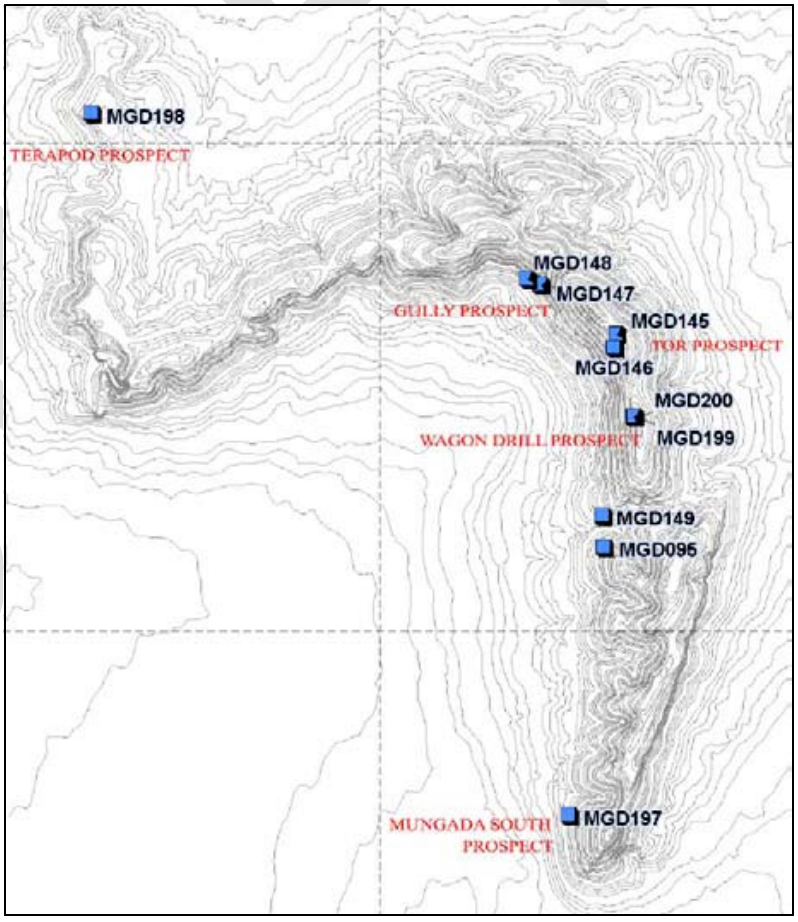
Sampling Plan for Subterranean Fauna Assessment at the Karara Iron Ore Project, Mid-West Region



Prepared for
Coffey Natural Systems
and
Gindalbie Metals Ltd
by Bennelongia Pty Ltd

20 September 2007

Report 2007/12

Sampling Plan for Subterranean Fauna Assessment at the Karara Iron Ore Project, Mid-West Region

Bennelongia Pty Ltd
64 Jersey Street
Jolimont WA 6913
www.bennelongia.com.au
ACN 124 110 167

20 September 2007

Report 2007/12

Client – Coffey Natural Systems and Gindalbie Metals Ltd

Report	Version	Prepared by	Checked by	Submitted to Client	
				Method	Date
Draft report	Vers. 1	Stuart Halse		email	9.ix.07
Final report	Vers. 2	Stuart Halse	Mike Scanlon	email	20.ix.07

K:/Projects/B_COFFEY/Report/BEC07_CNS_karara_2.doc

1.0 Introduction

The Karara Iron Ore Project, being developed by Gindalbie Metals Ltd, is located in the Blue Hills area of the Mid-West Region, about 220 km east of Geraldton. It consists of two projects that are being separately assessed at the level of Public Environmental Review: the Karara Magnetite Project and the Mungada Ridge Hematite Project. The two projects are about 12 km apart.

The Karara Magnetite Project will consist of open-cut mining of magnetite ore in a single pit with on-site processing to produce a slurry of magnetite concentrate, which will be transported to Geraldton in a slurry pipeline (Figure 1.1). The slurry will be de-watered and concentrated in Geraldton prior to shipping, with slurry water piped back to the mine-site for re-use. The Magnetite Project has an expected life of at least 40 years and will mine 36 Mtpa of an estimated resource of 1426 Mt. The mine pit will intersect the watertable (depth ca. 50 m) in the second year of operation. It is proposed to locate the process water borefield for the Magnetite Project in the Twin Hills Groundwater Sub-area of the Yarragadee Formation, northwest of Mingenew. It may also be necessary to obtain a portion of the process water from the Parmelia Formation in the Mingenew Groundwater Sub-area, south of Mingenew. About 12 GLpa of process water will be required.

The Mungada Ridge Hematite Project will consist of open-cut mining in a series of pits with on-site crushing and screening and a combination of road and rail transport to Geraldton (Figure 1.2). The Project has an expected life of 10 years and will mine about 14 Mtpa of rock to exploit the 22.8 Mt ore resource. All mining will be above the water table and water requirements for processing are comparatively low (ca. 0.3 GLpa). The Hematite Project will include the construction of minesite accommodation for both projects.

The issue of subterranean fauna at the Karara Iron Ore Project was first considered in a desktop assessment by Biota (2007). The aim was to determine the likelihood of subterranean fauna being present and the potential impacts of development on the fauna, if it were present. Biota (2007) determined that:

- it was possible that stygofauna occurred in shallower layers of aquifers in the project area
    - field survey should be undertaken at the Magnetite Project, where mining will occur below water table, to determine the extent of stygofaunal occurrence
- rock structure, as revealed by drill cores, suggested there was very little likelihood of troglofauna occurrence in the Magnetite Project but that some parts of the Hematite Project might contain suitable habitat for troglofauna
    - field survey should be undertaken to determine whether troglofauna occur at the Hematite Project.

Subsequent field sampling at the Hematite Project revealed the presence of troglofana in one of 12 bores sampled in March and April 2007. This bore (MGD198) in the planned Terapod Prospect (see Figure 3.1) contained a single specimen of troglobytic pseudoscorpion and three specimens of a species of possibly troglobytic isopod (Biota, unpubl.). Sampling for troglofauna in two boreholes in hematite at Midwest Corportation Ltd's Blue Hills mine site (on the eastern side of Mungada Ridge among Gindalbie Metal's leases) revealed no troglobytic species (*ecologia* 2007a).

There has been no stygofauna sampling, to date, at the Magnetite Project. Eight samples from a borefield about 60 km west of the Magnetite Project, that will supply process water to the Koolanooka/Blue Hills mine sites, revealed no species (*ecologia* 2007b).

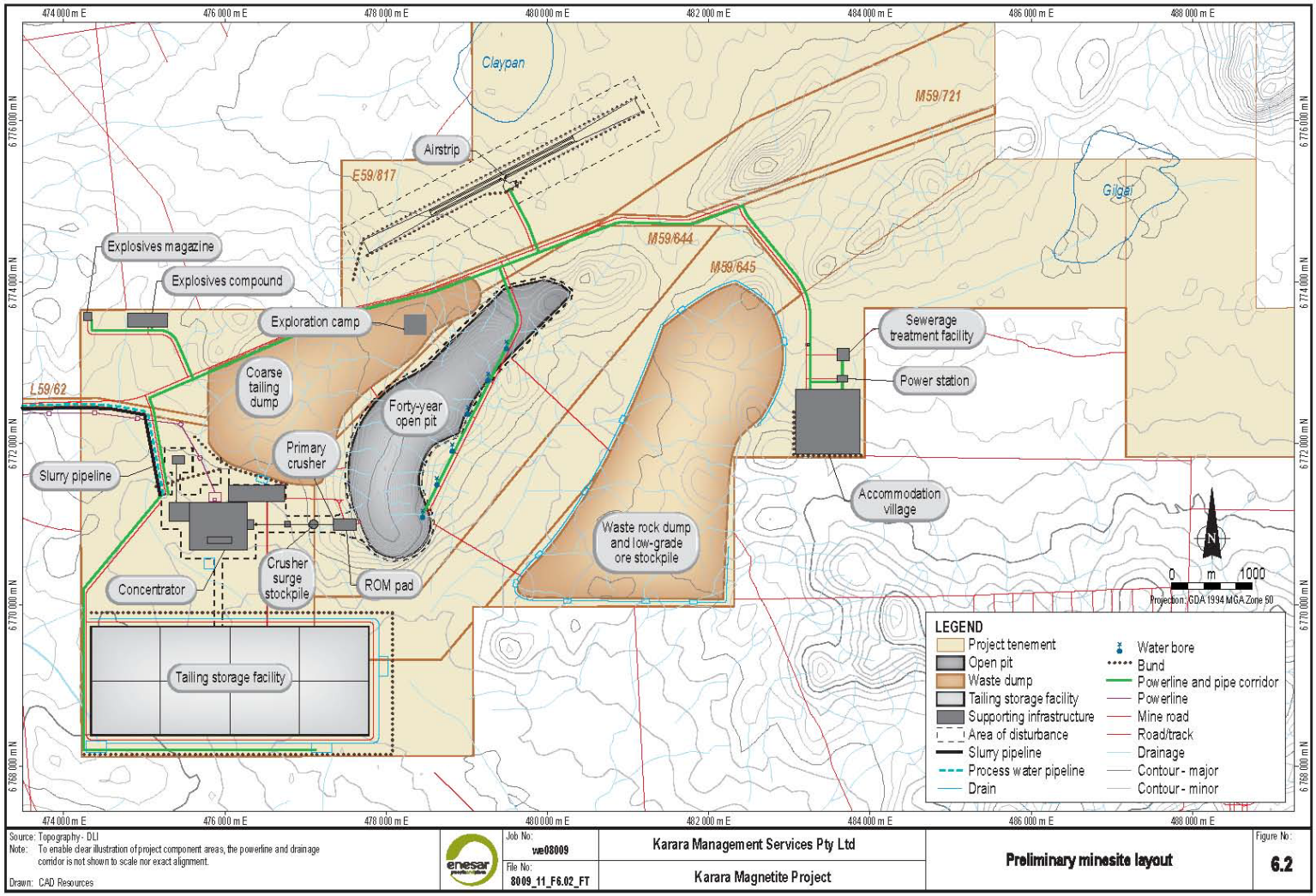


Figure 1.1. Magnetite Project showing proposed mine pit on Karara Ridge, associated infrastructure and waste dumps.

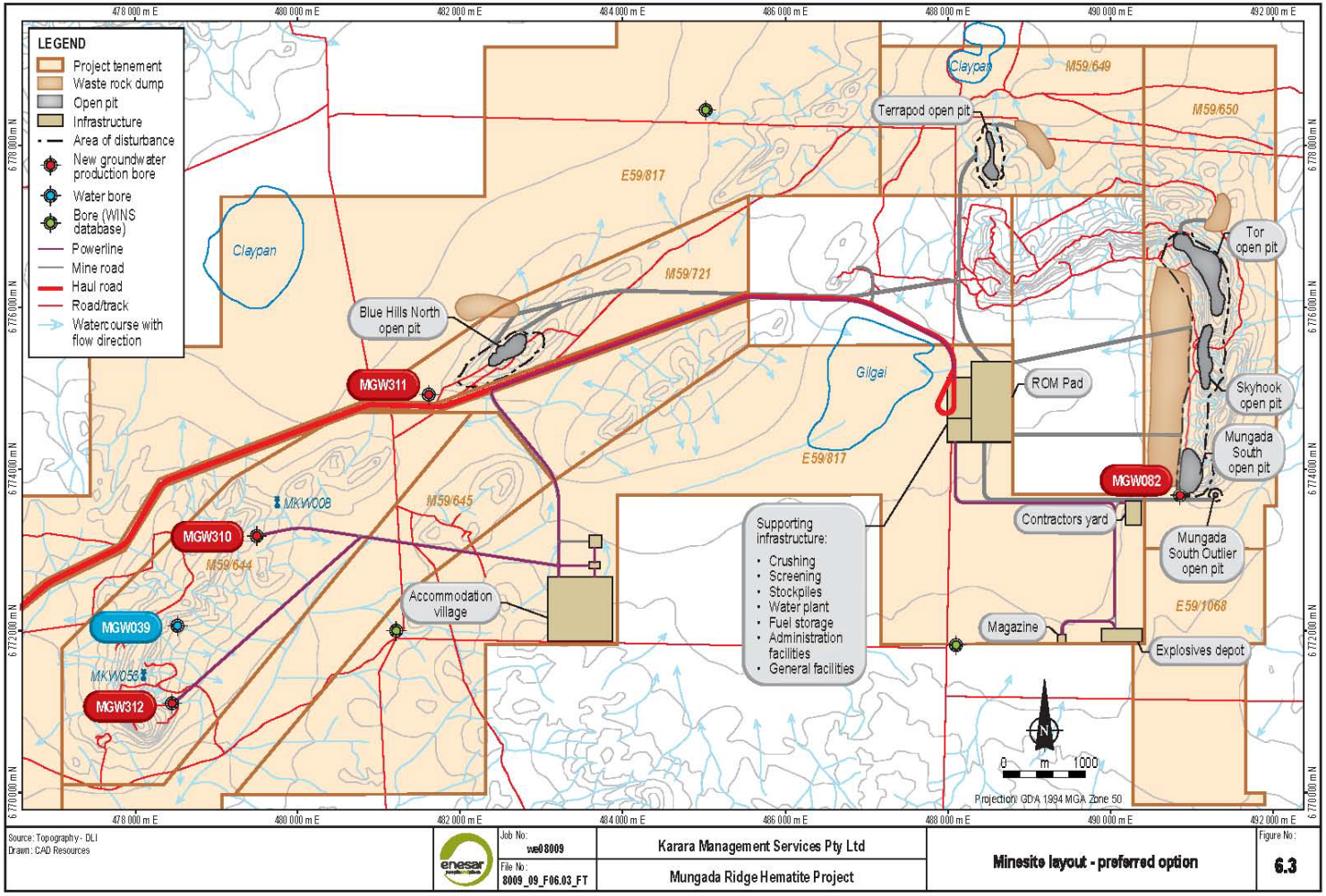


Figure 1.2. Hematite Project, showing six mine pits (five on Mungada Ridge and the Blue Hills North pit), associated infrastructure and waste dumps.

As a result of the discovery of troglofauna at the Hematite Project, and to undertake investigation of stygofaunal occurrence at the MagnetiteProject, Gindalbie Metals Ltd intends to initiate a program of subterranean fauna sampling at the Karara Iron Ore Project. This report describes the aims of sampling, survey design, and methodology to be employed.

2.0 Subterranean fauna of the region

The desktop study by Biota (2007) of the likelihood of subterranean fauna occurrence at the Karara Iron Ore Project did not report results of any subterranean surveys in the region and such information is difficult to obtain. Neither stygo- nor troglofauna were recorded by *ecologia* (2007a,b) in nearby surveys. Few other data about subterranean fauna from the vicinity have been published, although the Western Australian Museum has undertaken surveys to the north and east where rich faunas have been recorded (Humphreys 2001; Karanovic 2004). Despite the lack of regional information, the significant effort applied in this assessment recognizes the EPA's (2007) position that the probability of occurrence of subterranean fauna in banded ironstone is high and also that preliminary troglofauna sampling by Biota recorded the presence of some troglofauna (see Introduction).

3.0 Location and geology

The Karara Iron Ore Project lies within the Yalgoo-Singleton Archaean greenstone belt. Banded Iron Formations (BIFs) form a series of isolated peaks and ridges in an otherwise subdued landscape. Iron in the projects occurs within the Windanning Formation as a succession of abundant jasperlitic BIF and grey-white chert units overlying the Gabanintha Formation (Watkins and Hickman 1990). Most of the deposits within the Karara Iron Ore Project are dominated by interbedded strata of shales and BIF, with occasional areas of dolerite and kaolinite clays. The deposits are up to 150 m thick.

Examination of 11 drill cores from the Magnetite Project by Biota (2007) showed an absence of any small fractures, cavities or vugs that might provide habitat for troglofauna above the water table. Three of the 12 cores from the Hematite Project revealed potential habitat was present in the area (Mungada Ridge) at the Gully, Wagon Wheel and Mungada South Prospects (Figure 3.1).

Depth to watertable varies with topography but is about 50 m below the crest of Karara Ridge at the Magnetite Project, where mining will extend below watertable, and about 4-25 m under the adjacent plains. Salinity of groundwater is variable, ranging from fresh or brackish near the surface to about 70,000 mg/L at depth (Rockwater 2007). Groundwater yields are usually low, suggesting that habitat within the project area is unsuitable for stygofauna. However, some thin bands of alluvium, a habitat which is potentially suitable for stygofauna habitat, occur around the mine pit. It is also possible BIF provides stygofaunal habitat.

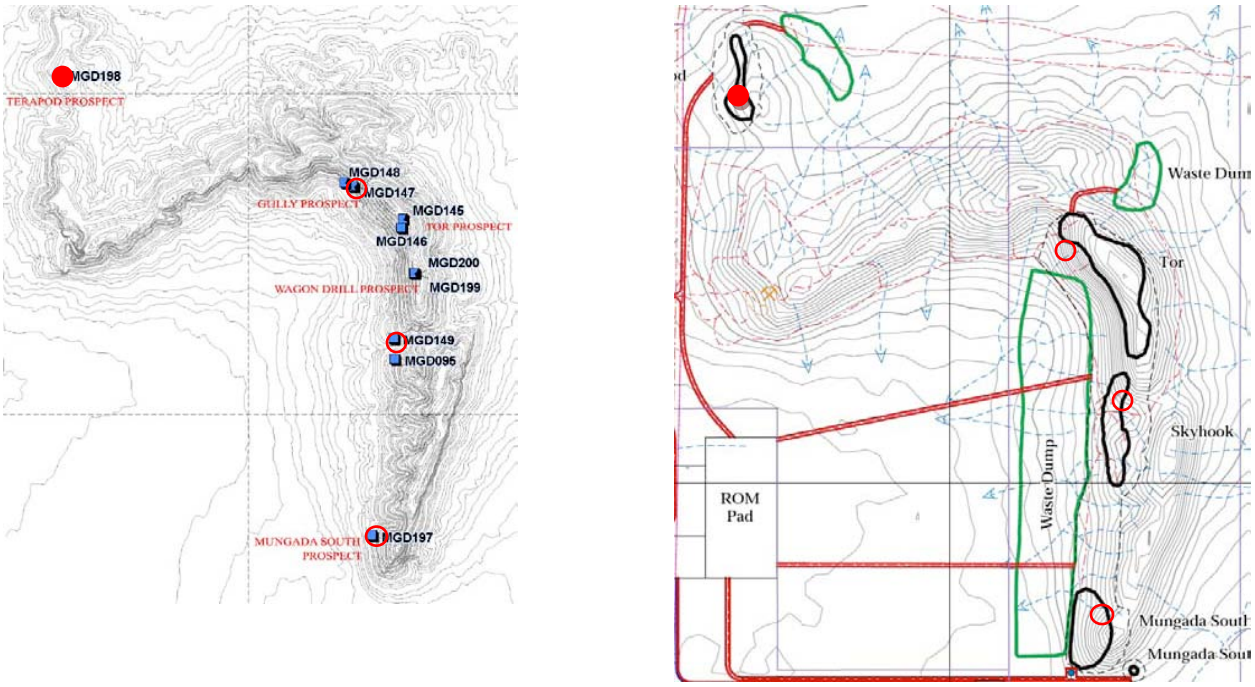


Figure 3.1. Locations of bores containing troglofauna (filled circle) or potential troglofaunal habitat at Mungada Ridge (open circles). The Blue Hills North pit farther west has not been evaluated.

4.0 Project impacts

The EPA (2007) recommends that changes to surface structure that alter natural input of nutrients should be considered when evaluating potential impacts of a development. Because of the relatively deep water table, and low transmissivity of much of the substrate, within the project area it is considered that piling up of waste rock, tailings storage, activities and facilities associated with processing of rock and accommodating staff will have minimal effect on subterranean fauna. It is considered that the potentially more significant impacts of the Karara Iron Ore Project are:

- removal of stygofauna habitat at the Magnetite Project as a result of dewatering to enable below watertable mining to a depth of 300 mbgl. Rockwater has developed a numerical groundwater model for the initial 27-year open pit[1], both during operations and post-closure when the final void partially recharges over the long term (forming a permanent pit lake) in a pit of approximate size 4.5 x 1.5 km. The model predicts that the 0.5 m drawdown contour will extend 7.5 km to the northeast and southwest along the BIF, but only 1 km to 1.5 km laterally to the southeast and northwest, where it will result in the dewatering of a band of alluvium (see Figure 4.1)
- physical removal of troglofaunal habitat at the Hematite Project. Six potential mine pits have currently been identified (Figure 1.2) and troglofauna (Terapod) or potential habitat (Tor, Skyhook, Mungada South) occur at four of the five evaluated (Biota 2007). Not all of Mungada Ridge will be mined and it is likely (albeit undemonstrated) that any troglofauna within the areas to be mined will occur in other parts of the ridge, if not beyond as well.

[1] At the time of model development, the 40-year pit shell design was not available. In comparison to the 27-year pit, the 40-year pit will be the same depth and width but will extend longitudinally along the Karara ridge to the northeast. Therefore, based on the geology of the ridge and assigned transmissivity values, it is expected that the area of groundwater drawdown for the 40-year pit will extend farther longitudinally/northeast along the ridge, but will extend no more laterally.

5.0 Sampling plan

5.1 Magnetite Project – stygofauna

5.1.1 Sampling effort and design

The aims of stygofauna sampling at the Magnetite Project will be:

- to determine whether any stygofauna are present within Karara Ridge and the wider area to be impacted by dewatering
- to identify the species present
- to determine the conservation significance of those species and the likely impact of mining and dewatering.

Bores that are representative of habitats within the area of drawdown for the 40 year pit at the Magnetite Project will be selected as 'impact zone' sites. A total of 40 stygofaunal samples will be collected from the impact zone, representing 20 bores sampled twice (in late September 2007 and February/March 2008). A further 40 samples will be collected from habitats outside the impact zone to provide a regional context for interpreting results of sampling and to provide more information about the ranges of any species collected within the impact area. The 'non-impact' samples will be come from 20 bores sampled twice in parallel with impact zone sampling.

It is intended to sample only bores ≥6 mo old. However, if it is necessary to drill additional bores, they will be sampled at 3 mo old. If the 3 mo old bores yield significantly fewer species in the second round of sampling than the first (compared with bores ≥ 6 mo old), a third round of sampling will be undertaken at the new bores. Details of bore construction will be provided with sampling results.

5.1.2 Sampling methods

Sampling will follow the protocol of the Pilbara Biological Survey (see Eberhard et al. 2005) and advocated for use in stygofauna assessment in Western Australia (EPA 2007). In summary, at each bore six net hauls will be collected using a weighted plankton net, which will be lowered to the bottom of the bore, bounced up and down to stir up sediment, and then slowly retrieved so that it filters both stirred up sediment and the water column. Contents of the net will be transferred to a polycarbonate vial after each haul and then contents will be preserved onsite in 100 % ethanol at the completion of sampling.

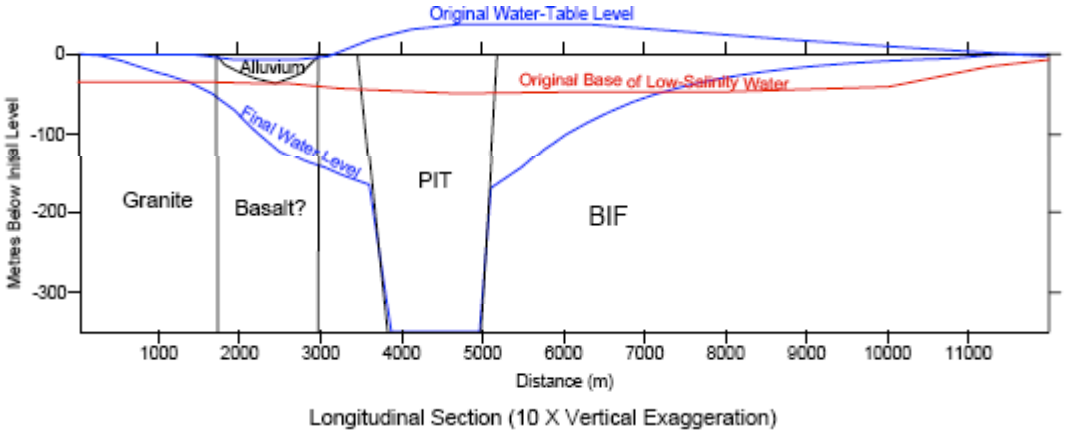


Figure 4.1. Drawdown associated with dewatering at the Magnetite Project, showing the drying of alluvium north of Karara Ridge.

Three net hauls will be made with a 50 µm mesh net and three with a 150 µm mesh net. Nets will be washed in a decontaminant solution between bores to minimize contamination between bores.

At each bore, depth to water will be recorded, available information on geology compiled and bore age, type of casing and slotting documented, if possible. A meter will be used to measure electrical conductivity and pH.

5.1.3 Sample sorting and species identification

Preserved samples will be sent to the laboratory for sorting, which will occur after elutriation to separate out heavy sediment particles and sieving the sample into size fractions using 250, 90 and 53 µm mesh sieves to improve searching efficiency. Sorting will be done under a dissecting microscope. All animals picked out of the samples will be identified to species or morpho-species level, unless damaged, juvenile or the wrong sex for identification, according to the specifications of EPA (2007, Table 3.3). Animals will be dissected and examined with either compound or dissecting microscopes, as appropriate. Unpublished and informal taxonomic keys will be used to assist identification of taxa for which no published keys are unavailable. The names of staff involved in fieldwork, sorting and identification, including any specialist taxonomists consulted, will be provided when results are presented.

5.2 Hematite Project – troglofauna

5.2.1 Sampling effort and design

The aims of troglofauna sampling at the Hematite Project will be:

- to identify the species of troglofauna present within Mungada Ridge and their distributions, with particular emphasis on the six identified mine pits (Figure 1.2)
- to determine the wider distribution of those species, their conservation significance and the likely impact of mining on their persistence.

EPA (2007) guidelines recommend that at least 60 samples are collected from within the impact area of projects where troglofauna are likely to occur. Given that troglofauna have been found at the Terapod Prospect, it is proposed to collect 60 samples from within the six proposed pits (Figure 1.2) on Mungada Ridge and at Blue Hills North. This will be done by sampling 30 bores twice (in late September through to November 2007 and in February through March 2008). Bores will be distributed among pits in approximate proportion to pit area. A further 60 samples will be collected elsewhere on Mungada Ridge in parallel with impact zone sampling to provide a better understanding of the distribution of troglofauna species throughout the ridge.

If necessary, additional bores will be drilled. No delay in colonization by any troglofauna present is anticipated (EPA 2007). All bores sampled will be un-cased. Details of bore geology and depths at which traps have been set will be provided with sampling results.

5.2.2 Sampling methods

Troglofauna sampling will be done by placing PVC tubes, baited with moist leaf litter, down bores (EPA 2007). These 'troglofauna traps' will have holes drilled in the sides of the PVC, an open top end and closed bottom. Leaf litter will be sterilized by microwaving. Bores will be sealed at the top while sampling occurs to minimize ingress of surface invertebrates, although experience has shown that invertebrates inhabiting the surface layers of soil will comprise the bulk of animals caught in the traps (Biota 2006).

Two traps will be set in each bore but these will be treated as providing a single sample for calculations of sampling effort. The lower trap will be about 1 m above water table (provided this is accessible) and the other mid-way down the bore. Traps will remain in place 6-7 weeks before they are retrieved, contents (including leaf litter) emptied into a zip-lock bag and sent to the laboratory.

5.2.3 Sample sorting and species identification

Troglofauna samples will be sorted in the laboratory using Berlese funnels. These consist of a container with a funnel into which the contents of the zip-lock bag are emptied. A light is placed above the container and a flask containing ethanol is aligned beneath the funnel. Troglofauna and soil animals move away from the light and heat of the lamp, down the funnel and fall into the ethanol in the flask (EPA 2007). After about 36 h, litter from each funnel will be removed and searched under a microscope for any remaining animals, which will be transferred to the appropriate flask. Then the contents of each flask will be sorted and identified using dissecting and compound microscopes, as appropriate.

All animals picked out of the samples will be identified to species or morpho-species level, unless damaged, juvenile or the wrong sex for identification, according to the specifications of EPA (2007, Table 3.4). Unpublished and informal taxonomic keys will be used to assist identification of taxa for which no published keys are unavailable and expert taxonomists will be consulted when necessary. The names of staff involved in fieldwork, sorting and identification, including taxonomists, will be provided when results are presented.

6.0 Reporting

The results of stygo- and troglofauna sampling at the Karara Iron Ore Project will be presented in a report that evaluates the conservation significance of the Magetite and Hematite Projects for stygofauna and troglofauna, respectively, and assesses potential risks that the projects may present to these conservation values. The report will provide information on:

- Background to the Karara Iron Ore Project
- Scope and objectives of subterranean fauna assessments, including reasons for limiting the scope of survey at the Magnetite and Hematite Projects to stygofauna and troglofauna, respectively
- Description of subterranean fauna habitats and likely physical impacts on the habitats, with impacts being mapped
- Survey designs, timing and sampling methods with maps of sites sampled
- Staff who undertook fieldwork and identified species
- Species collected and their conservation significance and ranges in relation to the areas impacted, as well as the conservation significance of the subterranean communities as a whole at the Magnetite and Hematite Projects
- Risk of the projects to the long-term survival of the subterranean communities and their constituent species, with any limitations to the studies and their conclusions being identified
- Commitments to any additional investigations or management, with a statement of the issues that investigations will address.

7.0 References

Biota (2006). Mesa A troglofauna survey: compilation of sampling results. Biota Environmental Sciences**,** Leederville**,** 51 pp.

Biota (2007). Hematite and Magnetite Projects desktop subterranean fauna assessment. Biota Environmental Sciences, Leederville, 29 pp.

Eberhard, S. M., Halse, S.A., Scanlon, M.D., Cocking, J.S. & Barron, H.J. (2005). Assessment and conservation of aquatic life in the subsurface of the Pilbara region, Western Australia. *In* World Subterranean Biodiversity. Proceedings of an International Symposium, 8th - 10th December 2004, Villeurbanne, France (ed. J. Gibert), pp. 61-68. University Claude Bernard of Lyon 1, PASCALIS European Research Programme, Lyon.

ecologia (2007a). Koolanooka/Blue Hills DSO Mining Project: stygofauna assessment. *ecologia* Environment**:** 19 pp.

ecologia (2007b). Koolanooka/Blue Hills DSO Mining Project: troglofauna assessment. West Perth, ecologia Environment, West Perth, 23 pp.

EPA (2007). Sampling methods and survey considerations for subterranean fauna in Western Australia (Technical Appendix to Guidance Statement No. 54). Guidance Statement 54A (Draft). Environmental Protection Authority, Perth, 32 pp.

Humphreys, W. F. (2001). Groundwater calcrete aquifers in the Australian arid zone: the context to an unfolding plethora of stygal biodiversity. *Records of the Western Australian Museum Supplement* **64**: 63-83.

Karanovic, T. (2004). Subterranean copepods (Crustacea: Copepoda) from arid Western Australia. *Crustaceana Supplement* **3**: 1-366.

Rockwater (2007). Karara Magnetite Project: groundwater impact assessment. Report 319.0/07/01. Rockwater Pty Ltd, Perth, 28 pp.

Watkins, K. P. and A. H. Hickman (1990). Geological evolution and mineralisation of the Murchison province, Western Australia. Bulletin 137. Geological Survey of Western Australia, Perth, 267 pp.