KOOLANOOKA / BLUE HILLS DSO MINING PROJECT

TROGLOFAUNA ASSESSMENT

Midwest Corporation Limited

12 September 2007

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Executive Summary

Midwest Corporation Limited (Midwest) is proposing to reopen and expand the previously mined ore bodies at Koolanooka in Western Australia. Midwest intends to ship existing fine ore stockpiles from site – the Direct Shipping Ore (DSO) component and, establish a shallow oxide open pit mining operation to the immediate south of the existing historical Koolanooka iron pit. Additionally, it is planned that some of the remnant detrital pisolitic scree ore on the western flanks of the existing pit will be mined in the late second or third year of the DSO Project. The DSO will be trucked to the proposed on-site crushing and screening plant via existing haul roads which will require minimal refurbishment.

A review of the geological data generated by the drilling programme did not suggest the presence of troglofauna within the proposed disturbance zones. There was a loss of sample in approximately 2-5 % of drill holes and where there was a loss, the typical loss was also 2 – 5% of sample. Such a loss is considered typical of RC drilling programmes (David Broomfield, pers. comm.).

However, due to the perceived ecological and conservation significance of Midwest Banded Ironstone Formations (BIFs) by the regulatory authorities and the public alike, Midwest commissioned *ecologia* Environment (*ecologia*) to undertake a preliminary troglofauna survey in February 2007.

A troglofauna survey was undertaken with the primary aim of determining the presence or absence of troglofauna in the impact areas of the proposed Koolanooka and Blue Hills pits. In case troglofauna was present, the second aim of the survey was to define the abundance, diversity and distribution of troglofauna in the project area.

Only a small number of drill holes were suitable for the insertion of troglofauna traps. This was due to the angle of the ore body, which necessitated drilling at 50°, a relatively small drilling programme, and the rapid rehabilitation of the drill pads. Over 30 drill holes were investigated, however only three holes were suitable for installation of three joined traps that comprised each ‘site’.

Traps were set at 10 metres, 20 m and 30 m below the natural ground level (bgl). Where there was waste soil piled on top of the ground level and drilled through, the depth of the first trap was adjusted so that it would be still positioned 10 m below the original ground level. Each trap unit was filled with wet, sterilised, locally sourced leaf litter and left in the bores for a period of 56 days. Tullgren funnels were used to provide efficient and effective extraction of any arthropod specimens present. Specimens were then viewed under a Leica L6 microscope to determine whether the specimens were obligate troglobites.

All traps set at 10 metres bgl contained two arthropod forms - springtails (Collembola) and mites (Acarina). The traps at 20 m bgl contained only a small number of springtails. The traps at 30 m recorded no specimens. Both groups were determined as non-troglobitic. Although largely lacking pigmentation, both species displayed functional eyes, indicating that they are not truly troglobitic. The fact that the traps set at 10 m bgl recorded a larger abundance of both groups also suggests that, rather than being true troglobites, these groups are soil dwelling forms that have moved from the surface down the drill hole toward the baited traps.

1.0 INTRODUCTION

Midwest Corporation Limited (Midwest) proposes to develop the Koolanooka/Blue Hills Direct Shipping Iron Ore (DSO) Mining Project to mine and process up to 2 mtpa of direct shipping grade iron ore for export, from a combination of three separate pits. The Koolanooka mine site is located approximately 160 km south east of Geraldton and 21 km east of Morawa. Blue Hills mine site is located 60 km to the east of Koolanooka (Figure 1.1). The mines were previously operated from 1966–1972 by WMC Resources Limited as part of the Geraldton Operations Joint Venture (GOJV) consisting of WMC Resources Ltd, Barrick Australia Limited and Australian Hanna Limited.

Midwest is currently exporting previously mined material from stockpiles at Koolanooka (Mining Proposal 4888, approved by the Department of Industry and Resources (DoIR) 21/12/2005) and site and port infrastructure is already permitted and in operation.

The Koolanooka/Blue Hills DSO Mining Project was referred to the EPA under Section 38 of the *Environmental Protection Act 1986* in September 2006 and June 2004. The EPA will formally assess the project on the basis of the potential environmental impacts of the project and has set the level of assessment as a Public Environmental Review (PER) (Current Assessment No 1653, previous Assessment No 1532). The public review period for this PER has been set at 6 weeks. The Koolanooka DSO Mining Project was also referred to the Department of Environment and Heritage (DEH) and it was determined that the project was not considered to be a Controlled Action under the *Environmental Protection and Biodiversity Conservation Act 1999* (Referral No 2004/1886).

Troglofauna are communities of terrestrial subterranean animals that inhabit air chambers in underground caves or small, humid voids. They are divided into three ecological categories: a) troglobites - obligate underground species that are unable to survive outside of the subterranean environment, b) troglofiles - facultative species that live and reproduce underground but that are also found in similar dark, humid microhabitat on surface; and c) trogloxenes - species that regularly inhabit underground caves and cavities for refuge but normally return to surface environment to feed. A fourth group, accidentals, wander into cave systems but cannot survive there (Howarth 1983). A species is considered truly troglobitic if it displays morphological characters that appear to restrict it to subterranean habitats (Howarth 1983). These include a significant reduction or a complete loss of eyes, pigmentation, wings, and a circadian rhythm (24-hour biological cycle), as well as development of elongated appendages, slender body form and, in some species, a lower metabolism. Troglobitic faunal assemblages are dominated by arthropods such as schizomids, pseudoscorpions, spiders, harvestmen, centipedes, millipedes, diplurans and mites. Many species are relict rainforest litter fauna from previous tropical climate eras (Humphreys 1993), therefore depending on subterranean habitats that are constantly humid. The food resources for the subterranean ecosystems are largely allochthonous (not formed in the region where found) and carried into caves and cavities by plant roots, water and animals (Howarth 1983).

True troglobites are incapable of dispersing on the surface and thus are subject to dispersal barriers due to geological structure of their habitat. Such dispersal limitations result in extremely small, fragmented species ranges and thus high levels of endemism (EPA 2003), which is characteristic of subterranean fauna worldwide (Strayer 1994). Examples include the millipede *Stygiochiropus peculiaris*, which is restricted to a single cave system at Cape

Range (Humphreys and Shear 1993). Exceptions exist, however - genetic analyses of some troglobitic mites from Pilbara provide evidence that these microscopic organisms have wide-range distribution, suggesting that they use other means of dispersal, possibly on the surface (Biota 2006).

The presence of troglofauna in Western Australia is still poorly understood and documented (Eberhard 2001). To date, troglofauna have been recorded from karstic limestone systems at Cape Range, Barrow Island and in the Kimberley (Biota 2005; Harvey 1988), pisolitic mesa formations in the Pilbara (Biota 2006) and in the cave systems of Yanchep (EPA 2005), Margaret River (Eberhard 2006) and across the Nullarbor (Moore 1995).

Due to the lack of available information concerning the presence of subterranean fauna and its habitat attributes / requirements in the Koolanooka project area or the Midwest region in general, it was considered imprudent to attempt to determine the potential impacts arising from Midwest proposal using solely the desktop review process. Instead, a preliminary sampling program was designed, with the primary aim being to determine the presence or absence of troglofauna in the area. If troglofauna were found, the second aim was to define abundance, diversity and distribution of the troglobites present, as well as their conservation significance, in order to formulate strategies to ensure the protection of the species concerned. This strategy was considered consistent with the Environmental Protection Authority's (EPA's) Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003).

Figure 1.1 Map of the Geraldton, Koolanooka and Blue Hills Local Area

1.1 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. Three of these principles are relevant to native fauna and flora:

- *The Precautionary Principle*

  Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principles of Intergenerational Equity*

  The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

  Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines adopted by the EPA, in this case Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003), Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004) and, principles outlined in the EPA's Position Statement No. 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2002).

Native fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level under the *Wildlife Conservation Act 1950* (WC Act).

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensure the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government*

Gazette, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection. The current listing was gazetted on the 1 December 2006.

1.2 AIMS AND OBJECTIVES

Midwest Corporation Ltd commissioned *ecologia* Environment (*ecologia*) to undertake a baseline biological survey of the troglofauna of the Koolanooka / Blue Hills study area as part of the environmental impact assessment for the project.

The EPA's objectives with regards to fauna management are to:

- maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and
- protect Specially Protected (Threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

Hence, the primary aim of the sampling programme was to determine the presence or absence of troglofauna in the area. In the event that troglofauna were found to be present, the second aim was to define the abundance, diversity and distribution of those troglobites and if of conservation significance, to formulate strategies to ensure the protection of those species through appropriate strategies.

1.3 LEGISLATIVE FRAMEWORK

Subterranean fauna are protected at a State level under the *Wildlife Protection Act 1950* (WP Act) and their environment is protected under the *Environmental Protection Act 1986* (EP Act). The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government Gazette*, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection. The current listing was gazetted on the 1 December 2006.

A Guidance Statement has been developed specifically to advise the public about the minimum requirements for environmental management with respect to subterranean fauna. EPA Guidance Statement 54: *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia 2003* states that:

"Proposals that, if implemented, could potentially have a significant impact on stygofaunal or troglofaunal habitat by:

- lowering the water table sufficiently to dry out the zone in which some species live, or otherwise artificially changing water tables; or
- changing water quality (e.g. increasing salinity levels or altering haloclines, increasing nutrient levels or the availability of organic matter, or introducing other pollutants); or

- destroying or damaging caves (including changing their air temperatures and humidity).

will be subject to formal EIA (Environmental Impact Assessment) under the EP Act.

The EP Act is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. Three of these principles are relevant to native fauna and flora:

- *The Precautionary Principle*

  Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principles of Intergenerational Equity*

  The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

  Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the EPA, in this case Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004), Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003), and principles outlined in the EPA's Position Statement No. 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2002). Additionally, a requirement to protect subterranean fauna, and to prevent or manage activities that may cause a decline in subterranean fauna populations is now written into the License to Operate for most mining and industrial activities.

Subterranean fauna in Western Australia are also protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensures the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

1.4 THE STUDY AREA

1.4.1 CLIMATE

The climate in the Koolanooka / Blue Hills area is semi-arid with a mean annual rainfall of approximately 335mm. Annual evaporation is 2,315mm and far exceeds the annual rainfall. Monthly average rainfall and temperatures recorded at Morawa, 21 km to the west of the proposed mine site are illustrated in Figure 1.2.

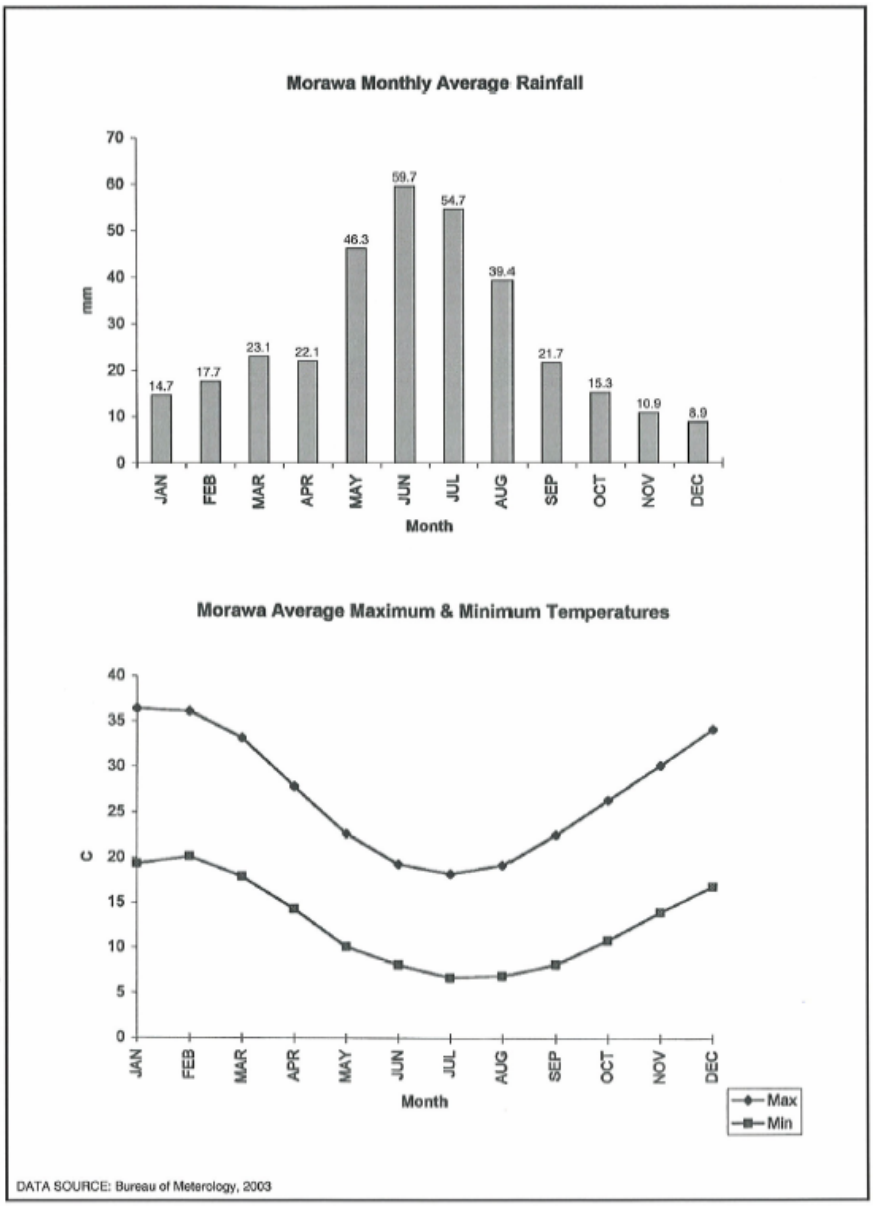

Figure 1.2 Average Rainfall and Temperature recorded at Morawa

1.4.2 GEOGRAPHY

1.4.2.1 Koolanooka

The major land systems in close proximity to the Koolanooka mine site are the Koolanooka, Pindar and Noolagabbi land systems. Small amounts of the Morawa and Mount Nunn land systems also occur in the area (Rogers, 1996).

The Koolanooka land system comprises the Koolanooka Hills, a range of rolling to very steep low hills with gently inclined foot slopes, which have been extensively cleared for agriculture. The system is characterised by a complex of Archaean and Proterozoic rocks. Soils are rocky or stony and commonly shallow, grading to red gravely loams.

The Pindar Land System is associated with the gently undulating sandplain with long gentle slopes that surrounds the Koolanooka Hills. This system has been even more extensively cleared for agriculture than the Koolanooka Land System, primarily for cropping and grazing. Soils are moderate to deep acidic sands with areas of gradational sands on ferruginous gravel and gritty sands on gravel.

The Noolagabbi land system is extensive level to very gently inclined flats and lower slopes found at the base of broad valleys. Extensively cleared for agriculture, the Noolagabbi system comprises quaternary alluvial and colluvial material forming valley infill on broad mature valleys often associated with saline drainage networks. Soils are relict red sands, loams and clays over a red-brown hardpan.

1.4.2.2 Blue Hills

The main Land Systems in close proximity to the Blue Hills mine site are the Tallering, Tealtoo, Yowie, Cunyu and Pindar Land Systems (Payne et al, 1998).

The Tallering Land System is characterised by prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks. The soils of the hill slopes and ridges are shallow red earths and stony red earths with smaller areas of red clayey sands with ferruginous gravel found on the stony and gravely plains.

The Tealtoo Land System consists of depositional surfaces of level to gently undulating loamy plains with fine ironstone lag gravel. The soils are deep red earths on ironstone gravel or hardpan, shallow hardpan loams and shallow red clayey sands with ferruginous gravel on hardpan or gravel.

The Yowie Land System dominated by loamy plains has soils of variable depth red clayey sands, hardpan loams and red earths on hardpan. Smaller areas of variable depth red clayey sands with ferruginous gravel over hardpan and deep red earths and juvenile alluvial deposits occur on the gravely plains and narrow drainage tracts of the land system.

The Cunyu Land System is characterised by calcrete platforms and intervening drainage floors and minor areas of alluvial plains. Soils of the calcrete platforms and plains are shallow red clayey sands or shallow calcareous loams, on calcrete. Soils of the alluvial plains also include shallow duplex on hardpan and deep duplex.

The Pindar Land System is associated with loamy plains surrounded by sand plain. Soils of the loamy plains are deep and shallow red earths on hardpan and occasionally shallow red clayey sands on hardpan. The soils of the sand sheet areas are deep red clayey sands.

1.5 REGIONAL CONTEXT

No studies examining the distribution and abundance of troglofauna have been conducted in the Murchison and Midwest regions to date. Until recently, troglofauna had been known only from karst landforms, e.g. caves in Yanchep, Margaret River, Cape Range Peninsula and along the Nullabor Plain. However, the recent discovery of troglobitic species within the iron ore rich Mesa landforms of the Pannawonica area and on Barrow Island suggests that troglofauna are likely to be found in a wider variety of landforms, geologies and regions within Western Australia.

2.0 SURVEY METHODS

2.1 SAMPLING METHODS

Drill holes located at three sites, one at Koolanooka (Figure 2.1) and two at Blue Hills (Figure 2.2) were sampled for troglofauna between the 27th and 28th of February. Each site was located within 50 m of the existing pit wall. A survey summary is presented below in Table 2.1.

Bores were sampled using custom designed traps which were lowered to a maximum depth of 30 meters and suspended. Each trap comprised three pvc units connected using nylon rope and fishing swivels and trace wires. Trap units were constructed from pvc piping sections cut into 10cm sections. The bottom end of the piping was covered in plastic gutter guard and the traps were filled with sterilised leaf litter (Plate 1).

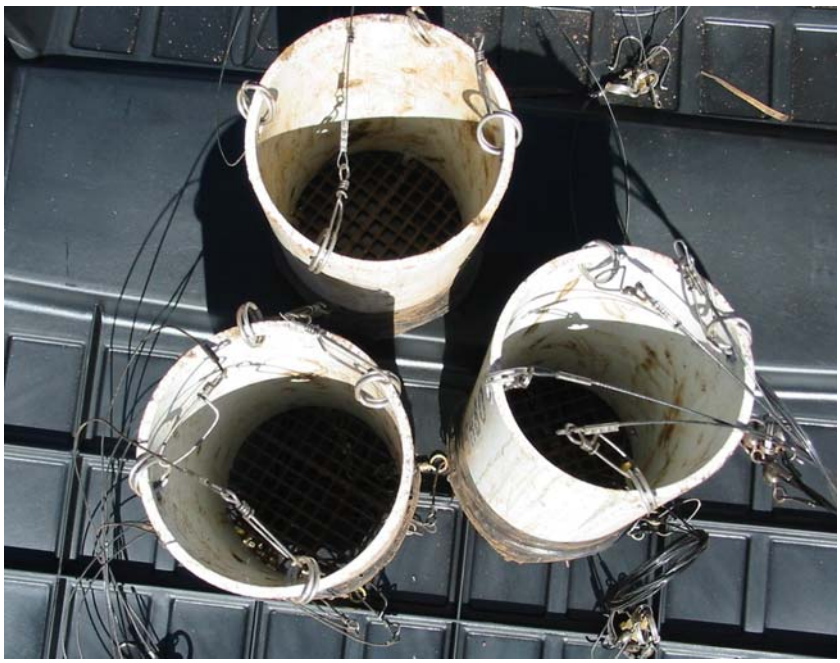

Plate 1 **Three Troglofauna trap units which are liked together and lowered into a borehole using plastic rope.**

Leaf litter was collected from under vegetation close to the sampled drill holes. The leaf litter was soaked and sterilised by microwaving at high setting for 30 seconds. This process facilitates leaf litter breakdown, kills any bacteria present so as to prevent contamination of sampling holes and groundwater, and kills any terrestrial predators that may reduce or completely remove troglofauna colonising the traps.

The sterilised leaf litter was stored in sealed containers filled with water in order to keep the leaf litter damp. The leaf litter was added to the traps immediately prior to inserting the traps into the bores.

Only drill holes which were sealed and unobstructed were used for sampling. The drill holes were re-sealed after the insertion of traps to maintain humidity levels and to reduce contamination from surface fauna.

Most holes were not maintained properly and thus were not in a suitable condition for sampling (i.e. blocked and uncapped). Despite attempting to sample all holes in the project area, only one hole at Koolanooka and two holes at Blue Hills were appropriate for the sampling program.

Traps were left in the ground for a minimum of eight weeks to ensure troglofauna colonisation. After this period, the traps were recovered and placed into plastic bags, which were immediately sealed to avoid contamination. Samples were then brought back to the *ecologia* Environment Perth laboratory for fauna extraction and sorting.

Table 2.1 Summary of bores sampled

Area	Site Name	Bait	Depth of Traps (m)			Number of Trap Nights Open	Sample Size (n)
			10m	20m	30m		
Koolanooka	TROG 1	Leaf litter and blue cheese.	√	√	√	56	**168**
Blue Hills	TROG 2	Leaf litter and blue cheese.	√	√	√	56	**168**
Blue Hills	TROG 3	Leaf litter	√	√	√	56	**168**
						168	**504**

In order to efficiently and effectively extract the live arthropod specimens from the trap units, the contents were transferred into Tullgren Funnels (Upton 1991) so that any specimens were immediately preserved in 70 % ethanol.

Figure 2.1 Koolanooka Troglofauna Drill Hole Sampling Locations

Figure 2.2 Blue Hills Bore Sampling Locations

2.2 SITE SELECTION

A total of 40 drill holes were investigated as potential samplable holes. A process of elimination was used due to the limited number of available and serviceable holes. The holes closest to the existing pit walls and cut back areas were investigated first, then sites progressively further away.

The only serviceable hole at Koolanooka (Trog 1) was located on the old waste dump on the eastern side of the Koolanooka pit. One of the sites established at Blue Hills (TROG 2) was also in a similar situation (Plate 3). In this case, the top 6 meters was comprised of waste material. TROG 3 at Blue Hills was situated at the bottom of an old pit, and the hole did not run through any waste material.

The large number of blocked and unserviceable holes at both Koolanooka and Blue Hills prevented a greater number of holes from being sampled. Loose waste material slipping from the top end of holes during investigation and attempted insertion of traps helped to explain the high proportion of unserviceable holes.

Plate 2 Troglofauna trap site TROG 1 at Koolanooka.

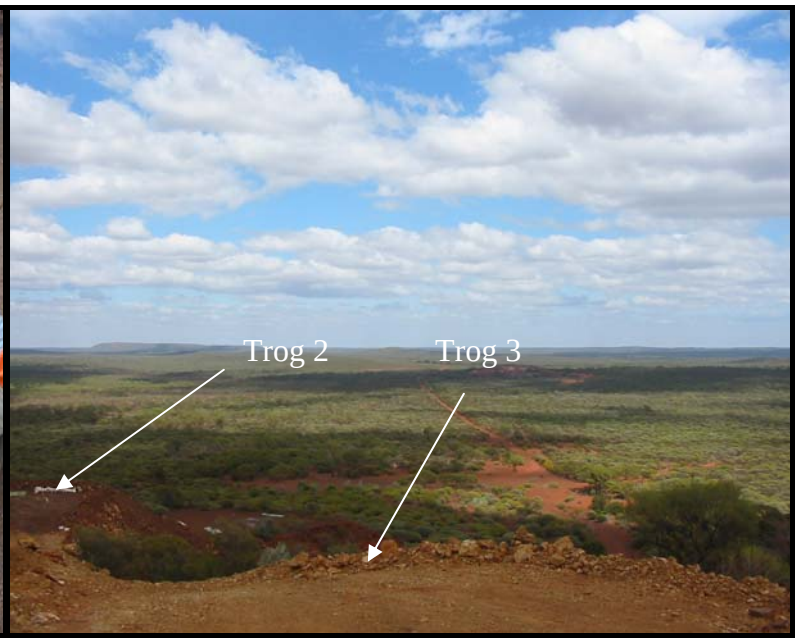

Plate 3 The location of troglofauna sampling sites (TROG 2 and 3) at Blue Hills. Note the waste material along the slope near TROG 2.

2.3 CURATION AND SPECIES IDENTIFICATION

All specimens were transferred from the 70% ethanol solution, placed at the bottom of the Tullgren Funnels during extraction, to glass preservation vials containing 100% absolute ethanol. This was done to ensure that the biological material was preserved appropriately for genetic analyses, should such methods be required to determine specimen identification. All vials were labelled with the date, site, GPS coordinates and the name of the collector(s). These details were written on the outside of the container and on waterproof paper placed in each vial.

The recorded specimens were identified to the lowest taxonomic resolution necessary. *Ecologia* scientists conducted the preliminary sample processing and troglobitic determination. Dr Mark Harvey at the Western Australian Museum (WAM) also viewed the specimens in order to confirm the absence of troglobitic forms.

3.0 RESULTS

No troglobitic arthropods were identified during this survey.

Springtails (Collembola) were recorded from all traps set at 10 metres depth, and from 20 and 30 m depths at Site Trog 2. Mites (Acarina) were found at Site Trog 2 at 10 m depth only. The presence of functional eyes on all specimens and the fact that the highest abundances were recorded in the traps closest to the surface strongly suggest that these individuals are soil dwelling forms that have moved from the surface down the drill hole toward the baited traps. As such, these forms are not truly troglobitic and therefore unlikely to be rare and restricted species and therefore unduly impacted upon by the Midwest proposal.

Table 3.1 The Troglofauna Results Obtained From the Koolanooka and Blue Hills Areas.

Site	Depth of Trap			Species Richness
	5 m	10 m	15 m	
Trog 1	C			**1**
Trog 2	C,A	C	C	**2**
Trog 3	C			**1**
	2	**1**	**1**	**2**

* 'C' refers to Collembolla (Springtails) records; 'A' refers to Acarina (Mites) records.

4.0 IMPACT RISK ASSESSMENT

A risk assessment is normally undertaken to determine potential impacts arising from the development on troglofauna and the residual impacts following the implementation of management strategies identified in this document. The 'Significance' of the risks is classified as either "High" (site/issue specific management programmes required, advice/approval from regulators required), "Medium" (specific management and procedures must be specified) or "Low" (managed by routine procedures). The impact risk assessment matrix is presented in the

Table 4.1.

Table 4.1 Koolanooka/Blue Hills Troglofauna Risk Assessment

Biological Environmental Impact Risk Assessment												
Project: Koolanooka DSO Project		*Location:Koolanooka and Blue Hills*					*Date: 6th June 2007*					
			Inherent Risk					Residual Risk				
Process/Activity	**Event**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Mining operations	Expansion of the Koolanooka and Blue Hills pits	Removal of Troglofauna habitat	1	5	5	Low	As no troglofauna habitat has been identified, no controls are necessary.	1	5	5	Low
	Hydrocarbon and other contamination	contamination of troglofauna habitat	1	3	3	Low	As no troglofauna habitat has been identified, no controls are necessary.	1	3	3	Low
DSO Component	Removal of existing fines	removal of Troglofauna habitat	1	5	5	Low	As no troglofauna habitat has been identified, no controls are necessary.	1	5	5	Low
	Hydrocarbon and other contamination	contamination of troglofauna habitat	1	5	5	Low	As no troglofauna habitat has been identified, no controls are necessary.	1	3	3	Low

Likelihood:

Value	Description	Criteria
5	Almost Certain	Environmental issue will occur, is currently a problem or is expected to occur in most circumstances.
4	Likely	Environmental issue has been a common problem in the past and there is a high probability that it will occur in most circumstances.
3	Possible	Environmental issue may have arisen in the past and there is a high probability that it could occur at some time.
2	Unlikely	Environmental issue may have occurred in the past and there is a moderate probability that it could occur at some time but not expected.
1	Rare	Environmental issue has not occurred in the past and there is a low probability that it may occur in exceptional circumstances.

Consequence:

Value	Description	Health & Safety	Environmental & *Example*
5	Catastrophic	Fatality(s) or permanent disability.	Significant extensive detrimental long-term impact on the environment, the community and/or public health. Catastrophic and/or extensive chronic discharge of persistent hazardous pollutant. Major breach of regulation identified and/or serious incident n *Major hydrocarbon spill to a land area, major tailings wall failure with extensive surface and water pollution.*
4	Major	Multiple Lost Time Injuries (LTI) Serious, chronic, long term effects. Admission to intensive care unit or equivalent.	Issues of a significant nature (medium term impact). It also includes incidents that could politically, legally or economically affect SDGM regardless of extent of environmental impact. Clean up or remediation external assistance required. *Groundwater pollution with potential serious biological damage and/or contamination of a potentially useable groundwater resource.*
3	Moderate	Single Lost Time Injury (LTI)	Long-term detrimental environmental or social impact. Issues of a continuous nature but with limited environmental effect. Probable serious breach of regulation identified with serious prosecution or fine. Clean up or remediation some external assistan *Groundwater pollution with limited biological damage and no contamination of a potentially useable groundwater resource.*
2	Minor	Medical Treatment Injury (MTI) Restricted Work Injury (RWI)	Short term impact on the environment but a non-recurrent issues. Public concern restricted to re-occurring local complaints. Clean up or remediation activities undertaken internally. *Isolated incidences of pollution standards that are exceeded.*
1	Insignificant	First Aid Injury (FAI) Nuisance value	Technical breach of environmental requirements with no environmental effect or no lasting detrimental effect on the environment. Public concern restricted to local complaints. Clean up or remediation undertaken internally. *Licence requiring a toe drain around TSF to receive any seepage. The drain is yet to be installed but there is no seepage.*

5.0 MANAGEMENT RECOMMENDATIONS

As no troglobitic fauna were recorded, no specific management recommendations can be made.

6.0 SURVEY TEAM

The Midwest Koolanooka Blue Hills DSO Project Troglofauna Biological Assessment Survey described in this document was planned, coordinated and executed by:

ecologia Environment

1025 Wellington Street

WEST PERTH WA 6005

Name	Position	Qualifications
Magdalena Zofkova	Senior Environmental Biologist / Project Manager	PhD (Zoology)
Jarrad Clark	Senior Environmental Biologist	Bsc. (Environmental Science)
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Licenses

The collection of invertebrates requires no licence under Department of Environment and Conservation guidelines.

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