KARARA MINE

MT KARARA
PIT EXTENSION

SUBTERRANEAN FAUNA
DESKTOP ASSESSMENT

REPORT FOR
KARARA MINING LTD

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Rockwater
HYDROGEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

76 Jersey Street Jolimont 6014 Western Australia Postal: PO Box 201 Wembley 6913 Western Australia
Ph: 61 8 9284 0222 Fax: 61 8 9284 1785 Email: consult@rockwater.com.au www.rockwater.com.au ABN: 43 008 804 653

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1 INTRODUCTION

The Karara Iron Ore Project (KIOP) is located approximately 90 km east of the town of Morawa and 220 km from Geraldton. The project involves mining of magnetite ore at Mt Karara. Previously, there has also been mining of hematite ore at Terapod and Blue Hills North (Fig. 1), and at Hinge, further north. Mining at those deposits is now completed.

Mining at Mt Karara is now planned to continue until 2053, which will involve slightly extending the Karara pit to the north-east. Excess water from the Karara pit will be discharged to Terapod West pit. The wet TSF will not continue to be used except in emergencies. As part of the mine planning, Rockwater re-calibrated the numerical groundwater model of the Mt Karara mine-site to predict the magnitude and extent of groundwater drawdown associated with the dewatering operations (Rockwater, 2024).

As the pit extension has the potential to impact any subterannean habitats for stygofauna or troglofauna in the area (if present), either through direct or indirect measures, an assessment of the subterranean fauna values of the Karara pit extension area is required.

This report presents the findings of a subterranean fauna desktop review within the impact area (both the pit extension and dewatering zone) for both stygofauna (aquatic) and troglofauna (terrestrial), as well as single phase of troglofauna sampling, in accordance with the regulatory guidance described in Section 2.1.

2 SUBTERRANEAN FAUNA

For the purposes of EIA, subterranean fauna is defined as fauna that lives its entire life (obligate) below the surface of the earth. Subterranean fauna is divided into two groups:

stygofauna – aquatic and living in groundwater

troglofauna – air-breathing and living in caves and voids

The obligate underground existence of subterranean fauna greatly increases the likelihood of short range endemism and the possibility that a species' conservation status may be impacted as a result of the implementation of a proposal.

Impacts to subterranean fauna may be **direct** or **indirect**.

Direct impacts include the removal of habitat, drawdown of groundwater, inundation, and water quality changes. The main threats include excavation of geologies known to support subterranean fauna; groundwater extraction for process or domestic purposes; dewatering for below water table excavation, and groundwater reinjection of waste or excess water. For the purposes of this study, the direct impacts to stygofauna and troglofauna are summarised in Table 1.

Indirect impacts include changes to hydrology, siltation, void collapse, alteration to nutrient balance and contamination. The main threats include changed surface topography due to compaction or creation of hard surfaces resulting in altered groundwater flow paths, increased runoff, and reduced infiltration and aquifer recharge; clearing of surface vegetation leading to sedimentation and changed nutrient inputs; potential leaks or leaching including tailings and waste water resulting in alterations to ground water chemistry and quality, and introduction of toxins or radiation; and salinisation due to intrusion of saline water into freshwater aquifers and leaching from pit voids.

Table 1: Potential Direct and Indirect Impacts to Subterranean Fauna

Impact Type	Impact area to be considered
Direct Impacts	Direct impacts to subterranean fauna due to a pit extension and borefield construction and groundwater drawdown as a result of borefield operations: • Direct habitat removal via pit extension • Groundwater drawdown (change in groundwater depth across the drawdown area)
Indirect Impacts	Impacts of proposed clearing and related activities, where such activities cause siltation, void collapse, alteration to nutrient balance and contamination, including clearing for: • Mine infrastructure and camp facilities • Water pipelines • Mine access roads
Cumulative Impacts	Impacts of proposal with consideration of other projects/users potentially impacting subterranean fauna. These include: • Neighbouring pit dewatering • Nearby groundwater users • Historical impacts of mining to subterranean fauna habitat in the region The extent of refugial habitat remaining during the life of the mine can be considered more widely, as a habitat-based assessment of groundwater impacts at the local catchment scale (for stygofauna). No agricultural activity is located near the proposed mine extension, climate change is unlikely to be a contributing factor (Rockwater, 2024a).

2.1 REGULATORY FRAMEWORK

The EPA's framework for consideration of subterranean fauna during EIA is outlined in the following Technical Guidance Statements:

1. Subterranean fauna survey (EPA, 2016). The document provides guidance on the impact assessment methods where subterranean fauna is likely to be a factor. The statement lists calcrete, alluvial formations and fractured rock as highly likely to contain habitat to support stygofauna and channel iron, calcrete, alluvium/colluvium and BIF for troglofauna.

2. Subterranean fauna surveys for environmental impact assessment (EPA, 2021). The document provides guidance on the level of survey required for proponents and the information required to understand impacts.

3. Guidance for the Assessment of Environmental Factors – Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007). The document addresses survey design and sampling methods for subterranean fauna.

3 PROJECT SETTING

3.1 CLIMATE

The climate of the Karara area is semi-arid, with hot dry summers and cool wet winters. Most rainfall is in the winter months associated with the passage of frontal systems. There can also be some heavy rainfalls in summer during thunderstorms or from the remnants of tropical cyclones.

Rainfall has been recorded at Karara (BoM Stn. 10195) from 1928 to 1940, and from 1991 to 2021. Monthly averages are given in Table 2, together with average pan evaporation recorded at Morawa by the Department of Agriculture and Food from 1991 to 2009. There has not been any significant change in average rainfall since 1991, compared to the long-term average.

Table 2: Average Rainfall at Karara, and Pan Evaporation at Morawa (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Av. Rainfall (1928-2021)	21.2	24.0	26.7	21.4	35.3	41.4	42.9	38.6	19.5	9.5	12.9	12.1	305.1
Av. Rainfall (1991-2021)	21.7	27.2	28.3	23.7	35.3	34.7	42.5	39.4	22.5	8.5	12.4	12.1	306.6
Pan Evap.	354	280	256	172	130	96	93	104	146	227	293	352	2,503

Dam evaporation at Karara is about 72 % of pan evaporation (Luke, Burke and O'Brien, 1988) and this would apply to evaporation from pit lakes. Evaporation exceeds average rainfall in all months of the year, and by a factor of eight times, overall.

Monthly mean maximum temperatures at Morawa Airport (BoM Stn. 08296 19, 1997 - 2023) range from 18.9^{0}C in July to 37.5^{0}C in January; and monthly mean minimum temperatures range from 6.2^{0}C in July to 20.4^{0}C in February.

3.2 GEOLOGY

The Project is within the Yalgoo-Singleton Greenstone Belt in the Southern Murchison Province of the Yilgarn Craton. The iron deposits are within two parallel and massive Banded Ironstone Formation (BIF) units that extend over three kilometres in strike, are about 400 m wide and 350 m deep. Rocks bounding the BIF include mafic and felsic volcanic rocks, metasediments, and to the south-west a granitic intrusion (Fig. 2).

Overlying the Archaean greenstone rocks are Cainozoic-aged palaeodrainage valleys and smaller tributary catchments containing generally clayey alluvium and lateritic weathering profiles that are up to 70 m thick.

3.3 HYDROGEOLOGY

3.3.1 GROUNDWATER OCCURRENCE

The main aquifers in the mining area are fractures within the BIF as well as secondary porosity formed in the iron-enrichment process. Complex folds and cross-cutting faults have contributed to the fracturing of the BIF. Other rocks of the greenstone belt and the granite are generally of low to very low permeability, although the contact zone between the BIF and adjoining metasediments is permeable locally; and there are local minor aquifers near the base of weathering in some greenstone rocks.

In the alluvium there are minor sand and gravel layers with the potential to transmit water, but they are mostly clayey and of low permeability.

The groundwater is recharged by the infiltration of rainfall and runoff following heavy rainfalls. Recharge rates would be low – less than one percent of average annual rainfall.

3.3.2 GROUNDWATER LEVELS & FLOW DIRECTIONS

Contoured groundwater levels prior to mining show that groundwater generally flows from the north-east to the south-west and south (Rockwater, 2024a). Prior to mining, there was a groundwater mound centred on Mt Karara (and presumably the other BIF ridges) from where groundwater flowed to the north, east, and south towards tributary palaeochannel aquifers. Groundwater flows preferentially down these palaeochannel aquifers and eventually discharges to the Mongers Lake palaeodrainage system.

Locally, groundwater flow in the BIF is largely controlled by the orientation and extent of the fractures (that are mostly unknown).

Some groundwater is also lost by evapotranspiration in areas where the water table is shallow.

3.3.3 GROUNDWATER QUALITY

Before groundwater extraction commenced at Mt Karara, groundwater was generally fresh to brackish near the water table, and highly saline below depths of between 50 m and 100 m. In some areas such as at bore MKW311, the groundwater was saline or hypersaline from the water table down, probably as a result of evapotranspiration from the water table in areas nearby.

Water samples from 10 Karara project bores were submitted for chemical analysis in 2008 prior to mining (Rockwater, 2008a). The results indicated that the groundwater ranged from fresh (salinity 580 mg/L TDS) to hypersaline (81,000 mg/L TDS); it was slightly acidic to slightly alkaline (pH 6.8 to 8.6); and of a sodium chloride type with relatively high concentrations of sulphate. Some samples had high total iron (up to 41 mg/L) and silica concentrations (up to 70 mg/L).

In the most recent sampling in March 2025, salinities in the pits were 66,640 mg/L (Karara), 63,464 mg/L (Blue Hills North) and 33,896 mg/L TDS (Terapod West) (Karara, unpublished data). Pumping bores had salinities ranging from 12,152 mg/L (TPD1001) to 90,960 mg/L TDS (MKW311); and monitoring bores from 2,102 mg/L (MKW321) to 47,144 mg/L TDS (MKW319).

4 SUBTERRANEAN FAUNA DESKTOP ASSESSMENT

Significant stygofauna communities in the Murchison and Yilgarn have generally been associated with calcrete aquifers (Cooper *et. al* 2007, Humphreys 2000, 2008) and, to a lesser extent alluvium, which are not relevant to the site geology at the Karara deposit. Sampling of BIF and other mineralised habitats in the Murchison, Yilgarn and Goldfields has previously produced few records of stygofauna and, where present, stygofauna communities have generally been found to be depauperate. The nearest calcrete habitats containing significant stygofauna communities are at least 42 km from the Project, at the Bunnawarra, Badja and Muralgarra calcretes (Fig. 3).

4.1 PREVIOUS SURVEYS AT KARARA

As part of the greater KIOP environmental assessment, several studies were conducted prior to mining. These assessments included both the hematite deposits (Blue Hills North, Terapod, Tor, Skyhook, Mungada South) and the Mt Karara magnetite deposit. Mining of the hematite deposits is now complete; the results for these studies are discussed below. The current pit extension only includes the magnetite deposit; however, the potential for troglofauna habitat in overburden material is also discussed in section 4.2.

4.1.1 STYGOFAUNA

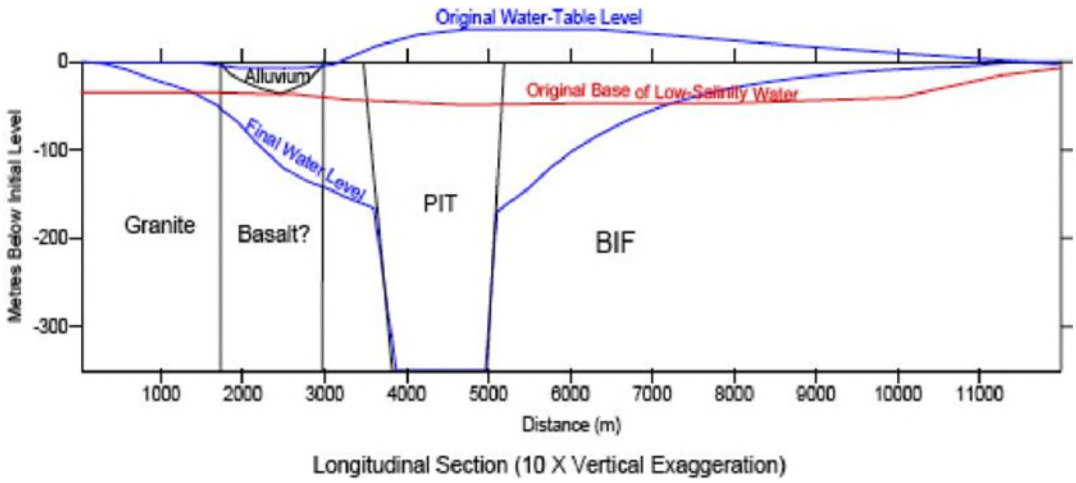
A desktop assessment of potential subterranean fauna values was conducted in 2007 for the magnetite project (Biota, 2007). The assessment concluded that there was some potential for stygofauna habitat in the superficial aquifer and a targeted sampling programme was recommended.

A targeted three-round sampling programme was conducted and included sites within the modelled drawdown contours and reference collections from pastoral bores and wells, which intersected the unconfined alluvial aquifers (Ecologia 2008). The sampling did not identify any stygofauna specimens inside the predicted dewatering drawdown zone. Reference collections included syncarids, ostracods, copepods and oligochaetes, taken from pastoral bores.

With reference to the 2008 stygofauna sampling at Karara (Ecologia 2008), five sites previously sampled as reference are now within the zone of drawdown impact; Blue Well Bore, MGC034, 106, 109 & 199. None of these sites yielded stygofauna during previous sampling at Mt Karara (Fig. 4).

The extended area of drawdown influence for the Karara pit extension area (based on revised groundwater modelling) does not include any geological structures or features that were not present in the original impact area. A small area of calcrete is mapped in the south-east portion of the impact area (labelled Drainage Area, Fig. 4), which was partially included in the original assessment. No bores or holes were available to sample within this area. Several field surveys have been conducted to try and investigate this calcrete; however, it has not been located (Rockwater, 2006). It is likely that the geological maps for the area were derived from air-borne magnetics and this feature may not be correctly identified. The marked location occurs in a natural depression surrounded by BIF ridges and has poorly developed surface drainage. The depression collects water that runs off these ridges after heavy rainfall. This is likely to form a shallow perched aquifer which supports the Melaleuca vegetation in the area. The water table in the depression is probably less than 5 m deep, and the water is expected to be fresh (<1,000 mg/L TDS). Groundwater in this perched aquifer would be recharged by surface water retained in the area, and would discharge by evapotranspiration and flow to the south. It is unlikely that pumping from the deep aquifer will impact this perched aquifer (when/if present).

Small areas of alluvium occur within the area of drawdown, but only a few of these areas are saturated. The alluvium is very shallow (<5 m depth) and generally overlies basalt (Text-Figure 1). In the alluvium there are minor sand and gravel layers with the potential to transmit water, but they are mostly clayey and of low permeability. Previous sampling of station bores/wells within this alluvium yielded syncarids, ostracods, copepods and oligochaetes. All collections were made from bores outside both the original and updated impact area. Alluvial aquifers in the Pilbara and Murchison are can be widespread and interconnected; and any fauna residing in these geologies are unlikely to have restricted ranges due to the large extent of this habitat (e.g. Rockwater 2024a). Furthermore, it is unlikely that pumping from the bores within the BIF ranges will cause drawdown impacts at any surrounding pastoral bores/wells screened in alluvial aquifers by more than 2 to 3 m (Rockwater 2024b). Therefore, it is considered unlikely that there would be impacts to the abundance and distribution of stygofauna within alluvial habitats.



Text-Figure 1: Conceptual cross section for Mt Karara magnetite deposit, with pre-mining and current water levels (taken from Bennelongia, 2007)

Pre-mining water levels within the BIF ridge were at approximately 25 m bgl. Since mining operations commenced, groundwater has been lowered to approximately 300 m bgl depth within the pit area. Groundwater yields from the magnetite BIF are generally in the order of 13 L/s. Pumping data for the previous pit development indicated dewatering rates of approximately 1,200 to 2,400 m^3/d.

No diamond drilling has been recently undertaken in Karara pit (in the last approx. 5 - 10 years). Historical drilling from the Stage 3 mining included diamond core photography, which intersected the (dewatered) water table at approximately 310 m depth. The formation at this depth is very tight, and representative core lacks any evidence of vugs, cavities or significant fractures that may indicate suitable voids for subterranean fauna (Plate 1).

Plate 1: Core photograph from MKD412 located in the current mine pit area, (left) at 308 - 316 m depth (about at 130m RL), (right) at 316 - 325 m depth (about at 140m RL)

Further to the east, within the mine pit extension area, several additional diamond holes have been drilled as part of the resource definition. MKD096, located within the central area of the mine pit extension (Figure 5), has shallow core available to inspect from 108 m bgl, which would be below the water table under natural conditions. Representative core indicates that the formation is tight with no vugs and limited fracturing (Plate 2). Remaining core photographs from MKD096 showed similar qualities (i.e. no indication of suitable stygofauna habitat was observed). Inspection of core from surrounding holes confirmed the same sequence is present for the entire pit extension area.

Plate 2: Representative core photograph from MKD096, at 107.9 – 113.1 m depth

Measured water levels in the pit extension in September 2024 ranged from 60.67 m bgl in the south at MKW318 to 62.88 m bgl in the north at MKW310 (Figure 5). This indicates that there has been at least 35 m of drawdown in the pit extension area as a result of dewatering (based on pre-mining levels approximating 25 m bgl). It can be assumed that the drawdown continues along strike.

The potential for stygofauna habitat in the Mt Karara pit extension area is considered to be low. Previous sampling has indicated that the likelihood of a significant stygofauna community within the magnetite BIF formation is low, and any species residing in the peripheral alluvium will likely be widespread. Extension of the modelled drawdown area into the proposed pit extension area is therefore unlikely to have any impact on any stygofauna conservation values within the region.

4.1.2 TROGLOFAUNA

The pre-mining impact assessment at Karara by Biota (2007) included both the hematite and magnetite projects. A review of the geology of the KIOP proposal area did not indicate suitable habitat for troglofauna within the magnetite deposit. Eleven core photographs were reviewed for potential habitat above the water table, with no prospective habitat noted (Table 3). These sites occur along the northern boundary of the (now mined) Karara Pit, and further to the north-east, in the pit extension area (Fig. 5). None of the examined core suggested suitable habitat for troglofauna (Table 3). No troglofauna sampling was conducted as part of the 2007 investigation.

Table 3: Previous Review of Diamond Drill Cores from the Magnetite Project and Interpretations of Suitability as Troglofauna Habitat (Taken from Biota, 2007)

Drillhole	Stratigraphy	Suitability for Troglofauna
MKD13	Some oxidation/fracturing but mostly solid BIF / shales	Non-prospective
MKD17	Solid BIF and shales	Non-prospective
MKD18	Solid BIF and shales	Non-prospective
MKD20	Solid BIF and shales	Non-prospective
MKD22A	0-101m: Solid BIF and shales	Non-prospective
MKD37	0-101m: Solid BIF and shales	Non-prospective
MKD44	Solid BIF and shales	Non-prospective
MKD45	Solid BIF and shales	Non-prospective
MKD73	0-105m: Solid BIF and shales	Non-prospective
MKD85	Solid BIF and shales	Non-prospective
MKD94	0-81m: solid shales, some BIF	Non-prospective

4.2 KARARA PIT EXTENSION GEOLOGY

Lithological logs from the shallow sections of RC exploration holes (0 to 100 m bgl) at Mt Karara indicate that there are areas of the pit extension that intersect hematite. The hematite occurs in silica rich bands interbedded with clay. Hematite (the weathered form of magnetite) can contain core troglofauna habitat depending on the level of weathering, and the sediment deposited within the weathered zones. The nature of RC drilling does not produce cuttings that can accurately determine the in-situ structures within the weathering profile, and the logging does not describe in detail the characteristics that determine if potential troglofauna habitat exists.

All holes in the pit extension area were drilled RC until the orebody was intersected and then diamond coring was employed within the resource. For this reason, no core was available to inspect for the surface 100 m. It is unlikely that the pit extension is different to that observed in the original assessment, and it can be assumed the geological sequence in the pit extension is very similar to that of the original pit. Inspected core confirmed that at depth, the BIF is typical of a magnetite deposit (i.e. is solid and lacks any significant weathering). Most holes inspected did not show any evidence of surface hematite that was logged in the pit extension, and very little weathering was evident. The exception was hole KPD0020 (Plates 3 & 4), which showed a weathered hematite profile similar to those logged within the pit extension area.

Plate 3: Core photograph from KDP-020, at 0 to 5.5 m depth

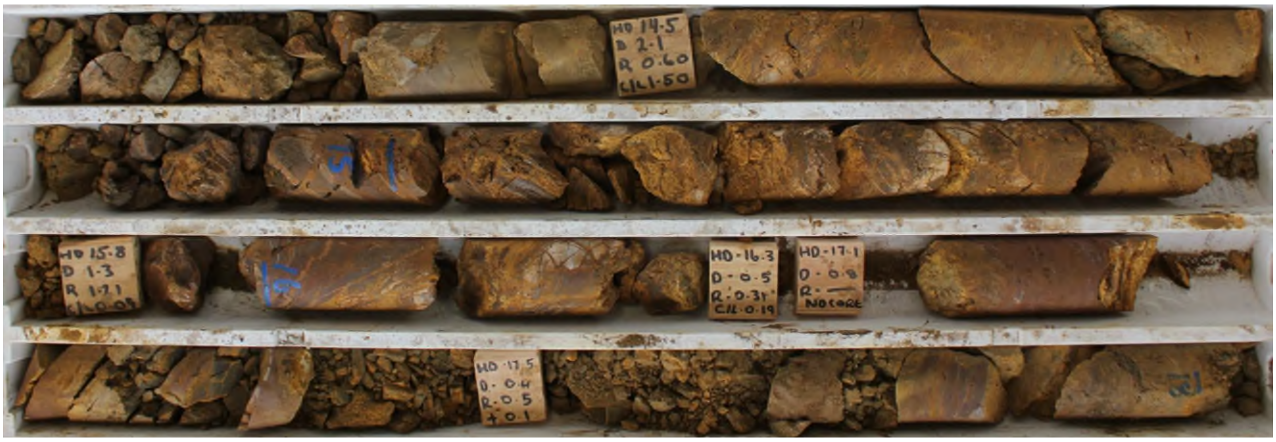


Plate 4: Core photograph from KDP-020, at 12.4 to 18 m depth

The hematite is suitably fractured and vuggy in places, indicating prospective habitat for troglofauna. The weathering extends to approximately 34 m at this location. Below this, in the transition zone between the hematite and magnetite, there are also areas of vuggy core (Plate 5), which may be suitable troglofauna habitat.

Plate 5: Core photograph from KDP-020, at 34.1 to 37.5 m depth

A range of diamond core holes drilled at the main pit area in 2014 were provided for contextual information on near-surface geology. Table 4 outlines details of weathering and stratigraphy for the 18 diamond holes, and indicates that near surface fracturing and vuggy BIF provides suitable voids for troglofauna in 8 holes. The most common depths for suitable weathering/voids are within the surface 10 m. However, there was weathering/fracturing up to 12.5 m depth at KPD019 (Plate 6), 58 m depth at KPD012, and KPD020 showed prospective vuggy and fractured hematite from surface to 40.8 m (Table 4, Plates 4 and 5).

Table 4: Additional Diamond Drill Core Revision and Interpretations of Suitability as Troglofauna Habitat

Drillhole	Core Depths		Stratigraphy	Suitability for Troglofauna
	From	To		
KPD001	0	48.3	Solid BIF and shales. Minor weathering/fracturing at surface (0 to 4 m)	Non-prospective
KPD002	0	36.5	Solid BIF and shales	Non-prospective
KPD003	0	36.4	Solid BIF and shales	Non-prospective
KPD004	0	36.4	Solid BIF and shales	Non-prospective
KPD005	0	41.8	Solid BIF and shales	Non-prospective
KPD006	0	81.6	Broken/fractured 0 – 3 m. Otherwise solid BIF	Non-prospective
KPD008	0	79.9	Solid BIF and shales	Non-prospective
KPD009	0	80.4	Minor weathering/fracturing at surface (0 to 4.6 m) Fractured zone 9.5 to 11 m	**Possibly-prospective 9.5 to 11 m**
KPD010	0	78.50	Solid BIF and shales. Minor weathering/fracturing at surface (0 to 4 m)	Non-prospective
KPD011	0	120.7	Fractured 0 to 3.9 m. Minor fractures at 24.4 m, otherwise solid BIF	**Possibly-prospective 0 to 4 m, 24.4 m**
KPD012	0	120.3	Minor weathering/fracturing at surface (0 to 3.8 m) Minor fractures 57 to 58 m	**Possibly-prospective 57 to 58 m**
KPD013A	0	120.5	Fractured to 5.4 m. Remainder Solid BIF and shales	**Possibly-prospective 0 to 5.4 m**
KPD014	0	120.4	Fractured to 6.4 m. Minor fractures 30.4 to 31 m, 46 to 49.5 m. Remainder Solid BIF and shales	**Possibly-prospective 0 to 6.4 m, 30.4 to 31 m, 46 to 49.5 m**
KPD016	0	120.6	Fractured to 4.4 m	Non-prospective
KPD017	0	120.6	Fractured 0 to 2.3 m. Remainder solid BIF and shales	**Possibly-prospective 0 to 2.3 m**
KPD019	0	198.6	Fractured and vuggy 0 to 5.1 m. Remainder solid BIF	**Possibly prospective 0 to 5.1 m**
KPD020	0	186.8	Fractured and vuggy 0 to 40.8 m. Remainder solid BIF	**Prospective 0 to 40.8 m**

Plate 6: Core photograph from KDP-019, at 0 to 12.5 m depth

4.3 LITERATURE REVIEW

A literature review was conducted to gather existing information on subterranean fauna near to the Project area. The review includes previous studies by Rockwater, publicly available technical reports and government publications. The results are presented in Table 5, and locations of these projects are shown in Figure 1.

The overwhelming picture is that generally, there is low potential for significant stygofauna or troglofauna communities within BIF deposits in the Murchison; however, there have been occasional records of troglofauna from similar deposits in the region (Table 5). When present, stygofauna has generally been found to occur in the alluvial aquifers, and individual species have been shown to be widespread and unlikely to have restricted distribution ranges (at individual project scales).

Table 5: Subterranean Fauna Projects in the Vicinity of KIOP

Site	Distance to KIOP	Reference / Year	Sampled for	Results
Greater Karara Iron Ore Project	8 km north-east	Biota 2007, Ecologia 2008	Level 1 Stygofauna: Desktop and Sampling	A desktop assessment concluded that stygofauna may be present in the superficial aquifers surrounding the Greater Karara Project, which may be impacted by groundwater abstraction. Sixty-nine samples were taken from both impact area and reference sites, including pastoral wells. No stygofauna were collected from sites within the BIF or in the adjacent impact area. Five orders of stygofauna were collected from neighbouring pastoral wells, beyond the impact footprint of the Project.
			Troglofauna: Desktop and Sampling	A desktop assessment of potential troglofauna habitat was identified at the Hematite deposits, Blue Hills North and Terrapod. Subsequent sampling yielded a single specimen of a new species of troglobitic Pseudoscorpion and three potential troglobitic Isopods from drill holes near the Terrapod Deposit. A second phase of sampling was undertaken, where a total of 56 holes were sampled across the two deposits. No troglofauna were collected at either the Blue Hills or Terapod BIF deposits.
Hinge BIF Deposit	20 km north-east	Rockwater 2014	Level 1 Stygofauna: Desktop only	The desktop assessment concluded that stygofauna were unlikely to be a significant environmental factor.
			Troglofauna: Desktop and Sampling	The desktop assessment identified potential troglofauna habitat in the zones of iron-enrichment. A sampling programme confirmed that troglofauna was not present at the Hinge Project.
Shine Deposit	40 km north-east	Rockwater 2012a	Level 1 Stygofauna: Desktop and Sampling	Stygofauna sampling recorded stygal and aquatic nematodes from one site in the proposed impact area. Given that few nematodes are known to be restricted to the groundwater environment. the Project was deemed that the project would not impact the conservation status of the taxa recorded by the survey.
			Troglofauna: Desktop and Sampling	Troglofauna was not recorded by the survey, suggesting that the BIF lithologies present at Shine do not provide suitable troglofauna habitat.
Koolanooka / Blue Hills (Mungada)	40 km west (Koolanooka), 8 km east (Mungada)	Ecologia 2008	Troglofauna: Desktop and Sampling	Three rounds of sampling were conducted at the Koolanooka and Blue Hills (Mungada) Deposits samples were collected from 26 drill holes at Blue Hills from within and outside the now existing Mungada East and West mine areas. Two groups of arthropods (collembolans and mites) were widely collected but all specimens had functional eyes and appeared to have moved into the traps from the surface. No troglofauna were collected at Blues Hills and a single troglobitic spider was found at Koolanooka.
Minjar Gold Mine	42 km north-east	Outback Ecology 2009	Level 1 Stygofauna:	Six sites were sampled for stygofauna, with one site yielding stygofauna. This site, located outside the impact zone, was a 50 mm exploration hole, screened within the

Site	Distance to KIOP	Reference / Year	Sampled for	Results
			Desktop and Sampling	alluvium and calcrete. Two crustacean orders (Bathynellacea and Harpacticoida) and annelid worms from the class Oligochaeta were collected in the survey.
Extension Hill	60 km south- east	ATA Environmental 2006, Rockwater 2008b, 2012b	Level 1 Stygofauna: Desktop and Sampling	Sampling targeted weathered mafic and metasedimentary rocks, and BIF, encountered below surface alluvium. Three sampling programmes (Rockwater 2008, Rockwater 2012b and ATA Environmental 2006) were undertaken for the project, all sampling yielding no stygofauna. The results suggested that the Project area is unlikely to contain a stygofauna community.
Iron Hill	70 km south- east	Bennelongia 2014, 2016	Level 2 Troglofauna: Desktop and Sampling	A total of 26 troglofaunal specimens were collected, representing five orders and eight different species. Five species were recorded from within the proposed Iron Hill and Iron Hill South mine pits and five species were recorded from drill holes outside of the proposed mine pits. Two species were common to both areas. The sampling results indicated the Iron Hill troglofauna community has similar composition and richness to other parts of the Yilgarn and, as has been found in all previous surveys in this region, animal abundance was very low. The study concluded that although the mine pit excavations for the proposed development of the Iron Hill Deposits will result in a reduction to the troglofauna habitat available, it was considered unlikely to threaten the persistence of any the species of troglofauna that occur at Iron Hill.
Mummaloo	75 km south- east	Bennelongia 2012	Level 1 Stygofauna: Desktop only	It was determined unlikely that a significant stygofauna community occurs in Mummaloo iron ore deposit given it occurs well above the water table. Furthermore, no dewatering is proposed by mining, so that any species present will experience minimal disturbance.
			Troglofauna: Desktop and Sampling	Twenty troglofauna samples were taken, yielding one troglofauna specimen, a silverfish belonging to the subfamily Atelurinae. Troglofauna species belonging to the subfamily Atelurinae occur commonly in Yilgarn and Pilbara, and have relatively large ranges. It was determined highly unlikely that a significant troglofauna community occurs at Mummaloo.
Dalgaranga Gold Project	157 km north	Rockwater 2016	Level 1 Stygofauna: Desktop and Sampling	The sampling targeted two mine pits and a low-salinity borefield. The study concluded that no species of conservation significance were known to occur within the mining areas at Dalgaranga. The sampling results, together with desktop interpretation of geological and hydrogeological information, suggested that stygofauna communities of the Project area are unlikely to contain any restricted species.

4.4 DATABASE SEARCHES

Database searches were undertaken to detail any stygofauna or troglofauna previously recorded within or near to the Project area, and to identify if any threatened or priority ecological communities (TEC's and PEC's) relating to subterranean fauna occur in the vicinity of the project. The database search areas are specified in Table 6 and/or plotted on Figure 3.

Database sources included:

- Dandjoo Database of Western Australia;
- Western Australian Museum's (WAM) crustacean database;
- Department of Biodiversity, Conservation and Attractions (DBCA) TEC/PEC database; and
- Atlas of Living Australia (ALA).

Table 6: Defined Search Parameters of Database and Internet Sources

Data Source	Search Area	No of records (un-screened)
DBCA TEC/PEC	100 km radius	5
DBCA Dandjoo Database		26,018
WAM Collections (Crustacean and Annelid)	200 by 150 km rectangle	192 (Crustacean), 2 (Annelid)
ALA		53,260

4.4.1 STYGOFAUNA

DBCA TEC/PEC Database

A search of the DBCA TEC/PEC Database detailed five priority subterranean ecosystems in the vicinity of the Project, all stygobitic, and all within calcrete drainages to the north and east of the project (Fig. 3). The closest community is the Priority 1 Ninghan Calcrete Groundwater Assemblage, located 42 km east of the project.

The listed TEC/PEC communities are;

- Ninghan Calcrete Groundwater Assemblage, Priority 1, 42 km east of the project.
- Badja Calcrete Groundwater Assemblage, Priority 1, 46 km north of the project
- Muralgarra Calcrete Groundwater Assemblage, Priority 1, 58 km north west of the project
- Bunnawarra Calcrete Groundwater Assemblage, Priority 1, 62 km north west of the project; and
- Wagga Wagga groundwater assemblage Priority 1, 84 km north-west of the project.

Regional mapping of these communities together with regional paleovalleys (Fig. 3) shows the correlation of the two drainage systems and the presence of significant stygofauna communities. Neither of these drainage systems are present in or in the vicinity of, the KIOP.

Dandjoo Database

Screened search results from the DBCA Dandjoo Database did not produce any potential stygobitic species.

WAM Database

The WAM crustacean database returned a total of 192 records, including five stygofauna records (Table 7). The closest record was from the previous stygofauna sampling for the KIOP, located approximately 100 m south of the proposed Karara pit extension. A single Ostracod collection was made in Pinyalling (between Fields Find & Paynes Find) with no additional detail available. It is not clear if this is a surface or subterranean collection.

Table 7: WAM Crustacea Database Results Screened for Stygofauna

Class	Order	Family	Genus	No. Records	Closest Record To KIOP
Ostracoda	-	-	-	1	Pinyalling (55 km East)
	Podocopida	Cyprididae	Sarscypridopsis	4	100 m
		Total		**5**	

The WAM Annelid search listed a single collection from a stygofauna net sample in Yalgoo, 84 km north of Karara (Table 8). Enchytraeidae are a highly diverse family which include terrestrial, subterranean and marine species. No further detail is provided and it is likely that this is a widespread species.

Table 8: WAM Annelida Database Results Screened for Stygofauna

Class	Order	Family	Genus	No. Records	Closest Record To KIOP
Oligochaeta	Tubificida	Enchytraeidae	-	1	84 km North
		Total		**1**	

Atlas of Living Australia

The Atlas of Living Australia (ALA) was screened for stygofauna, with only four records being confirmed stygobitic species. The records, all collected (or entered into the database) in 2008 were ostracods from the family Cyprididae, and appear to be the same records as found in the WAM database (Table 9). These were specimens collected from regional sites in the initial sampling for the KIOP.

Table 9: ALA Database Results Screened for Stygofauna

Class	Order	Family	Genus	No. Records	Closest Record To KIOP
Ostracoda	Podocopida	Cyprididae	Sarscypridopsis	4	100 m
		Total		**4**	

Summary

Database search results indicate that very few stygofauna collections have been made in the area, and those that have been documented are all associated with distinct calcrete aquifers, which are not relevant to the KIOP.

4.4.2 TROGLOFAUNA

DBCA TEC/PEC Database

A search of the DBCA TEC/PEC Database did not produce any troglofauna records.

Dandjoo Database

Search results from the DBCA Dandjoo Database were screened for troglofauna (Table 10). The closest known record is from the Mount Gibson/Iron Hill Minesite, 60 km south east of the project, listed in the WAMs Arachnid collection.

Table 10: Dandjoo Database Results Screened for Subterranean Fauna

Accepted name	Data provider	Dataset	Count	Method/protocol	Distance to KIOP (km)
Lophoturus madecassus (Marquet & Condá, 1950)	WA Museum	WAM Arachnid Collection	1	Trap;Troglofauna	60
Australoschendyla Jones, 1996	WA Museum	WAM Arachnid Collection	1	Trap;Troglofauna	60
Hahniidae Bertkau, 1878	WA Museum	WAM Arachnid Collection	1	trog scrape, 50 m	60
	Total		**3**		

WA Museum

A total of five troglofauna records are listed in the WAM search results, with all records from the order Isopoda (Table 11). The most abundant group was *Trichorhina* (3 records), all collected at Mt Gibson and Iron Hill.

Table 11: WAM Crustacea Database Results Screened for Troglofauna

Order	Family	Genus	No. Records	Closest Record To KIOP
Isopoda	Armadillidae	*Acanthodillo*	1	Iron Hill (69 km SE)
		Troglarmadillo	1	Mt Gibson (60 km SE)
	Platyarthridae	*Trichorhina*	3	Mt Gibson (60 km SE)
	Total		**5**	

Atlas of Living Australia

A single troglofauna record was listed on the ALA database, a pseudoscorpion from the family Olpiidae (Table 12). A range of pseudoscorpions were listed in the database; however, these are likely to be terrestrial collections. The troglobitic pseudoscorpion was collected 8 km north-west of the Karara pit from the Mummaloo Deposit. This was identified as a widespread species.

Table 12: ALA Database Results Screened for Troglofauna

Class	Order	Family	No. Records	Closest Record To KIOP
Arachnida	Pseudoscorpiones	Olpiidae	1	8 km north-west
		Total	**1**	

Summary

Very few records of troglofauna have been entered into the relevant databases. The records that exist are from the Mt Gibson/Iron Hill ranges and the Mummaloo Deposit, and when cross-referenced with relevant literature (see section 4.2), these species have been shown to have wide distribution ranges.

5 FIELD SURVEY

A low intensity sampling programme was undertaken following the desktop study, in line with relevant EPA guidelines, to ascertain if troglofauna is present in subterranean habitats within the pit extension area.

The sites available for sampling were dictated by the condition of holes drilled in a 2005 resource definition campaign. The holes and tracks had been rehabilitated and partially buried. Holes were re-opened by Rockwater personnel and sampled using standard techniques. The sites sampled are plotted on Figure 6. Samples recovered are considered adequate to assess the troglofauna values of the Karara pit extension area.

Twenty troglofauna samples in total were collected, using a combination of scrape and trap sampling techniques. Scrape samples were taken immediately before baited traps were set. Scrape and net samples from each site were processed separately, although they were considered to represent one sample. All sites were both scraped and then baited with troglofauna traps; were assigned a value of 0.5 sample units for the calculation of sampling effort (Table 13).

Table 13: Sampling Effort for Stygofauna Sampling at the Mount Karara Pit Extension

	Sample Type		Total Samples
	Scrape	Trap	
Pit Extension Area	20	20	20

*scrape and trap samples were each assigned a value of 0.5 sample units and combined to form one sample for calculating sampling effort.

5.1 METHODS

Troglofauna sampling was undertaken as follows:

- A scrape sample was taken from each uncased hole using reinforced stygofauna sampling nets prior to the installation of the baited trap.
- A baited trap(s) was installed at pre-determined depth to match prospective troglofauna habitat
- A cap or plug was placed over hole to minimise the amount of terrestrial fauna entering the traps, and to maintain a humid environment.
- Traps were retrieved after 8 weeks, when mulch was removed and immediately placed into sealed bags for transport to the laboratory.

Troglofauna traps are constructed of 120-180 mm long sections of 65 mm diameter PVC pipe. Each trap has a series of 10-20 mm holes drilled into the side and a vented PVC cap to allow fauna to colonise the baited trap.

Traps were baited with a mixture of leaf litter sourced from nearby native vegetation. The litter was soaked in water and irradiated in a microwave oven on maximum power setting for 6 minutes prior to use (to kill any surface invertebrates and assist in breakdown).

The positioning of traps was tailored to match either fracture zones or prospective strata identified from lithological logs, geological sections or diamond drill cores provided by Karara. All traps were placed within 13 m of ground surface based on the assessment of prospective habitat.

Samples were submitted to the laboratory for sorting and identification at the end of each sampling phase (scrape- and trap-sampling). Sorting and identification was undertaken by specialist subterranean biologists, Bennelongia Environmental Consultants.

5.2 RESULTS

Two troglofauna specimens (a symphylan and a beetle from the family Curculionidae) and an amphibious annelid were recovered from the scrape samples taken in the proposed Karara pit extension area. No troglofauna specimens were recovered from the baited troglofauna traps. Terrestrial isopods (*Laevophiloscia*) that are potential short-range endemic fauna were recovered from down-hole traps at six sites. These specimens are not considered to be troglofauna and are accidental/opportunistic fauna that have entered plugged holes that have been reopened. Results of the troglofauna sampling are presented in Table 14 and plotted over the proposed pit extension outline in Figure 6.

Table 14: Troglofauna Sampling Results at Karara Pit Extension

Class	Order	Family	Genus	No. specimens	Site
Clitellata	Enchytraeida	Enchytraeidae	*Enchytraeidae `2 bundle` s.l.* *	1	MKC133
Symphylla	-	-	*Symphyla sp.*	1	MKC466
Insecta	Coleoptera	Platyarthridae	*Curculionidae `BCO272`*	1	MKD227
Malacostraca	Isopoda	Philosciidae	*Laevophiloscia sp.*#	90	MKC093, MKC238, MKC318, MKC144, MKC472, MKC112
		Total		**93**	

 # Laevophiloscia sp.is a terrestrial species (non-troglobitic)

** Enchtraeid worms are amphibious and not assessed as troglofauna for EIA purposes in WA*

6 ASSESSMENT OF POTENTIAL IMPACTS

6.1 STYGOFAUNA

The modelled drawdown contours predict that drawdowns of 1 m or more could extend up to 5.4 km south-west of Karara pit and to about 6.7 km north-east of Terapod (along-strike); and to distances of about 3 km to 4 km across-strike from the pits. The revised drawdown impact-zone for the Karara mine life extension proposal (Rockwater 2024a) is approximately double the area modelled for the original Mt Karara proposal (approx. 15,600 ha versus 7,100 ha) under MS805 (Govt. of Western Australia 2009).

Stygofauna is not considered to be a relevant environmental factor for the Mt Karara pit extension. The adjacent pit has been dewatered to a depth of approximately 300 m bgl depth and the cone of depression for the pit has affected water levels in the pit extension area. The geology of the proposal area does not represent suitable stygofauna habitat.

6.2 TROGLOFAUNA

The potential impact of the proposal on troglofauna is limited to direct removal of habitat (if present) within the mine pit extension area (Fig. 6). The pit extension has a total area of approximately 254 ha.

Assessment of geological information indicates that hematite (the weathered form of magnetite) occurs in silica rich bands interbedded with clay in the planned Karara pit extension. The weathered hematite profile may represent troglofauna habitat depending on the degree of weathering, and the sediment (infill) deposited within the weathered zones. The hematite is suitably fractured and vuggy in places, indicating potential habitat for troglofauna.

Results of sampling indicate that a depauperate troglofauna community is present in the weathered surface strata of the planned Karara pit extension area. Two singleton records of troglofauna species from the southern section of this area provide very limited information about their likely distribution ranges or conservation status. The beetle *Curculionidae `BCO272`* was identified as dead on collection, meaning that it may have come from a sampling net used at a previous site/location. The specimen looks like *Cryptorhinae,* but is distinguished by the absence of a pronotal groove. The single symphylan collected by the survey was a poorly preserved fragment of an animal that was too damaged to identify further.

Troglobitic Symphyla have typically been shown to have ranges of several kilometres (e.g. 4 km in Rockwater 2015; 4.5 km in Bennelongia 2015; 7 km in Rockwater 2012c) up to at least 80 km (Rockwater 2010) in weathered hematite/BIF habitats in Western Australia. Halse (2018) calculated a median range of 3.2 km for Symphyla recorded from subterranean habitats including detritals and mineralized rock in the Pilbara and Yilgarn. Members of this group (e.g. *Hanseniella)* have also been shown to occur across a wide variety of habitats including a number of BIF units, as well as from a variety of other rock types including gossan, ferricrete, schist and phyllite. The variety of habitats and demonstrated ranges of Symphyla in other parts of the state suggest that the Karara specimen is unlikely to be restricted to the Project area. It is therefore also unlikely that the Karara pit extension would have any impact on troglofauna values of the Project area.

7 SUMMARY

7.1 STYGOFAUNA

Interpretation of geological data suggests that stygofauna habitat is unlikely to occur in the Project area. The groundwater levels have already been reduced from 25 m bgl to approximately 300 m bgl in the existing Karara mine pit, and so any potential habitat that may have occurred in the immediate area has already been dewatered/impacted.

The extended area of influence associated with the Karara pit extension does not include any structures or features that were not present in the initial impact assessment, and none of the sites previously sampled within the revised impact area yielded stygofauna. The desktop assessment has concluded that stygofauna is unlikely to occur in the KIOP Mine Life Extension impact area.

7.2 TROGLOFAUNA

Karara Mining plan to extend the Karara pit to the north east, expanding the existing pit to 254 ha. Construction of the mine pit extension has the potential to directly impact any troglofauna residing in the area via habitat removal. The desktop assessment confirmed a low likelihood of any core troglofauna habitat within the magnetite orebody of the pit extension area. Field sampling in accordance with EPA guidelines identified singleton records of two potential troglofauna species in the shallow hematite layer (overburden). The troglofauna of the KIOP area is considered to be depauperate, and the Karara pit extension proposal is unlikely to impact any troglofauna conservation values of the region.

Dated: 28 March 2025 **ROCKWATER PTY LTD**

Daisy Scott
Senior Environmental Scientist

Nick Evelegh
Principal Environmental Scientist

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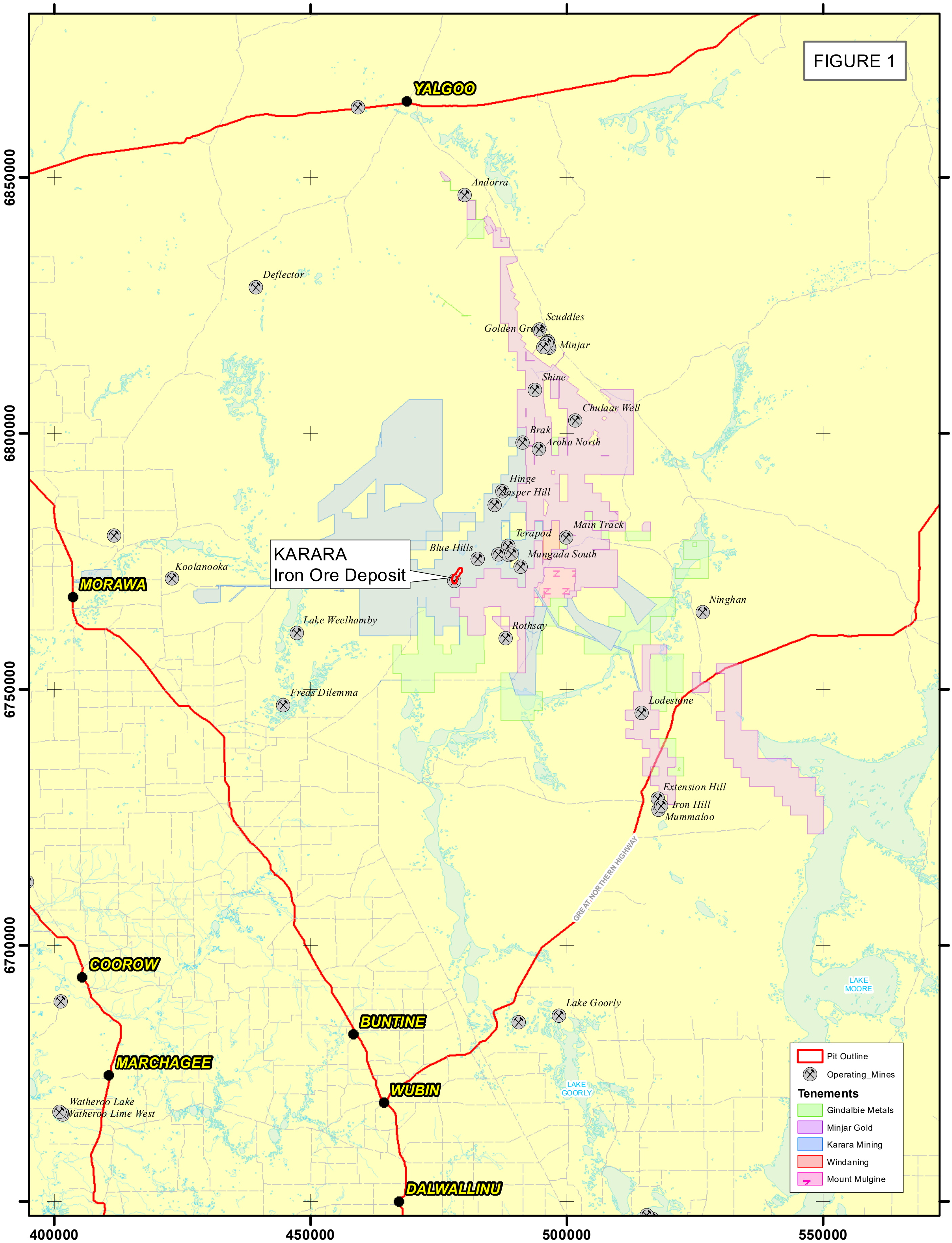
FIGURES



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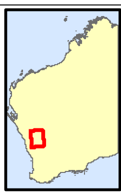
DWG NO:	319-0/25/01-1



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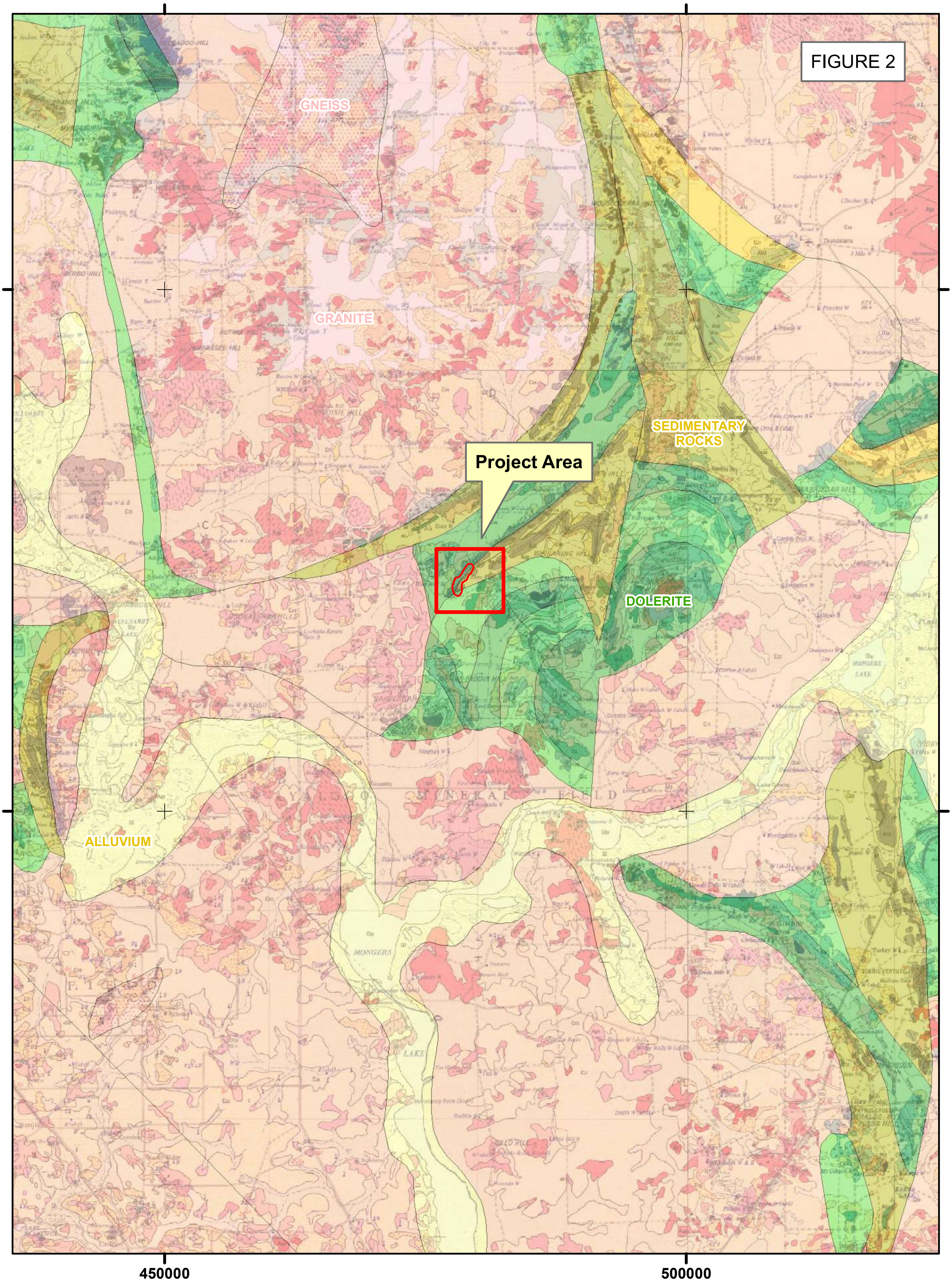
KARARA PROJECT

LOCALITY

Rockwater



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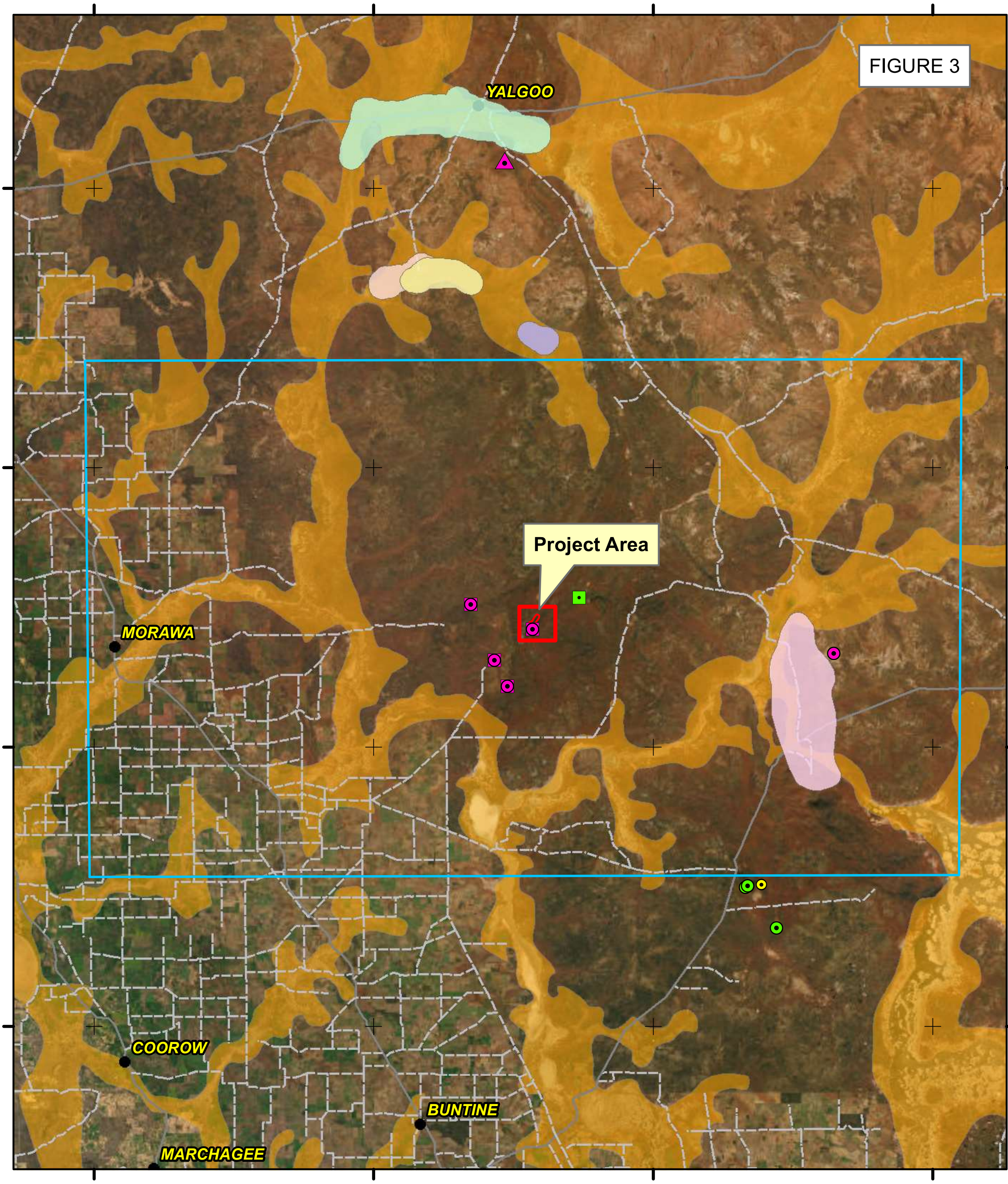
REGIONAL GEOLOGY

Rockwater

FIGURE 3



TEC / PEC Search Results

- Badja calcrete groundwater assemblage
- Bunnawarra calcrete groundwater assemblage
- Muralgarra calcrete groundwater assemblage
- Ninghan calcrete groundwater assemblage
- Wagga Wagga and Yalgoo calcrete groundwater assemblage

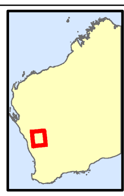
Database Seach Results

- WAM Crustacea Database - Stygofauna
- WAM Crustacea Database - Troglofauna
- WAM Annelid Database
- ALA_Database - Stygofauna
- ALA_Database - Troglofauna
- Dandjoo Database - WA Museum - Troglofauna

- Pit Outline
- ALA Search Boundary
- Paleovalleys

Roads/Tracks

- Principal Road
- Minor Road



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CLIENT: Karara Mining Ltd

PROJECT: Pit Extension - Subterranean Fauna Desktop Assessment

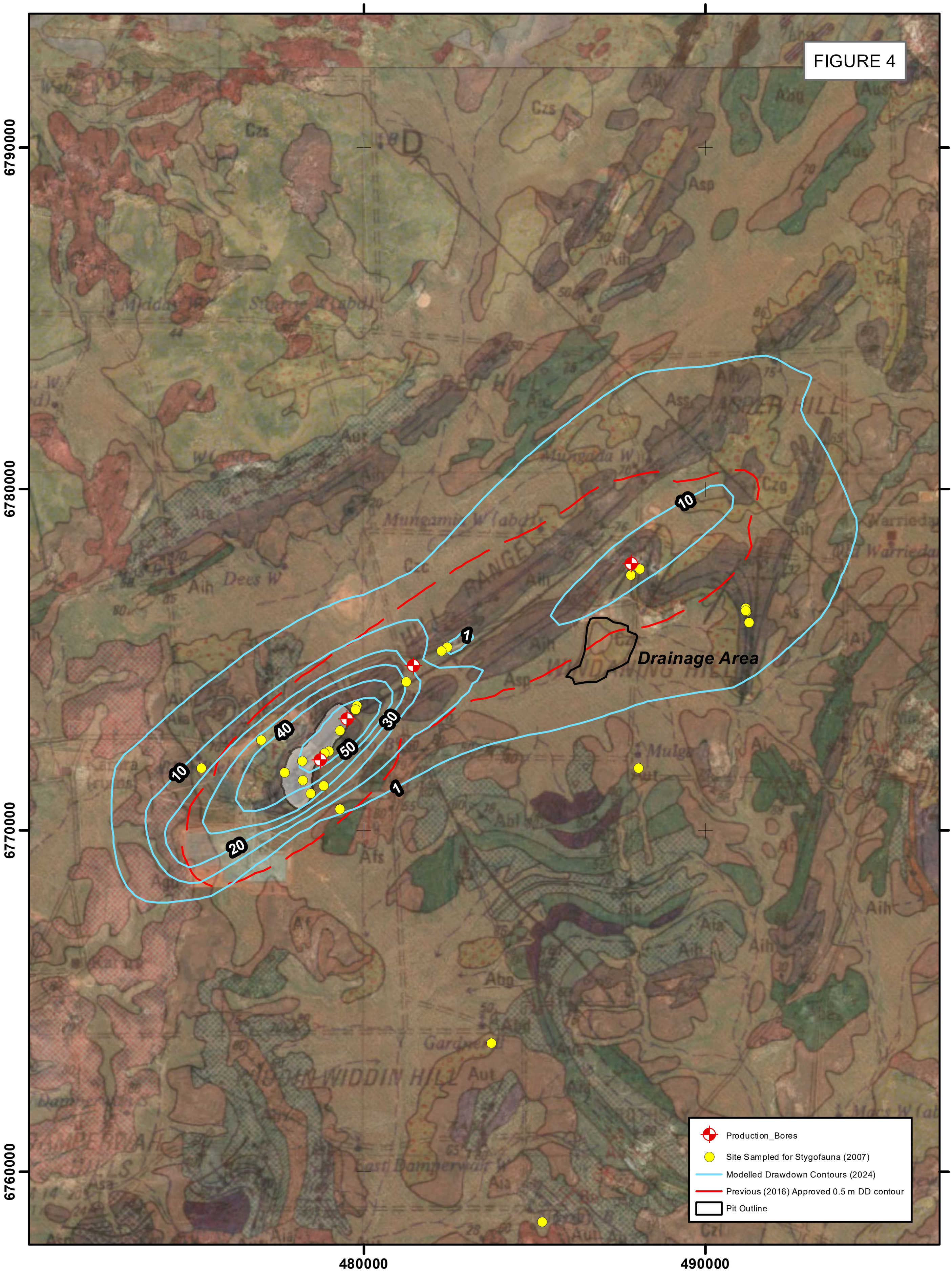
DATE: April 2024

DWG NO: 319-0/24/01-3

KARARA PROJECT

DATABASE SEARCHES

Rockwater



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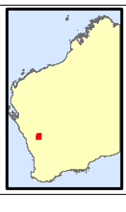

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STYGOFAUNA RISK ASSESSMENT

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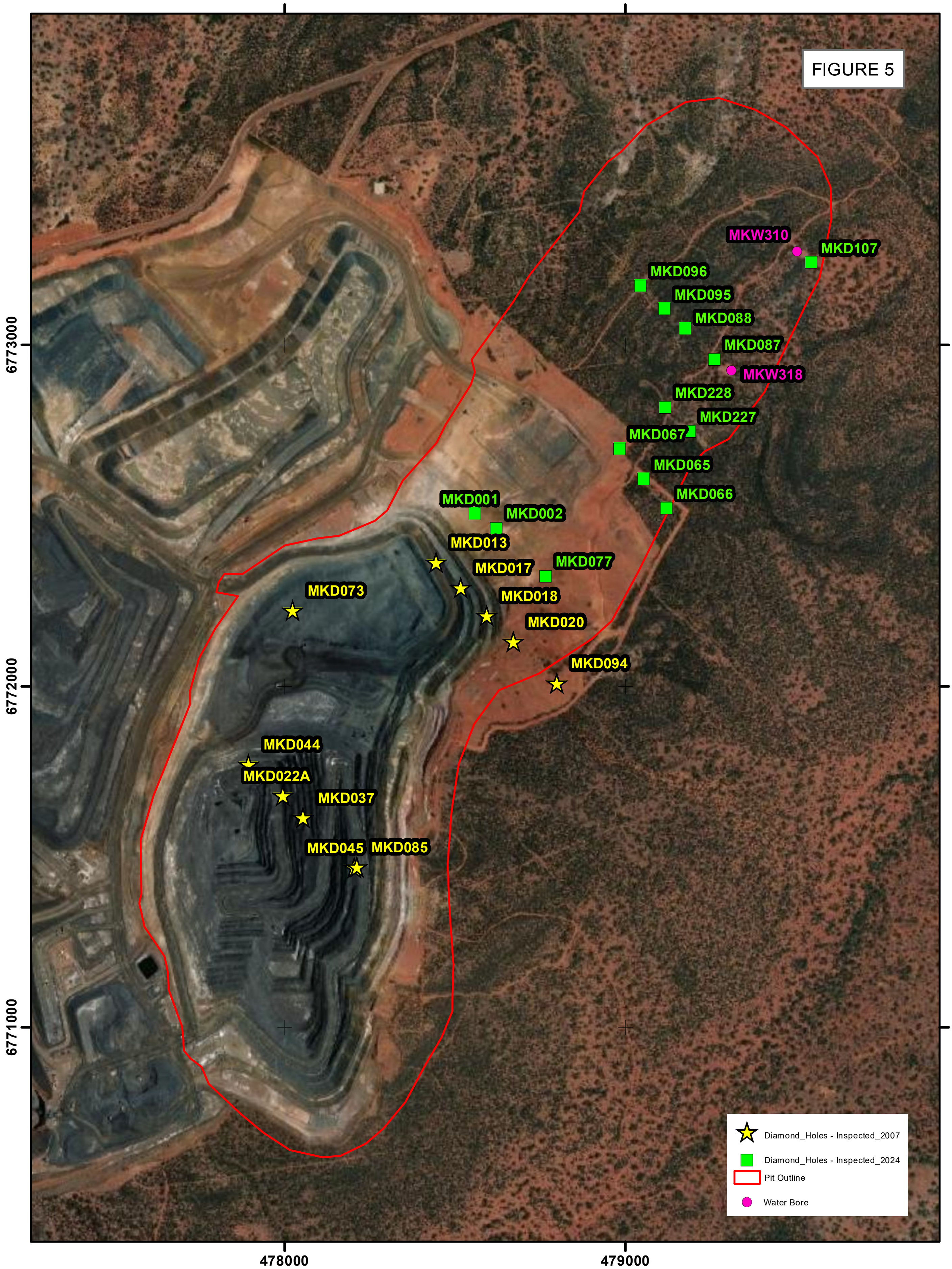

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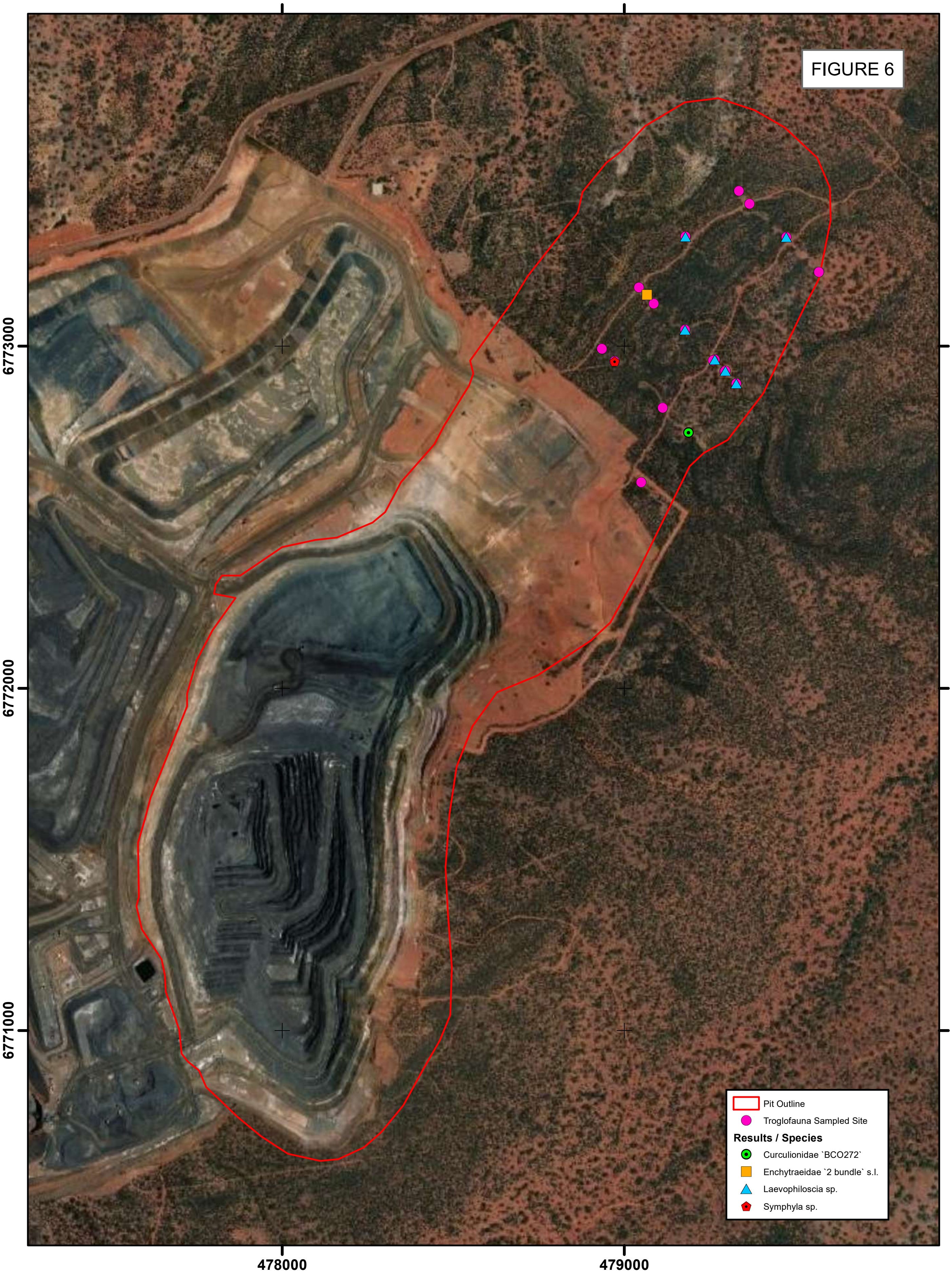

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Zone 50

TROGLOFAUNA SAMPLED SITES & RESULTS

Rockwater