.
NB: Orange indicates targeted species

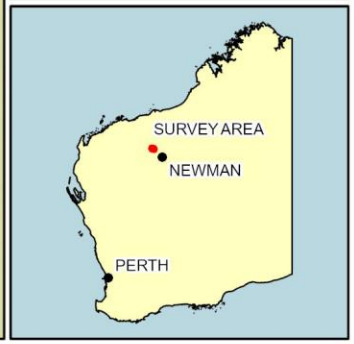
Higher Order Identification	Lowest Identification	Number of Specimens	Collected Bore	Distribution	Animal Comment
Arthropoda					
Arachnida					
Pseudoscorpiones					
Chthoniidae	*Lagynochthonius* `BPS601`	2	YW3955DG	Single Site	New species
Schizomida					
Hubbardiidae	*Draculoides* sp.	1	HYX0018	Unknown	Most likely *D.* `SCH030`/`SCH107-DNA` or *D.* `SCH071`
Araneae					
Oonopidae	*Prethopalpus* `BAR146`	3	YW3560D	11.5 km	
Diplopoda					
Polydesmida					
Haplodesmidae	Haplodesmidae `Helix-DIHAP001`	1	YE2020R	Pilbara Wide	Was Haplodesmidae `BDI080`. No longer restricted. Also matches WAM record of Haplodesmidae sp. DNA02
Polyxenida					
Lophoproctidae	*Lophoturus madecassus*	242	YW2682RD, YW2686RD, YW3554D, YW3556D, YW3560D, YW3567DG, YW3910DG, YW3913D, YW3933D and YW3955DG	Widespread	Cosmopolitan circumtropical species
Spirobolida					
Trigoniulidae	Trigoniulidae `BDI079`	1	YE2020R	110 m	
Entognatha					
Diplura					
Japygidae	Japygidae sp.	4	HYX0017 and YX0030R	Unknown	Some in poor condition but Japygids are cryptic and difficult to identify. Other Japygids in the area include Japygidae `BDP155` (DPL002) which has a relative wide distribution.

Higher Order Identification	**Lowest Identification**	**Number of Specimens**	**Collected Bore**	**Distribution**	**Animal Comment**
Insecta					
Zygentoma					
Nicoletiidae	*Trinemura* \`BZY117\`	7	YX0030R	Single Site	New species. Possible synonym to *T.* \`BZY105\`
	Trinemura sp.	2	HYX0017	Unknown	Specimens in poor condition. More likely to be *T.* B32 or *T.* \`BZY112\` based on size
Blattodea					
Nocticolidae	*Nocticola* \`BBL038 / B10\` (*cockingi* s.l.)	3	YW2682RD	64 km	
	Nocticola sp.	8	YE2020R, YW2682RD, YW2686RD, YW3556D, YW3909D and YW3955DG	Unknown	Either wrong sex or wrong life stage for morphological ID but likely representatives of *N.* \`BBL038 / B10\` (*cockingi* s.l.) or *N. quartermainei* s.l.
Hemiptera					
Cixiidae	Cixiidae sp. B02	1	YW2682RD	Widespread	
Meenoplidae	*Phaconeura* sp.	7	YW3910DG and HMJ0002	Unknown	Nymphs. Can't progress ID based on morphology. Other species in the area include the widespread *P.* B02 or *P.* B03, or locally widespread *P.* 'BHE030' or *P.* 'BHE032'
Coleoptera	Coleoptera sp. B09	1	YE2064RE	12.5 km	
Carabidae	*Gilesdytes vixsulcatus*	5	HYX0017 and YE2089R	30 km	
Curculionidae	Cryptorhynchinae sp. B10	3	YE2061R and HYX0017	9 km	
Ptiliidae	*Ptinella* sp. B01 (=MC)	28	YW3955DG and YW2686RD	Pilbara Wide	
Diptera					
Sciaridae	*Allopnyxia* sp. B01	14	YW3913D and HYW0148	Widespread	
Grand Total		**333**			



GCS GDA 1994
Author: hclark
Date: 10/03/2025

Figure 16. Updated distribution of Trigoniulidae `BDI079` after the 2024 targeted survey



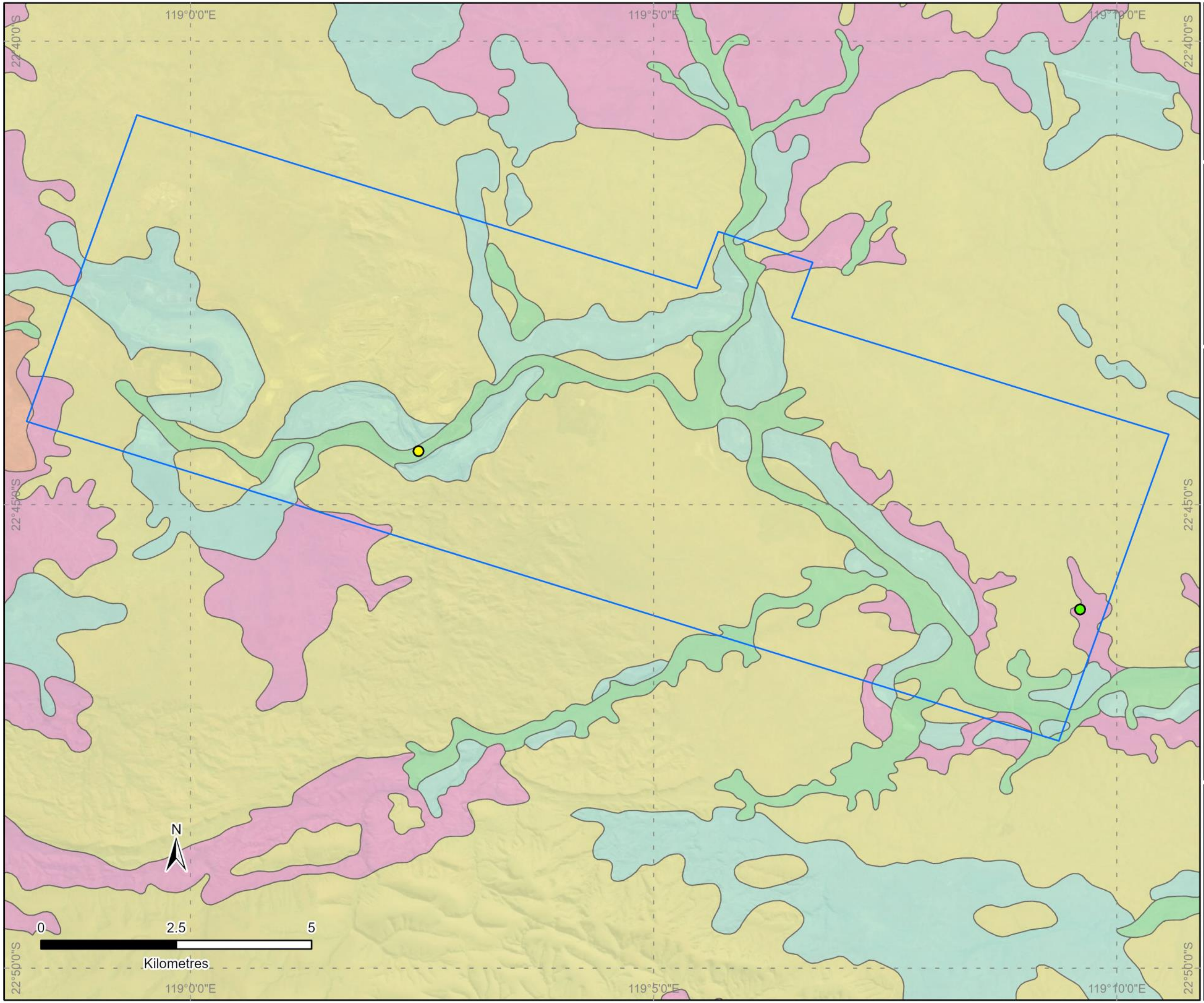


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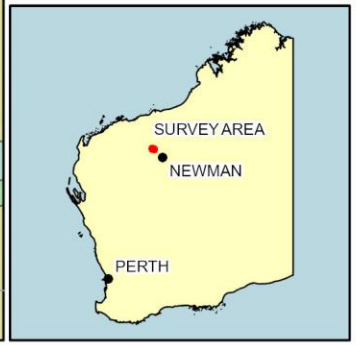
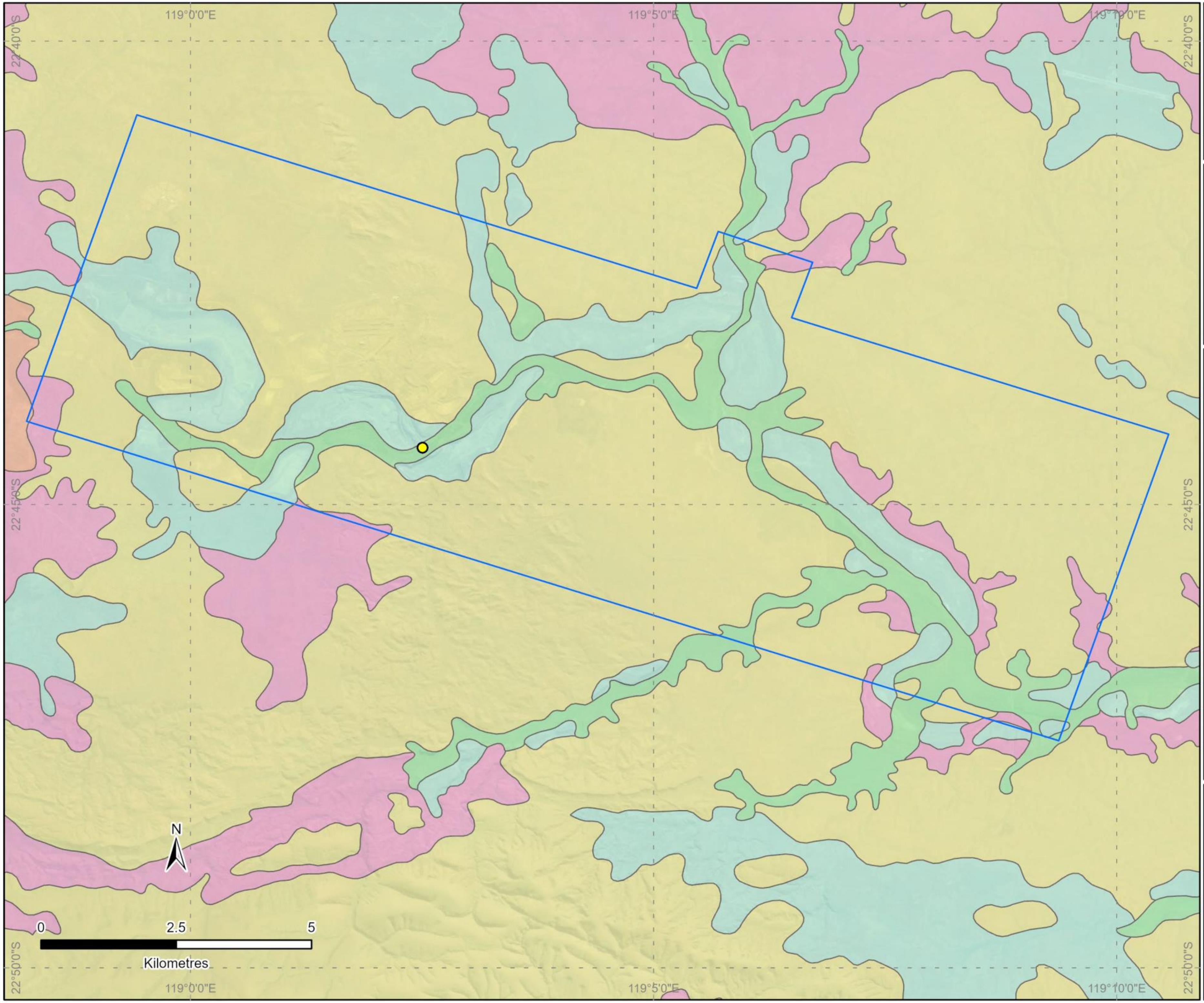
Figure 17. Two new troglofauna species collected for the first time in 2024

Legend

New troglofauna species
- Lagynochthonius `BPS601`
- Trinemura `BZY117`
- Yandi tenement

Surface geology
- Alluvium
- Calcrete
- Colluvium
- Exposed
- Residual
- Project Location (inset)
- Towns (inset)





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Date: 10/03/2025

Figure 18. Collection location of *Symphylella* `BSYM139`

Legend

Yandi tenement

Surface geology

Alluvium

Calcrete

Colluvium

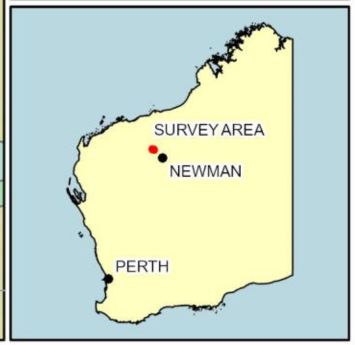
Exposed

Residual

Project Location (inset)

Towns (inset)

Symphylella `BSYM139`



6. DISCUSSION

The targeted subterranean fauna survey was designed to attempt to recollect seven species of interest: two species of stygofauna and five species of troglofauna. After a single round targeted search consisting of 39 stygofauna samples and 27 troglofauna samples (Table 1), three of the species were recollected, extending the known linear distribution of each of these species. Table 7 summarises the final known taxonomy and distributions of the target taxa.

Table 7: Current known taxonomy and distribution of target taxa.

Current taxon name	Original taxon name	Recollected (Y/N)	Current known linear distribution	Collection Locations
Elaphoidella \`BHA342\`	*Elaphoidella* \`BHA342\`	N	600 m	YE2070R, HYE1511
Parastenocaris \`BHA343\`	*Parastenocaris* \`BHA343\`	Y	33 km	YE2070R, HMJ0027
Hanseniella sp. indet.	*Hanseniella* sp. indet.	N	Singleton	YE2061R
Hesperanillus \`BCO247\`	*Hesperanillus* \`BCO247\`	N	Singleton	YE2045R
Cryptops \`BSCOL091\`	*Cryptops* \`BSCOL091\`	N	600 m	YE2029R, YE2033R
Haplodesmidae \`Helix-DIHAP001\`	Haplodesmidae \`BDI080\`	Y	Pilbara Wide	At least 47 locations across the Pilbara
Trigoniulidae \`BDI079\`	Trigoniulidae \`BDI079\`	Y	110 m	YE2033R, YE2020R

Unfortunately, the higher order identification of *Hanseniella* sp. indet collected from site YE2061R remains a higher order identification. It was originally sequenced for the 2024 Bennelongia work at Yandi (Bennelongia 2024), during which the entire specimen was used for sequencing purposes. Unfortunately, this attempt at generating a sequence failed. For this report, we re-used the original extracted DNA in an attempt to generate a sequence which resulted in the same outcome of a failed sequence. The Bennelongia report in 2024 implied that this specimen is likely a new species; however further inspection of records around Yandi demonstrates that at least three other species of *Hanseniella* have been collected in the vicinity of the Project, *H.* B14, *H.* B42 and *H.* B43 (Figure 19). We cannot rule out the possibility that the specimen collected in 2023 is a member of one of these three species. Symphylans can be challenging to differentiate morphologically, even at the genus level.

Three of the seven target species (~43%) were recollected during the targeted subterranean fauna survey extending the known distributions of each of these species (Table 7). The targeted search also recovered four new species, two stygofauna species (both ostracods - Figure 15) and two troglofauna species (a pseudoscorpion and a silverfish - Figure 17), however each of these was collected in regional bores at the Project.

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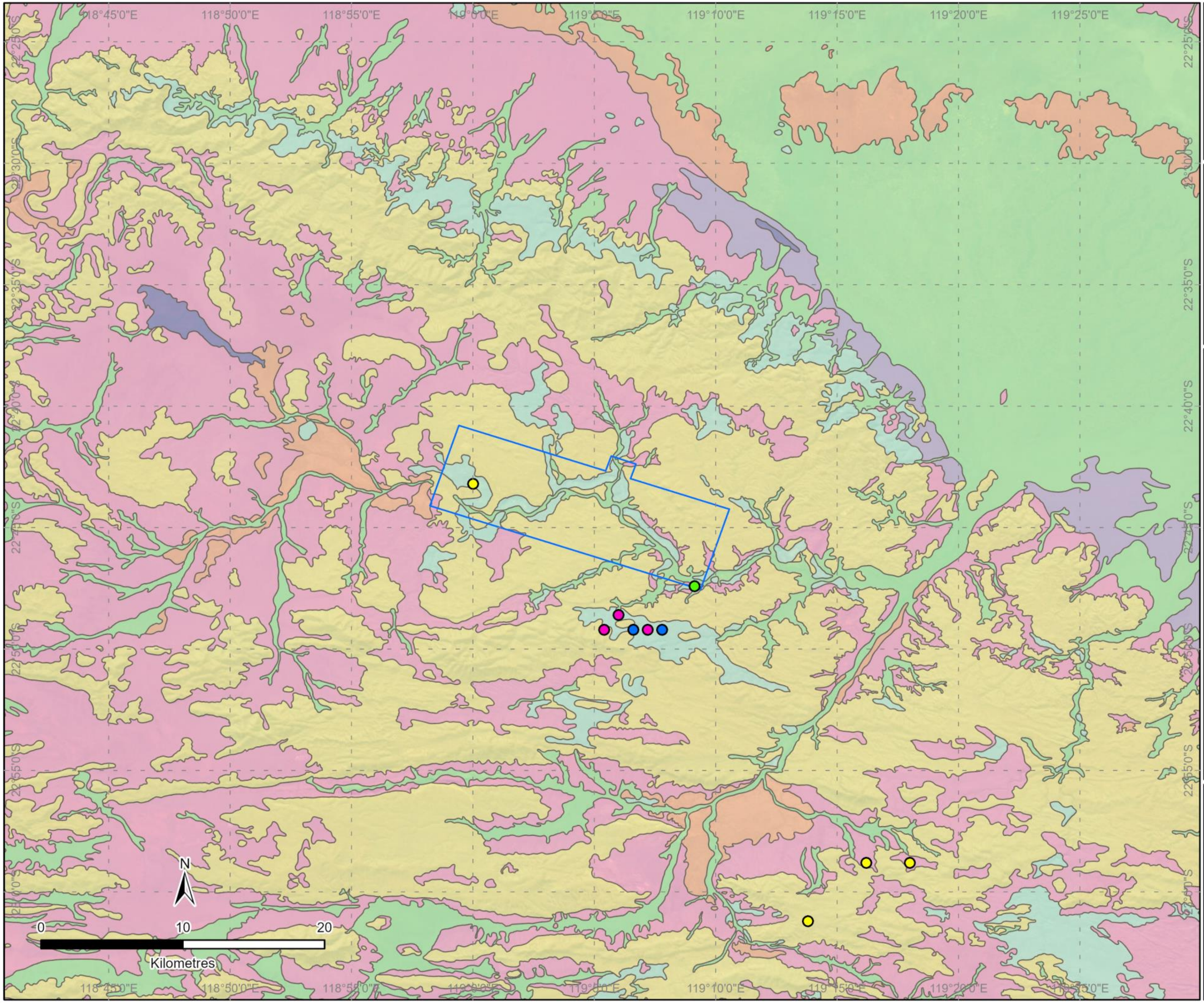


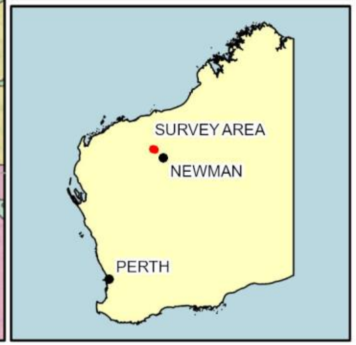
Figure 19. Location of *Hanseniella* sp. indet. in relation to other *Hanseniella* species in the vicinity of the Project

Legend

Yandi tenement

Surface geology

- Alluvium
- Calcrete
- Colluvium
- Exposed
- Lacustrine
- Residual
- Sandplain
- Hanseniella sp. indet
- Hanseniella sp. B14
- Hanseniella sp. B42
- Hanseniella sp. B43
- Project Location (inset)
- Towns (inset)



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Appendix 1: Sample locations and recorded physical parameters

Site	Latitude	Longitude	Sample Type	SWL (m)	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	ORP (mV)
HMJ0001	-22.68733	118.8691	Stygofauna	13.09	1310	7.66	24.8	1.6	28.2
HMJ0002	-22.64406	118.83644	Stygofauna	12.25	606	6.76	25.7	4.11	69.4
HMJ0003	-22.6332	118.85475	Stygofauna	9.03	1204	6.78	25.5	3.17	60.1
HMJ0004	-22.69524	118.87589	Stygofauna	10.35	1050	6.18	25.2	5.96	77.1
HMJ0005	-22.67824	118.87896	Stygofauna	10.73	2193	7.16	25.9	2.59	19.8
HMJ0006	-22.67349	118.88435	Stygofauna	8.92	956	7.85	25	4.51	56.6
HMJ0007	-22.67053	118.89057	Stygofauna	11.62	1242	7.41	26.2	4.08	58.6
HMJ0008	-22.67647	118.866	Stygofauna	8.42	1270	7.25	25.1	4.4	91.4
HMJ0009	-22.66021	118.8603	Stygofauna	10.29	1062	5.76	25	4.39	115.7
HMJ0010	-22.6521	118.86124	Stygofauna	10.35	1333	7.02	25.2	4.76	68.4
HMJ0011	-22.64403	118.85664	Stygofauna	6.23	1090	7.84	24.5	6.28	63.9
HMJ0012	-22.68692	118.87768	Stygofauna	12.31	2046	6.44	22.5	3.68	-5.2
HMJ0014	-22.69011	118.8701	Stygofauna	11.47	1229	6.89	25.2	3.56	61.3
HMJ0016	-22.69011	118.87024	Stygofauna	11.57	1327	6.86	24.8	3.73	91.9
HMJ0019	-22.69705	118.87258	Stygofauna	11.8	541	6.67	25.9	6.03	101.6
HMJ0020	-22.66325	118.86141	Stygofauna	10.27	973	7.6	25	5.15	70.7
HMJ0022	-22.66326	118.8611	Stygofauna	10.12	1300	6.97	25.1	4.45	82.6
HMJ0023	-22.65771	118.85731	Stygofauna	9.66	1071	7.16	24.9	6.94	52.8
HMJ0026	-22.65769	118.86115	Stygofauna	4.8	891	7.65	24.1	3.15	63.9
HMJ0027	-22.65781	118.86122	Stygofauna	4.69	1339	6.99	23.9	3.54	77.5
HMJ0036	-22.63307	118.85571	Stygofauna	9.06	1126	6.38	24.8	2.73	-15.4
HMJ0044	-22.64429	118.8396	Stygofauna	12.32	633	6.72	25.9	4.25	54.9
HMJ0047	-22.67496	118.88271	Stygofauna	11.57	1212	7.76	26.2	2.66	23.3
HMJ0048	-22.6381	118.84094	Stygofauna	8.3	838	7.53	26.4	5.61	29
HMJ0049	-22.70919	118.88026	Stygofauna	18.79	1869	6.73	26.4	4.69	-150.9
HMJ0050	-22.70375	118.88053	Stygofauna	16.75	1995	6.64	26	1.49	-190.2
HYX0003	-22.69394	118.99966	Stygofauna	35.62	1011	6.29	25.8	3.48	68.7
HYX0009	-22.76897	119.1601	Stygofauna	22.63	1061	7.3	26.7	3.26	55.8
HYX0016	-22.75982	119.16185	Stygofauna	23.49	865	7.55	27.5	2.52	-23.8
HYX0017	-22.75724	119.14079	Stygofauna	45.19	1567	7.24	27	3.92	59.9
HYX0018	-22.7429	119.12955	Stygofauna	56.74	824	7.06	28	3.97	24
MB16YSN0003	-22.71929	118.96639	Stygofauna	14.14	524	7.15	26.7	3.14	10.4
MJ1138R	-22.67648	118.86598	Stygofauna	7.77	1357	6.97	25.6	4.86	84
MUNK01	-22.64442	118.83954	Stygofauna	12.26	471	7.6	26.3	2.02	36.5
MWB0001	-22.62857	118.87203	Stygofauna	9.63	1373	8.1	24.9	3.65	43.5
WW18	-22.69433	118.87366	Stygofauna	10.35	878	7.45	26.4	1.69	88
YC3601R	-22.71345	119.09976	Stygofauna	20.02	359.3	6.06	27.1	3.5	67.3
YM0121	-22.78069	119.16039	Stygofauna	22	1034	7.13	28	4.67	41.6
YNCSGW0026D	-22.76384	119.14397	Stygofauna	38.14	1217	7.57	27.5	3.41	23.1
HYW0148	-22.73242	119.05299	Troglofauna						

Site	Latitude	Longitude	Sample Type	SWL (m)	EC (µS/cm)	pH	Temp (°C)	DO (mg/L)	ORP (mV)
YE2020R	-22.7911	119.15582	Troglofauna	36					
YE2045R	-22.79117	119.15402	Troglofauna	50					
YE2055R	-22.7909	119.15263	Troglofauna						
YE2061R	-22.79016	119.15201	Troglofauna	41					
YE2064RE	-22.78891	119.15188	Troglofauna						
YE2086R	-22.7893	119.14969	Troglofauna	45					
YE2087R	-22.78988	119.14944	Troglofauna						
YE2088R	-22.78938	119.1493	Troglofauna	45					
YE2089R	-22.78977	119.149	Troglofauna						
YEUNK01	-22.78999	119.14989	Troglofauna						
YW2682RD	-22.73047	119.05484	Troglofauna						
YW2686RD	-22.73009	119.05524	Troglofauna						
YW3544D	-22.72443	119.06093	Troglofauna						
YW3554D	-22.72602	119.05917	Troglofauna						
YW3556D	-22.72621	119.05904	Troglofauna						
YW3560D	-22.72679	119.05812	Troglofauna						
YW3567DG	-22.72744	119.05711	Troglofauna						
YW3763RD	-22.74062	119.03678	Troglofauna						
YW3909D	-22.74075	119.03648	Troglofauna	16					
YW3910DG	-22.74129	119.03624	Troglofauna						
YW3913D	-22.74119	119.04015	Troglofauna						
YW3933D	-22.74107	119.03967	Troglofauna	53					
YW3955DG	-22.74039	119.04099	Troglofauna						
YW3957D	-22.74079	119.0408	Troglofauna						
YWUNK01	-22.74181	119.03814	Troglofauna	10					
YX0030R	-22.76883	119.16003	Troglofauna						