September 2008

KOOLANOOKA – BLUE HILLS DSO MINING PROJECT STYGOFAUNA ASSESSMENT SURVEY

Providing sustainable environmental strategies, management and monitoring solutions to industry and government.

ecologia ENVIRONMENT

Midwest Corporation Limited

MIDWEST CORPORATION LIMITED

KOOLANOOKA/ BLUE HILLS DSO MINING PROJECT

Stygofauna Assessment Survey

Report prepared by

ecologia ENVIRONMENT

Prepared for

Midwest Corporation Limited

19 September 2008

Document Status						
Rev No.	Author	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	M. White	M. Zofkova	04/08/08			

Restrictions on Use

This report has been prepared specifically for Midwest Corporation Limited. Neither the report nor its contents may be referred to or quoted in any statement, study, report, application, prospectus, loan, or other agreement document, without the express approval of Midwest Corporation Limited and/or *ecologia* Environment.

***ecologia* Environment**
1025 Wellington Street
WEST PERTH WA 6005
Phone: 08 9322 1944
Fax: 08 9322 1599
Email: admin@ecologia.com.au
www.ecologia.com.au

Table of Contents

Tables

Figures

Executive Summary

Midwest Corporation Limited (Midwest) is proposing to reopen and expand the previously mined ore bodies at Koolanooka and Blue Hills in the Murchison Region of Western Australia. Midwest intends to ship existing fine ore stockpiles from site 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 Direct Shipping Ore (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.

In order to determine the potential impact to subterranean aquatic fauna (stygofauna), Midwest commissioned *ecologia* Environment to undertake a preliminary stygofauna survey in February 2007. Due to the relatively small scale of the project and the limited number of bores available at the time, the aim of the sampling assessment was to define the presence or absence of stygofauna in the project area. Should significant stygofauna species or communities be present within the project area, a more extensive sampling program would need to be developed and conducted at a later date.

Stygofauna may occur in groundwater within suitable substrate such as limestone strata and paleochannels within the Midwest/Yilgarn area. The Koolanooka Springs Road borefield comprised eight bores suitable for stygofauna sampling. As four of these contained pumps which were used to supply water for exploration purposes during phase one of surveying at the time, only the four remaining bores were sampled at Koolanooka during the first phase of sampling in February 2007. During the second phase in March 2008, seven bores were sampled within the Koolanooka Borefield and a single bore was sampled at Tilley Siding. In addition, four bores /wells were sampled regionally in order to assess the regional significance of the results within the project impact areas.

Stygofauna sampling took place in three stages:

1. Description of the physical parameters of the bore;
2. Measurement of a number of physico-chemical parameters using a 90 FL multi-parameter meter from water bailed using sterile single use bailers; and
3. Stygofauna sampling following the methods recommended by the Department of Environment and Conservation (DEC).

Phase 1 yielded no stygofauna, while Phase 2 yielded two specimens of a stygobitic copepod from the genus *Microcyclops*. One of these specimens was collected within the Project area, and the other specimen was collected in a regional well approx. 70 km away from the Project area. The species identity could not be confirmed as both specimens were immature, however, based on the location of the Project area, the specimens are likely to belong to a cosmopolitan species *Microcyclops varicans*.

Only established bores and pit waters will be utilised for water supply at Koolanooka - water which is already in use for current operations. As the current survey very limited stygofauna presence, this water contains little risk that its use will impact on significant stygofauna populations. Similarly, as excavation of both the East and West Mungada pits

will not extend below the water table, no dewatering will be required at this location, and hence no interference to stygofauna populations is expected to occur from these sources. Given that no dewatering of the aquifer within the project area is required and specimens were found approximately 70 km apart, both inside and outside of the impact area, no significant impact from the Project is expected to occur on the species.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

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. Koolanooka/blue hills lies near the western border of the Yilgarn Craton within the southern region of the Murchison district. The project is based at the old Koolanooka mine site approximately 160 km southeast of Geraldton and 21 km east of Morawa with Blue Hills a further 60 km east of Koolanooka (Figure 1-1).

No mining below the water table is expected at either location, however water for ore processing will be required via abstraction of a suitable source in the vicinity of either Koolanooka or Blue Hills. In order to ascertain the presence or absence of stygofauna within the existing Koolanooka Borefield, Midwest commissioned *ecologia* Environment to undertake an initial baseline stygofauna survey. The aim of the sampling program was to determine the presence or absence of stygofauna in the project area. Midwest were aware that in the event that stygofauna were shown to be present in the Koolanooka borefield, a more intensive and extensive sampling regime would need to be developed to meet EPA guidelines (EPA 2003a) and expectations.

1.2 STYGOFAUNA

Stygofauna (“stygo” meaning adapted to living underground and referring to the River Styx in Greek and Roman mythology) are obligate, groundwater dwelling fauna known to be present in a variety of rock types including karst limestone, fissured rock (e.g. granite) and porous rock (e.g. alluvium)(Mamonier et al. 1993). They are typically adapted for the subterranean environment with features such as lack of pigmentation, elongated appendages, filiform body shape (worm like) and reduced or absent eyes. Many of these fauna have other primitive features which link them to geological periods when vast areas of Australia were covered by tropical forests. They are regarded as ‘relict’ fauna which have survived in aquifers over geological timeframes (Humphreys 1993; Danielopol and Stanford 1994; Humphreys 2001).

Stygofauna have significant roles in our ecosystem, they graze on nutrients and matter percolating down from the ground's surface maintaining water quality. Groundwater is also kept flowing as stygofauna continually maintain voids between soil particles.

Any proposed impact to the environment may have an effect on stygofauna. Stygobitic species are particularly at risk by any action that specifically reduces the standing level of the water table or if not reducing it any foreign pollutants can have drastic effects as stygofauna can be sensitive to any change in water chemistry. Surface impacts can also have indirect effects on the subterranean environment. Voids in which stygofauna dwell can be at risk of compaction destroying their habitat and reducing the possible water flow from the surface.

The presence of stygofauna in Western Australia has been well documented, especially from regions such as Pilbara, Kimberley, mid-west and south-western Western Australia (De Laurentiis et al. 2001; Humphreys 2001; Wilson and Keable 2002; Eberhard 2004; Karanovic 2004a; Cho et al. 2005). The aim of the sampling program was to define the abundance, diversity and distribution of stygofauna in the project area so that a strategy to ensure the protection of important habitats for subterranean communities could be developed. This is 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 2003b).

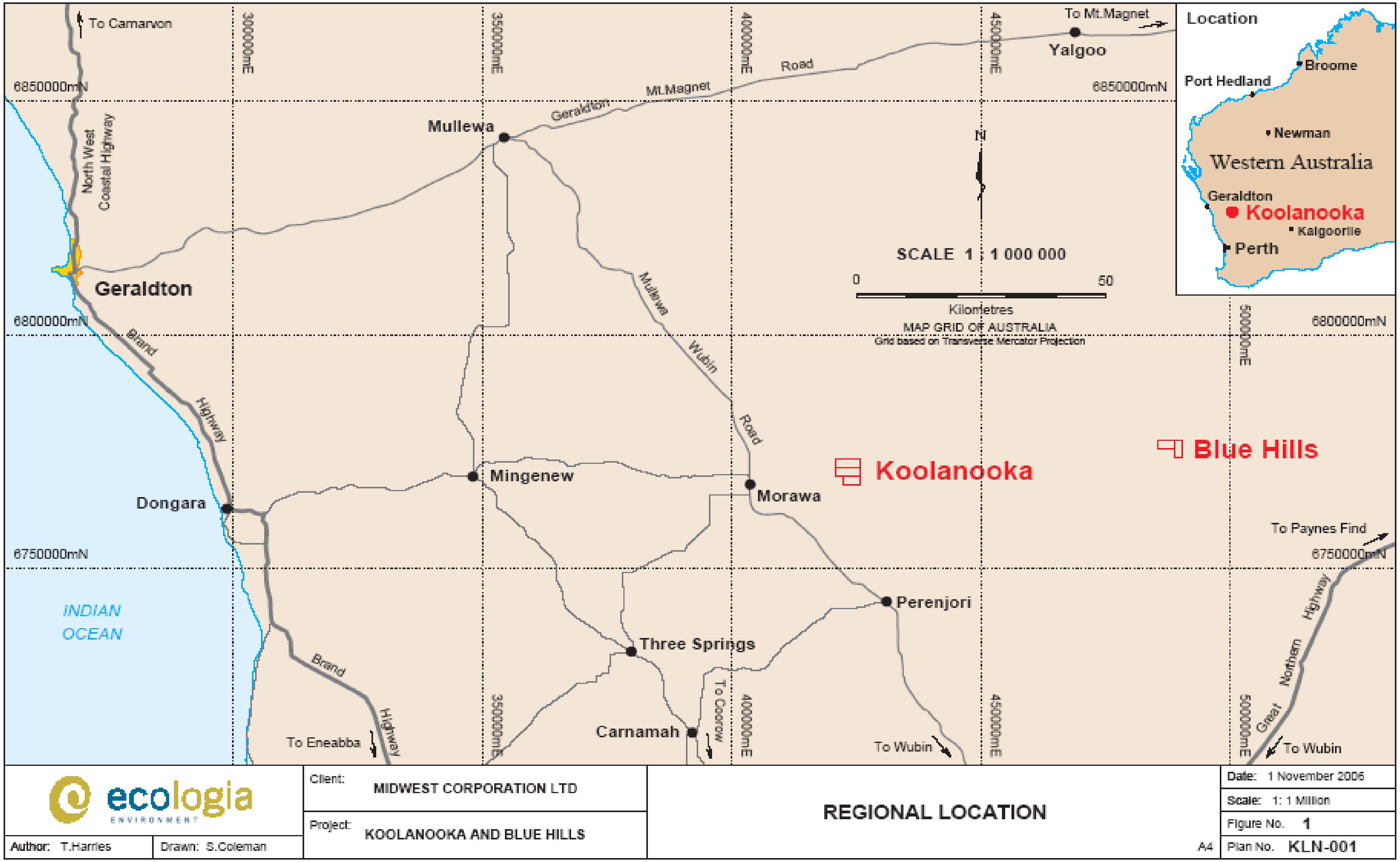


Figure 1-1 Locality of the Koolanooka and Blue Hills DSO Project.

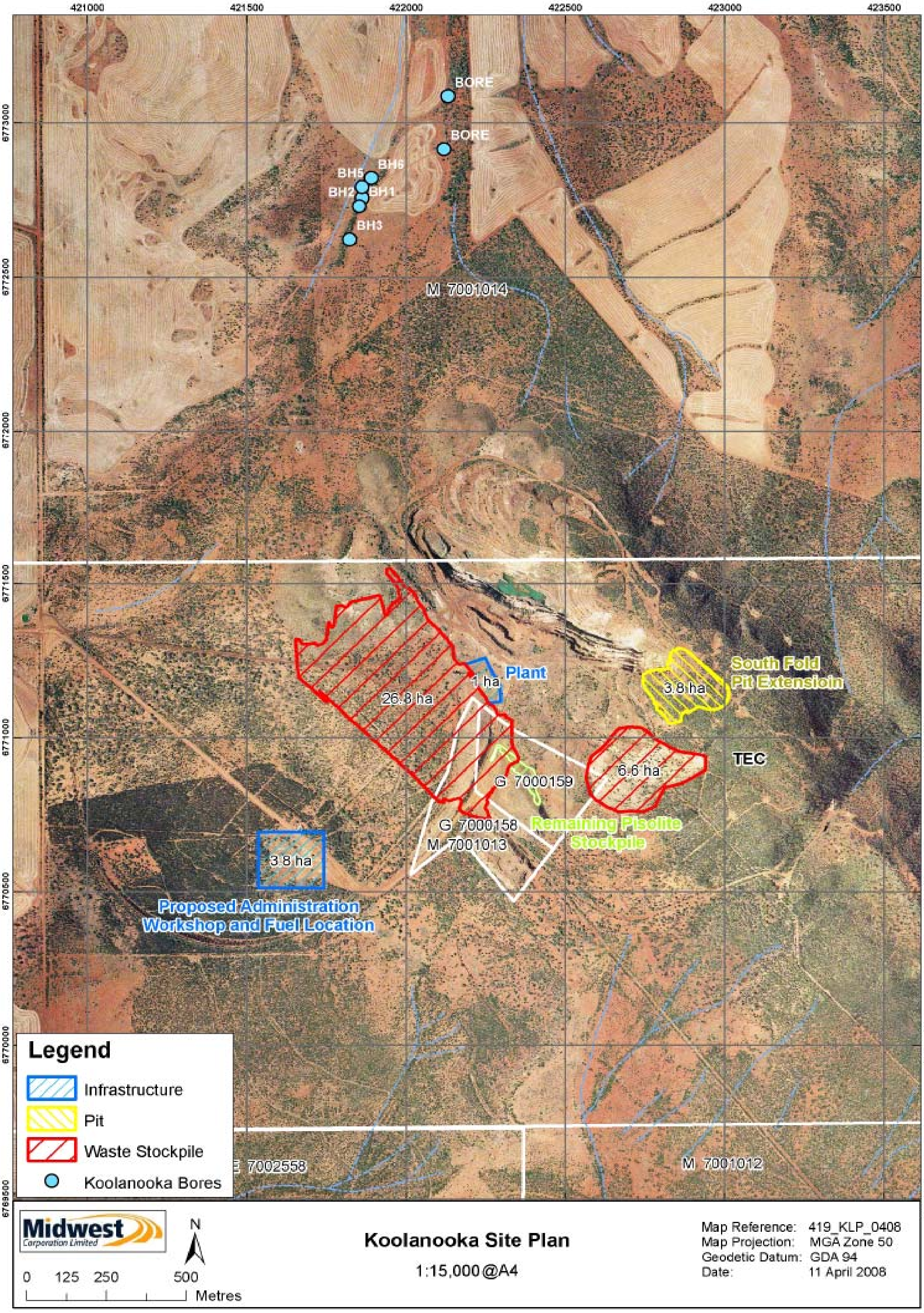
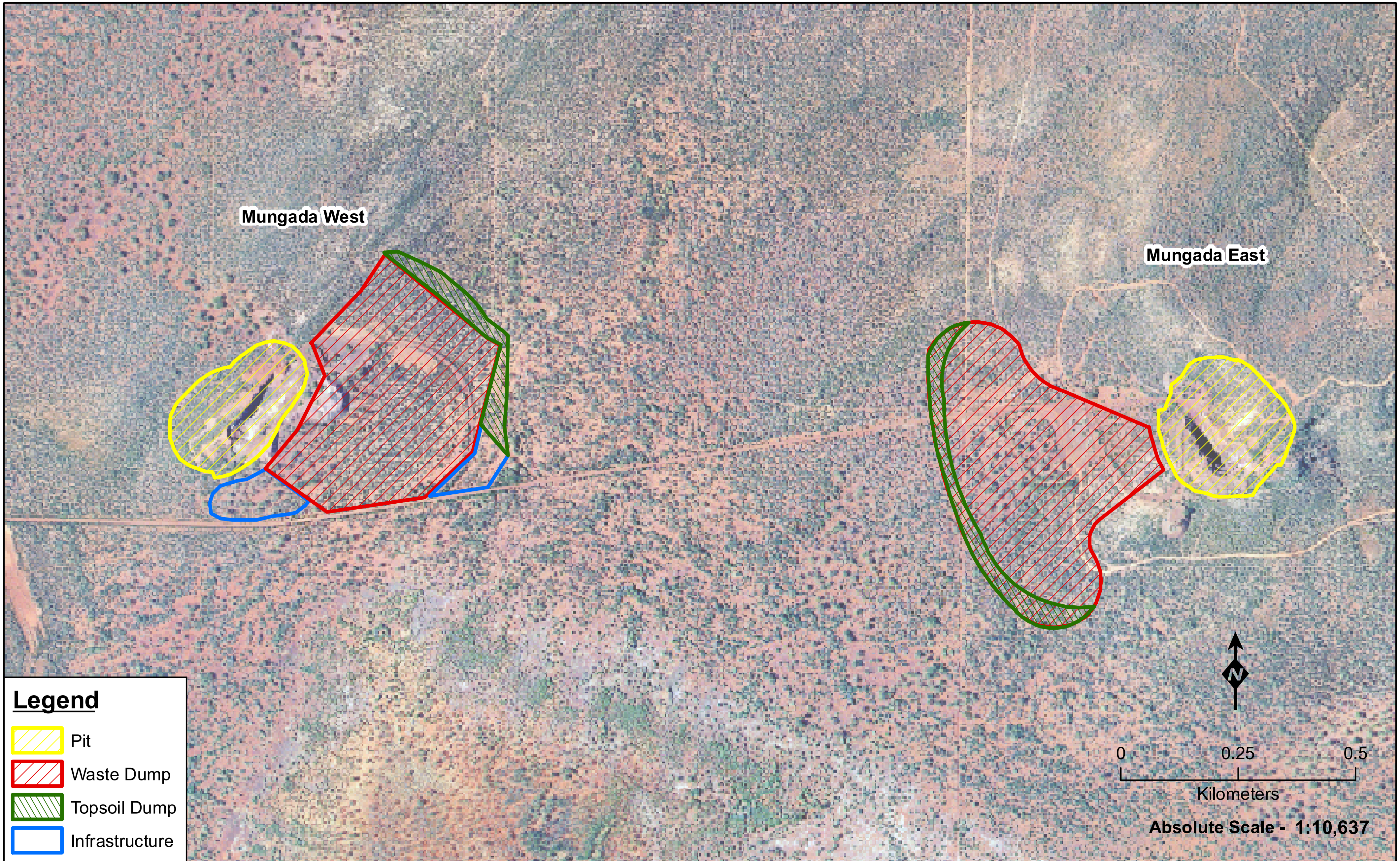


Figure 1-2 Koolanooka Project infrastructure



ecologia ENVIRONMENT

Midwest Corporation Limited

Blue Hills Project Area

Figure:
Project ID:

Drawn: SG
Date: 24/09/08

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

A4

1.3 LEGISLATIVE FRAMEWORK

Subterranean fauna are protected at a State level under the *Wildlife Conservation Act 1950* (WC 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. Currently there are only a handful of subterranean species (stygofauna) which are listed under the WP Act. These are almost entirely restricted to the Cape Range karstic system. No subterranean fauna from the Midwest region are currently listed as requiring special protection.

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 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),

<u>will</u> 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 must 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 undergoing formal EIA assessment 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 Licence 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 SURVEY OBJECTIVES

Midwest Corporation Limited commissioned ecologia Environment (ecologia) to undertake a baseline biological survey of the stygofauna 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 Subterranean terrestrial invertebrate fauna; and

- protect Specially Protected (Threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of the project on the invertebrate fauna of the area, thereby ensuring that these objectives will be upheld.

Specifically, the objectives of this survey were to undertake a survey that satisfies the requirements documented in EPA's Guidance Statement 56 and Position Statement No. 3, thus providing:

- A review of background information;

- An inventory of Subterranean fauna species occurring in the study area, incorporating recent published and unpublished records;
- An inventory of species of biological and conservation significance recorded or likely to occur within the project area and surrounds;
- A review of regional and biogeographical significance, including the conservation status of species recorded in the project area; and
- A risk assessment to determine likely impacts of threatening processes on subterranean fauna within the study area.

2 BIOPHYSICAL ENVIRONMENT

2.1 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 mine site are illustrated inFigure 2-1.

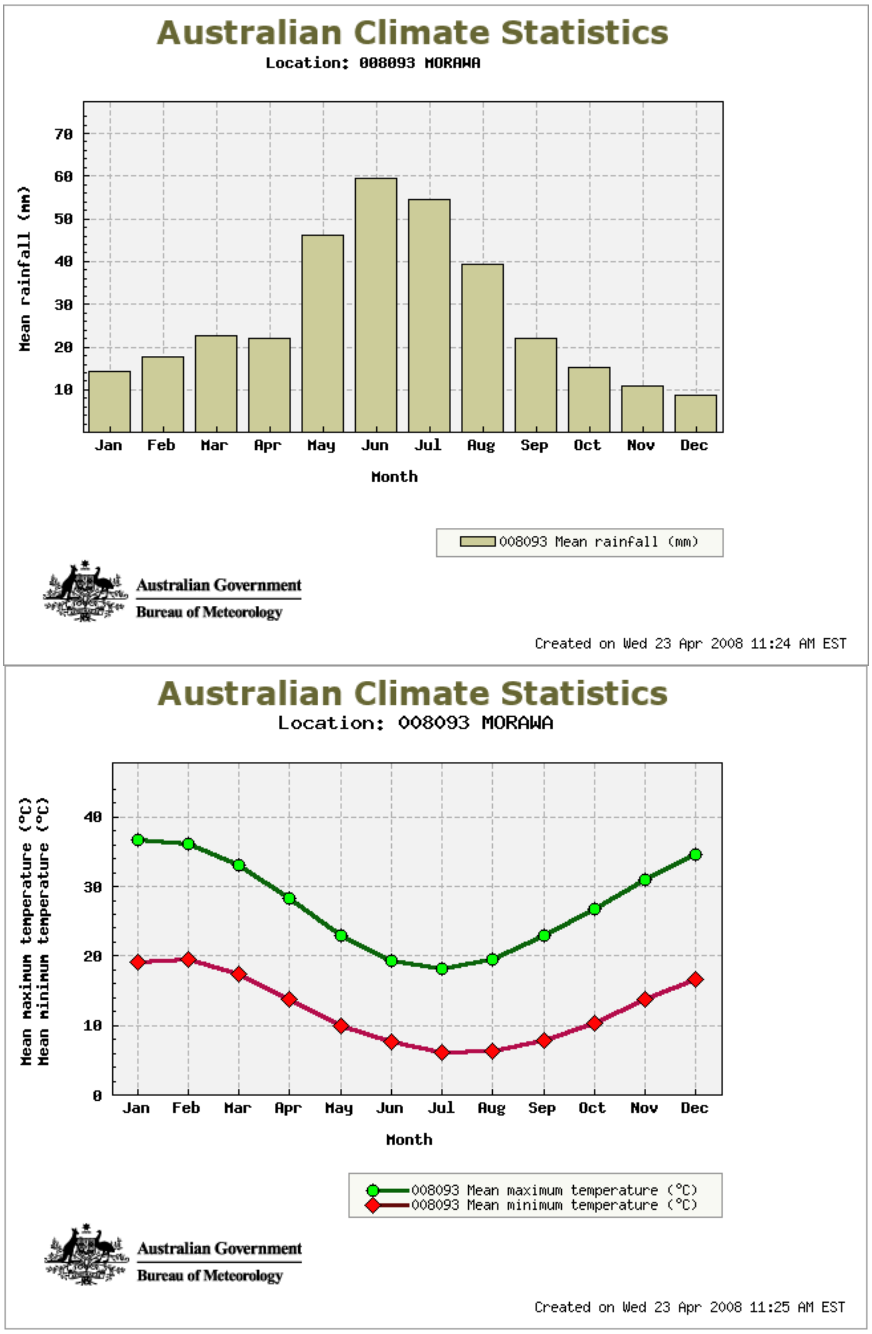


Figure 2-1 Average annual rainfall and temperature of Morawa

2.2 HYDROLOGY

The proposed mining of the South Fold and Pisolite orebodies will occur within existing disturbed areas whilst the shipping of the fine ore is a simple earthmoving operation. The South Fold orebody is effectively a cut-back situation to the south-east of the existing pit and the lowest level of the proposed pit will be approximately 95 metres above the free standing water table, thus aquifer dewatering will not be necessary at this stage. Similarly, the Pisolite ore body to the west of the existing pit is considerably higher than the regional water table and the mining of this orebody will not disturb either the ground or surface waters.

Water supply for site dust suppression and for watering of the haul roads is expected to come from the pumping of water out of the existing pit at Koolanooka, thus limited aquifer abstraction will be required for this purpose. No water will be pumped off site and in the second year of operation, water will be sourced locally for wet screening of the pisolite ore. Aquifer abstraction will be required however for ore processing. Groundwater exploration for this purpose by Rockwater (Rockwater 2004, 2006) has revealed negligible results to date.

Should further groundwater exploration activities identify a suitable water source for ore processing, additional stygofauna surveys will be required, depending on the salinity levels of the aquifer under investigation. Many potentially sources investigated to date in the area have been shown to have salinities approaching that of seawater and thus, are unlikely to contain stygofauna.

2.2.1 Surface waters

There are no permanent fresh water streams. Water courses which drain from the Koolanooka Hills to the south-west and north flow only during extended thunderstorm activity. Annual evaporation far exceeds rainfall and dams constructed to intersect these ephemeral flows are of limited use for water supply.

2.2.2 Groundwater

The regional ground water level generally occurs at around 255m AHD. Annual evaporation far exceeds annual rainfall although some minor subsurface recharge does occur during intense rainfall events. Groundwater in the bottom of the existing pit is slightly saline but personal communication with ex WMC employees suggests inflowing groundwater during previous mining operations was relatively fresh.

Storage systems for ground water in the region may be broadly divided to three types (Johnson and Wright 2001).

- *Shallow Alluvial Sediments* - Limited volumes of ground water are stored in surficial sandy sediments associated with current drainages.
- *Fractured Bedrock* - Bedrock in the project area consists of Archaean supracrustal rocks enclosed in gneissic rocks and intruded by later granitoid rocks. The supracrustal sequence comprises a basal volcanic facies conformably overlain by clastic and chemical sedimentary rocks. The sedimentary sequence which is the focus of attention in this project consists of siltstone, feldspathic sandstone, pebbly sandstone and minor beds of quartz-pebble conglomerate overlain by, and interbedded with, banded iron-formation and well-laminated to massive, graded pelitic shale. It has been observed from drill core that the sedimentary sequence is almost completely porous in the oxidised upper levels. Secondary permeability in the fresh deeper levels

is less pronounced but may be enhanced by the presence of large strike slip faults that truncate the orebody.

- *Palaeodrainages* - Drainage during the Tertiary sub-era in the region was in an arcuate river system which flowed around the Koolanooka Hills to the west, north and east. This is now delineated by a series of salt lakes (Lake Nullewa to the north and Weelhamby Lake to the east) which flow periodically during intense rainfall events.

2.3 BIOGEOGRAPHY

Koolanooka/blue hills lies near the western border of the Yilgarn Craton within the southern region of the Murchison district. The project is based at the old Koolanooka mine site approximately 190 km east of Geraldton with Blue Hills a further 70 km east of Koolanooka.

The project area lies within the Western Murchison subregion described as:

> "Mulga low woodlands, often rich in ephemerals, on outcrop and fine textured Quaternary alluvial and eluvial surfaces mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout the hummock grasslands on Quaternary sandplains, saltbush shrublands on calcareous soils and Halosarcia low shrublands on saline alluvia" (Desmond et al. 2001).

The area of the Western Merchison subregion is 7,847,996 ha. Only 0.06% of the subregion is classed as conservation land.

In the eastern part of the subregion calcrete aquifers are present. Calcrete is known to provide suitable habitat for stygofauna. There is a limited understanding of stygofauna distribution although Humphries et al. suggests the Murchison system contains significant stygofauna.

3 SURVEY METHODS

3.1 SURVEY TIMING

The stygofauna survey comprised two phases of sampling separated by a year interval. A summary table of survey timing is presented below (Table 3-1):

Table 3-1 Survey timing

Aspect	Bores Sampled Phase 1 (26th Feb 2007)	Bores Sampled Phase 2 (13th – 14th March 2008)	Total Sample Size to Date
Impact areas	4	8	**12**
Non-impact areas	0	4	**4**
Sample Size	**4**	**12**	**16**

3.2 SAMPLING METHODS

Stygofauna sampling was conducted within 8 bores for the Koolanooka and Tilley Siding impact area. The "impact area" is defined as the footprint of the drawdown area produced by the dewatering process required to enable mining below the water table.

Four reference sites beyond the proposed drawdown footprint were also sampled (Figure 3.1). These included regional pastoral bores/wells within the Karara / Blue Hills area. The aim of sampling the reference sites was to determine the presence/absence of stygofauna beyond the project impact area.

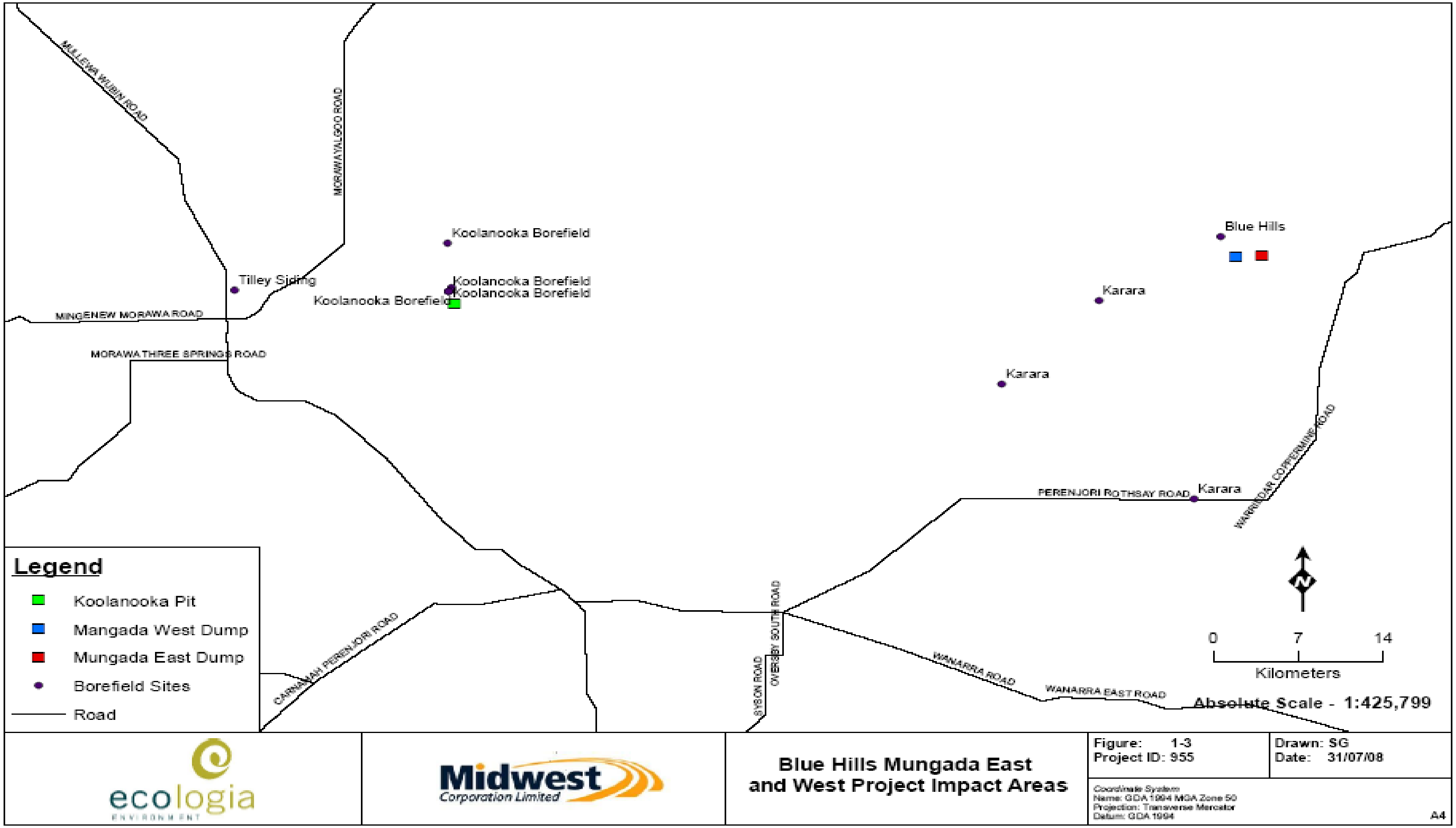

MULLEWA WUBIN ROAD
MORAWA YALGOO ROAD
Koolanooka Borefield
Tilley Siding
Koolanooka Borefield
Koolanooka Borefield
Koolanooka Borefield
MINGENEW MORAWA ROAD
MORAWA THREE SPRINGS ROAD
Blue Hills
Karara
Karara
PERENJORI ROTHSAY ROAD
Karara
WARRIEDAR COPPERMINE ROAD
Legend
Koolanooka Pit
Mangada West Dump
Mungada East Dump
Borefield Sites
Road
CARNAMAH PERENJORI ROAD
SYSON ROAD
OVERSBY SOUTH ROAD
WANARRA ROAD
WANARRA EAST ROAD
0
7
14
Kilometers
Absolute Scale - 1:425,799
Midwest Corporation Limited
Blue Hills Mungada East and West Project Impact Areas
Figure: 1-3
Project ID: 955
Drawn: SG
Date: 31/07/08
Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
A4

Figure 3-1

Table 3-2 Stygofauna sampling sites

Phase sampled	Area	Bore ID	GPS Coordinates (WGS84)
Phase 1 & 2	Koolanooka Borefield	BH03	421821E 6772620N
Phase 1 & 2	Koolanooka Borefield	BH02	421854E 6772732N
Phase 1 & 2	Koolanooka Borefield	BH01	421861E 6772757N
Phase 2	Koolanooka Borefield	BH10	422127E 6773093N
Phase 2	Koolanooka Borefield	BH07	422119E 6772914N
Phase 2	Tilley Siding	Hole 8	404289E 6772923N
Phase 1 & 2	Koolanooka Borefield	BH05	421862E 6772792N
Phase 2	Koolanooka Borefield	BH06	421887E 6772819N
Phase 2	Blue Hills	Mungamia Well	485291E 6778327N
Phase 2	Karara	Blue Well Bore	475238E 6771832N
Phase 2	Karara	Tootah Well	467293E 6763418N
Phase 2	Karara	Pop Bore	483050E 6751877N

At each site physical properties of the bore were recorded and using a dipper the standing water level (m). Water samples were withdrawn using a bailer submerged under the water level. From the sample a water meter measured the following physical parameters:

- pH
- Temperature (°C)
- Dissolved Oxygen (DO) (ppm, %sat)
- Oxidation Reduction Potential (ORP) (mV)
- Conductivity (µS/cm)
- Total dissolved solids (TDS) (ppm)

Where possible each hole was sampled three (3) times each with a 50µm and a 150µm weighted net for a total six (6) sampling attempts. In cases where not all six samples could be collected (dry holes, lost nets etc) a note was made. The contents of each sample were rinsed in a 50µm sieve and the contents transferred into vials of 100% ethanol. 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.

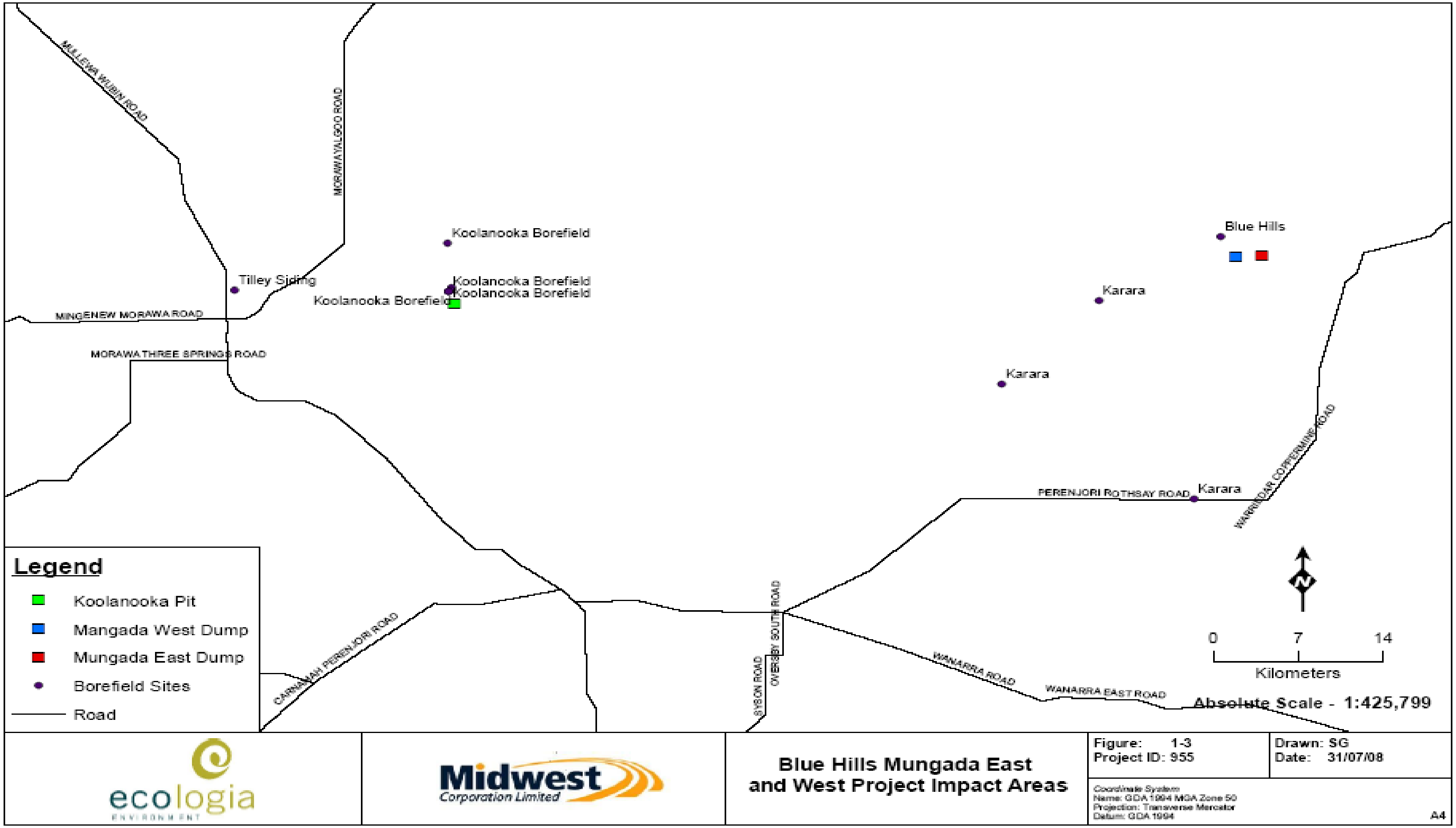


Figure 3-1 Koolanooka Borefield stygofauna sampling sites

3.3 DATA ANALYSIS AND SPECIES IDENTIFICATION

Sample sorting was completed by Melissa White and Catherine Taylor at *ecologia*'s Perth laboratory under a Leica S6 microscope. Each potential stygofauna specimen was placed in a vial with 100% ethanol (to allow for potential DNA analysis) and assigned a unique identification code for tracking.

3.4 STAKEHOLDER CONSULTATION

e*cologia* scientists conducted the preliminary sample processing and stygofaunal determination. Potentially stygobitic specimens were sent to the relevant taxonomic specialist for further identification.

3.5 SURVEY TEAM

The survey was executed by *ecologia* Environment. The following personnel contributed to the successful completion of the project:

Table 3-3 Survey team

Team Member	Position	Qualifications
Magdalena Zofkova (Project Manager)	Manager Invertebrate Zoology	PhD. (Zoology)
Melissa White	Level 2 Invertebrate Zoologist	BSc. (Zoology / Marine Science) Hons.
Catherine Taylor	Invertebrate Zoologist	BSc. (Environment Science) Hons.

4 RESULTS

4.1 WATER CHEMISTRY

Seven physico-chemical parameters (temperature, pH, Conductivity, Total dissolved solids, Oxidation reduction potential and dissolved oxygen) were measured in vitro from bailed water at each site prior to stygofauna sampling (Table 4-1 and Table 4-2). Stygofauna can be very sensitive to changes in their habitat (Masciopinto et al. 2006) and the physico-chemical features of groundwater habitats can be a limiting factor for them (Hahn 2006).

Water temperature is one of the most important water quality parameters as it can impact both water quality and the functions of any organisms present in it (Oberlin and Blinn 1997). The average water temperature recorded in the bores was 25.29 °C.

Dissolved oxygen (DO) is can directly impact an organisms reproduction, incubation and survival (Malard and Hervant 1999). The mean DO concentration of the bores sampled was higher than groundwaters throughout Western Australia, where no photosynthetic plants are available to supply oxygen to the system (Table 4-1 and Table 4-2).

Water pH can have a significant influence in determining invertebrate community structure (Rosemond et al. 1992). At the extreme end of the scale (4.0 or 13.0) physical damage to an organism can occur, however, the mean pH of the water sampled at the Koolanooka bores was recorded as a fairly neutral 6.85 (Table 4-1 and Table 4-2).

Table 4-1 Phase one water quality data

Hole ID	Temp. (°C)	pH	TDS (ppm)	EC (µs)	D.O. (ppm)	Electrical Potential (mV)	Depth To Water (m)	End of Hole (m)
BH01	25.3	6.28	1244	2158	1.43	40	20.08	54
BH02	25.3	6.59	1160	2030	1.50	-94	19.99	42
BH03	25.3	6.73	991	1742	3.52	8	22.22	48
BH?	26.2	6.76	2360	4000	1.77	99	14.71	45

Table 4-2 Phase two water quality data

Hole ID	Temp. (°C)	pH	TDS (g/L)	EC (µs/cm)	D.O. (ppm)	D.O. (%sat)	ORP (mV)	Depth To Water (m)	End of Hole (m)
BH03	25.89	6.84	1	1.6	6.07	75.9	176	21.92	47
BH02	28.00	6.51	1.4	2.2	3.23	38.7	174	20.11	40
BH01	26.43	6.17	0.1	0.1	4.07	51.4	177	20	51
BH10	25.77	6.35	2.5	4.0	24.6	31.2	30	11	40
BH07	25.55	6.28	2.5	3.9	4.57	57.2	1.32	14.36	45
Hole 8	24.54	6.54	22.9	35.7	4.04	55.5	-153	3.14	33
BH05	24.61	7.56	1.4	-2.2	4.09	49.9	140	18.7	40
BH06	24.68	7.27	1.8	27.5	3.98	47.8	122	17.74	40
Mungamia Well	23.18	7.67	16.8	26.2	0.75	10.32	- 237	20.34	29
Blue Well Bore	25.43	8.05	4	6.3	1.53	19	-57	19	25
Tootah Well	24.79	6.65	1.8	2.9	3.54	44.3	95	11.76	15
Pop Bore	24.6	6.34	2.8	4.3	2.6	32	175	13.46	16

4.2 BIOLOGICAL

A single specimen of a stygobitic copepod from the genus *Microcyclops* was collected from within the Project area at BH10 and another specimen was collected from Mungamia Well, a regional well outside the Project area approximately 70 km away. Species identity could not be confirmed as both specimens were immature, however based on the location of the Project area, the specimens are likely to belong to a cosmopolitan species *Microcyclops varicans* (G.O. Sars, 1863); Dr D. Tang, pers comm 2008.

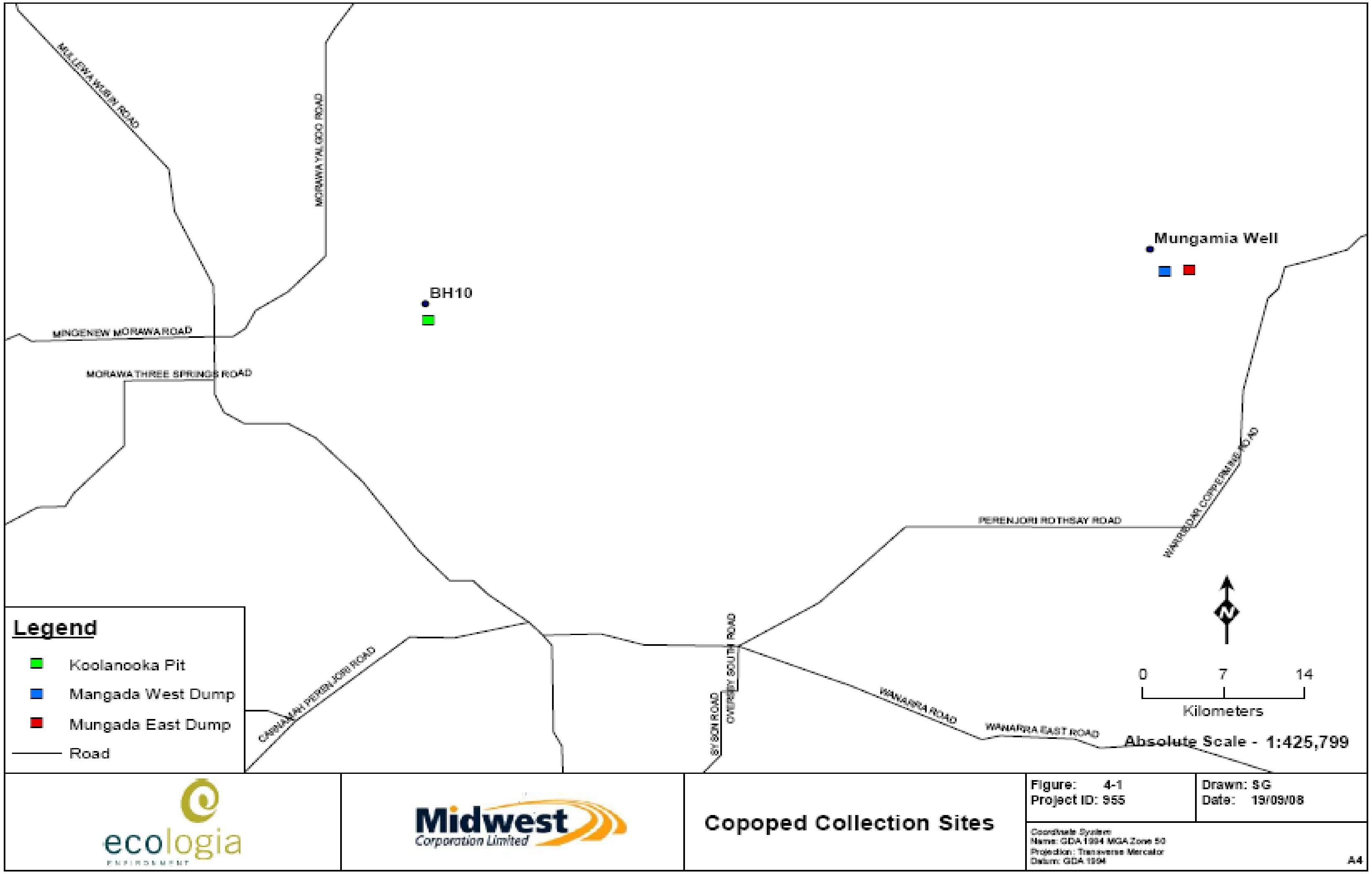


Figure 4-1 Copepod collection sites

5 THREATENING PROCESSES AND RISK ASSESSMENT

Aspects of the DSO Project that may directly or indirectly impact on stygofauna include:

1. Changes to surface water hydrology;
2. Changes to subterranean microclimate;
3. Surface and groundwater contamination; and
4. Changes to organic inputs.

A risk assessment is normally undertaken to determine potential impacts arising from the development on stygofauna 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 **Error! Reference source not found.** (page 27).

6 DISCUSSION

Stygofauna may occur in groundwater within suitable substrate such as limestone strata and paleochannels within the Midwest/Yilgarn area. Groundwater abstraction for the project is unlikely to impact stygofauna as there will be no impact on substrates prospective for that fauna.

Only established bores and pit waters will be utilised for water supply at Koolanooka - water which is already in use for current operations. As such, this water contains little risk that its use will impact on significant stygofauna populations (ecologia 2007). Similarly, as excavation of both the East and West Mungada pits will not proceed below the water table, there will be no dewatering required at this location, and hence no potential interaction with stygofauna populations from these sources.

ecologia Environment has conducted two phases of sampling of the established local bores, the latter of which yielded a single specimen of a stygobitic copepod from the genus *Microcyclops* present within the Project area and another specimen present in a regional well outside the Project area approximately 70 km away. Species identity could not be confirmed as both specimens were immature, however based on the location of the Project area, the specimens are likely to belong to a cosmopolitan species *Microcyclops varicans* (G.O. Sars, 1863); Dr D. Tang, pers comm 2008.

Copepods are a group of crustaceans found in the sea and nearly every freshwater habitat. Stygobitic copepods typically colonize subterranean voids and recesses where aquifers are present. As many known copepods are sensitive to changes in their environment (water quality, temperature etc) they can sometimes considered bio-indicators for an impacted area.

As little stygofauna surveying has been completed near the Koolanooka/Blue Hills there is currently limited knowledge of the current diversity of the area. Although Humphries et al (2001) suggests that there is significant stygofauna in the Murchison system, at Austin Downs (northeast of Blue Hills) and Killara Stations (relational position unknown). Karanovic, T. (2004b) has described species of copepod from the Murchison area. The Yilgarn region, which is the impact area is within, also has a recorded copepod species (P. de Laurentiis et al. 2001).

Given that no dewatering of the aquifer within the project area is required and specimens were found both inside and outside of the impact area approximately 70 km apart, no significant impact from the Project is expected to occur on the species.

7 MANAGEMENT RECOMMENDATIONS

As no new bores or dewatering will be required on the Project, no significant impact to stygofauna species or communities is expected .Water abstraction from bore BH10 within the Koolanooka borefield where the stygobitic copepod was found should be managed based on a dedicated Stygofauna Management Plan. If new bores do need to be developed at a later stage, then presence for stygofauna populations will need to be assessed before the new source is utilised on the project.

8 ASSESSMENT COMPLIANCE

The stygofauna sampling programme for the DSO project at Koolanooka and Blue Hills was developed prior to the release of the Draft Guidance Statement 54a: *Survey Methods and Survey Considerations for Subterranean Fauna in Western Australia.* However, this sampling programme was developed in close consultation with the DEC subterranean fauna specialists and was considered an appropriate sampling effort for the Project.

The project impacts to stygofauna are minimal and upon recommendation from the DEC sampling was restricted to existing bores. Despite the small size of this stygofauna sampling programme (n= 12), the program was deemed sufficient by the DEC. The DEC considered the option of Midwest creating more bores to increase the sample size unnecessary and potentially having a greater impact upon the subterranean environment than the Project itself.

9 REFERENCES

Cho, J.-L., J.-G. Park, and W. F. Humphreys. 2005. A new genus and six new species of the Parabathynellidae (Bathenellacea, Syncarida) from the Kimberley region, Western Australia. Journal of natural History 39:2225-2255.

Danielopol, D. L., and J. A. Stanford, eds. 1994. Groundwater Ecology. Academic Press., San Diego.

De Laurentiis, P., G. L. Pesce, and W. F. Humphreys. 2001. Copepods from ground waters of Western Australia, VI. Cyclopidae (Crustacea: Copepoda) from the Yilgarn Region and the Swan Coastal Plain. Pp. 115-131 *in* W. F. Humphreys, and M. S. Harvey, eds. Subterranean Biology in Australia. Records of the Western Australian Museum, Supplement No. 64., Perth.

Desmond, A., M. Cowan, and A. Chant. 2001. A Biodiversity Audit of WA's 53 Biogeographical Subregions 2002: Murchison 2 (MUR2 – Western Murchison subregion). Department of Conservation and Land Management, Perth.

Eberhard, S. M. 2004. Preliminary Investigation of Stygofauna in the Blackwood Groundwater Area. Unpublished report prepared for URS Australia Pty Ltd., Perth.

ecologia. 2007. Risk assessment for potential impact to Stygofauna on the DSO project. ecologia Environment, Perth.

EPA. 2003a. Guidance for the Assessment of Environmental Factors, Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia. EPA.

EPA. 2003b. Guidance for the Assessment of Environmental Factors, Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia. EPA.

Hahn, H. 2006. The GW-Fauna-Index : A first approach to a quantitative ecological assessment of groundwater habitats. Limnologica: Ecology and Management of Inland Waters 36:119 - 137.

Humphreys, W. F. 1993. Stygofauna in semi-arid tropical Western Australia: a Tethyan connection?. Mém. Biospéol. 20:111 - 116.

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 No. 64: Subterranean Biology in Australia 2000:63-83.

Humphreys, W.F., Laurentiis, P. De and Pesce, G. L. (2001) Copepods from ground waters of Western Australia, VI. Cyclopidae (Crustacea: Copepoda) from the Yilgarn

Region and the Swan Coastal Plain. *Records of the Western Australian Museum* Supplement No. 64 115-131 (2001)

Johnson, S. L., and A. H. Wright. 2001. Central Pilbara groundwaterstudy. Water and Rivers Commission, Perth.

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

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

Malard, F., and F. Hervant. 1999. Special Review: Oxygen Supply and the adaptations of animals in groundwater. Freshwater Biology 41:1 - 30.

Mamonier, P., P. Vervier, J. Gilbert, and M. J. Dole-Oliver. 1993. Biodiversity in Groundwaters. Tree 8:392 - 395.

Masciopinto, C., F. Semeraro, R. La Mantia, S. Inguscio, and E. Rossi. 2006. Stygofauna abundance and distribution in the fissures and caves of the Nardo (Southern Italy) Fractured Asuifer subject to reclaimed water injections. Geomicrobiology Journal 23:267-278.

Oberlin, G., and D. Blinn. 1997. The effect of temperature on the metabolism and behaviour of an endemic amphipod, Hyalella Montezuma, from Montezuma Well, Arizona U.S.A. Freshwater Biology 37.

Rockwater. 2004. Assessment of Groundwater Supplies for Proposed Mining of Haemetite Ore at Koolanooka (Stage1). Unpublished report for Midwest Corporation Ltd., Jolimont, W.A.

Rockwater. 2006. Results of Groundwater Exploration Drilling at Koolanooka and Blue Hills. Unpublished report for Midwest Corporation Ltd., Jolimont, W.A.

Rosemond, A., S. Reice, J. Elwood, and P. Mulholland. 1992. The effect of stream acidity on benthic invertebrate communities in the south-eastern United States. Freshwater Biology 27:193 - 209.

Wilson, G. D. F., and S. J. Keable. 2002. New genera of Phreatoicidea (Crustacea: Isopoda) from Western Australia. Records of the Australian Museum 54:41-70.

APPENDIX A BIOLOGICAL RISK ASSESSMENT

Biological Environmental Impact Risk Assessment

Project: Midwest Corp. DSO PER		*Location: Koolanooka and Blue Hills*					*Date:*				
			Inherent Risk					**Residual Risk**			
Risk Issue	**Aspect (Event)**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Mine Site											
Changes to groundwater recharge rates / water infiltration through compacted surfaces.	Expansion of Koolanooka and Blue Hills Pits	Loss of suitable stygofauna habitat	2	4	8	**Medium**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	2	2	4	**Low**
Changes to groundwater recharge rates.	Water use for general mine activities.	Loss of suitable stygofauna habitat	3	4	12	**High**	Ensure water consumption does not exceed aquifer recharge rates.	1	4	4	**Low**
Contamination of Koolanooka / Bluhe Hills aquifers	Nutrients, heavy metals or other contaminants adversely impacting stygofauna habitats	Loss of suitable stygofauna habitat	3	4	12	**High**	Spills to be cleaned immediately and reported to supervisors.	1	4	4	**Low**

Risk Matrix:

		LIKELIHOOD				
	Risk Assessment Rating	5 ALMOST CERTAIN Is expected to occur in most circumstance	4 LIKELY Will probably occur in most circumstance	3 POSSIBLE Could occur	2 UNLIKELY Could occur but not expected	1 RARE Occurs in exceptional circumstances
CONSEQUENCES	5 - CATASTROPHIC Significant impact to fauna species of conservation significance or regional biodiversity	25	20	15	10	5
	4 - MAJOR Impact to fauna species of conservation significance in project area.	20	16	12	8	4
	3 - MODERATE Loss of fauna biodiversity in project area.	15	12	9	6	3
	2 - MINOR Short term or localised impact to fauna biodiversity.	10	8	6	4	2
	1 - INSIGNIFICANT No impact to fauna of conservation significance or biodiversity.	5	4	3	2	1

11-25	High risk, site/issue specific management programmes required, advice/approval from regulators required.
6 – 10	Medium risk, specific management and procedures must be specified.
1 – 5	Low risk, managed by routine procedures.

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 very low probability that it may occur in exceptional circumstances.

Consequence:		
Value	**Description**	**Criteria**
5	Catastrophic	Significant impact to fauna species of conservation significance or regional biodiversity
4	Major	Impact to fauna species of conservation significance in project area.
3	Moderate	Loss of fauna biodiversity in project area.
2	Minor	Short term or localised impact to fauna biodiversity.
1	Insignificant	No impact to fauna of conservation significance or biodiversity.

Figure A-1 The definitions used in the determination of the biological impact risk assessment.