
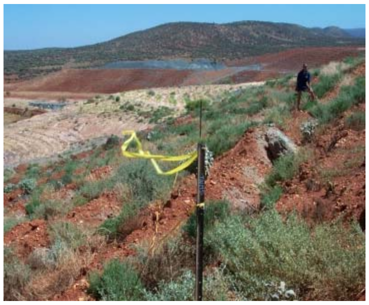


Moly Mines Limited
Spinifex Ridge Molybdenum Project

Spinifex Ridge Project Area and Borefields

Baseline Subterranean Fauna Survey

August 2007

FINAL DRAFT
To be updated with information from Canning borefield in 2008

MOLY MINES LIMITED

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Spinifex Ridge Project Area and Borefields

Baseline Subterranean Fauna Survey

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Executive Summary

Moly Mines Limited (Moly Metals) is currently undertaking a Definitive Feasibility Study (DFS) for the design, construction, and operation of a molybdenum mine in the Pilbara region of Western Australia. Spinifex Ridge is the proposed location for the development, situated approximately 50kms north-east of Marble Bar within the pastoral lease of Yarrie Station, where Moly Mines currently holds an Exploration Licence of approximately 20km² (E45/2226), with an interest in an extended footprint area immediately to the north, within EA45/2825.

A mining and processing operation will be developed at Spinifex Ridge, including the development of an open pit mine, transport tunnel, processing plant, utilities, services and infrastructure associated with a nominal twelve year life-of-mine. This report documents the results of subterranean fauna assessments undertaken over the Project Area and proposed water supply areas of the De Grey borefield and Woodie Woodie open pit. At the time of writing, assessments over the Canning borefield have been planned but not commenced. This report will be updated at the conclusion of the Canning assessment.

Sampling was consistent with guidance and methodologies outlined in Environmental Protection Authority (EPA) Guidance Statement Number 54 (EPA, 2003), and according to methods recommended by the Department of Environment and Conservation (DEC) and other authors such as Eberhard *et al.*(2004).

The overall objectives of assessment were to:

a) Develop an inventory of species of subterranean fauna identified from areas potentially impacted by the proposal, in particular the Project Area itself and associated water supply areas. This incorporated a review of available information and appropriate sampling at each location.
b) Assess site information in the regional context by comparisons with available data from other localities within the bioregion, and to provide an assessment of potential impact from the proposal. This included obtaining regional information, as well as sampling in locations outside of the potential area of impact from the proposal.
c) Collect quantitative data that can provide a baseline against which future impacts can be assessed, and that can form the basis of a monitoring program.

Specific objectives of surveys over the Project Area, Woodie Woodie, and De Grey borefields, were to:

- Identify appropriate groundwater bores both within, and outside, potential areas of impact;
- Undertake field surveys to collect samples from 20 bores within the potentially-impacted areas, and up to 20 bores within the surrounding, un-impacted areas for comparison;
- Describe water quality and bore condition for all bores sampled;

- Identify stygofauna samples to species level where possible, and determine the uniqueness and abundance of species identified, and their significance and distribution in a local and regional context;
- Lodge specimens with the WA Museum as required;
- Use available hydrological information to determine potential impacts to aquifers, and therefore stygofauna.

Potential habitat for stygofauna was determined for each of three survey areas; Spinifex Ridge Project Area, Woodie Woodie, and De Grey. Within the Project Area, there are little alluvial-type, subterranean habitats for stygofauna within the area of impact by pit dewatering. Geological data was too limited at Woodie Woodie and De Grey to draw strong conclusions about stygofauna/habitat associations. For troglofauna, no significant habitat was identified in Project Area or borefields, although groundwater bores in the Project Area were sampled as a precaution.

Within the Project Area, 22 bores were sampled for stygofauna in the impact zone, and three in control areas, over four surveys. This reflects a total sampling effort of 43 samples and 4 samples for bores in the impact zone (impact bores) and control bores, respectively. Eighteen bores in the Project Area were sampled for troglofauna in a single sampling event. At Woodie Woodie, 16 impact bores and three control bores were sampled over two surveys. This reflects a total sampling effort of 17 samples and three samples for impact and control bores, respectively. At De Grey, eight impact bores and five control bores have been sampled over two surveys. This reflects a total sampling effort of 14 samples and five samples for impact and control bores, respectively.

Due to the paucity of locally-accessible control bores at each area, regional data was sourced where available, and DEC provided regional context for species identified from the Woodie Woodie borefield.

Sampling at Spinifex Ridge and the Woodie Woodie and De Grey borefields has not been adequate, according to species accumulation curve data. Further sampling of the three areas is scheduled for mid-2007. In that regard, the data from this report should be considered preliminary.

Stygofauna yields were highest at the Spinifex Ridge Project Area, with 64% of impact bores containing fauna in at least one survey, compared to 44% of impact bores at Woodie Woodie and 13% of impact bores at De Grey. Higher salinity and lower dissolved oxygen at De Grey, compared to other sites, may have also contributed to this result, but more data is required to validate trends. Stygofauna at De Grey appear to be restricted to the shallow aquifer, with no taxa recorded from the basal aquifer samples.

During the survey 24 stygofauna species were recorded from Spinifex Ridge, 13 species from Woodie Woodie, and 13 species from De Grey. During these surveys, species identification and definitive comment regarding species distribution and endemism has been limited due to:

- The condition of specimens sampled (some samples contained damaged or incomplete specimens, which limited identification);
- The presence of juveniles which cannot be used to conclusively identify to species level;
- The lack of detailed, formally-described taxonomy for some groups; and
- The dynamic state of knowledge about stygofauna in the Pilbara.

A preliminary assessment of conservation significance was undertaken on the basis of data from these partially-completed surveys, and in consideration of current knowledge. The outcomes of this assessment are that:

- One bore located near the edge of the > 5 m drawdown contour at the proposed Woodie Woodie borefield supports an endemic species (*Goniocyclops* sp. 1 n. sp. (Karanovic))
- One bore at the proposed Woodie Woodie borefield supports a species not previously recorded from the Australian mainland (*Halophytophilus* sp. 1 n. sp. (Karanovic)) and that is therefore endemic. The bore housing this species is in an area potentially-impacted from previous mining and dewatering;
- One bore at the proposed De Grey borefield supports a species which may be new and locally-endemic (*Mesocyclops* cf. *kieferi* n. sp), but requires further work. The bore hosting this species is in poor condition and has been used previously as a pastoral bore;
- One bore within the Spinifex Ridge Project Area hosted a female of *Leicandona quasihalsei*, previously only represented in the Pilbara by a recent record of a male specimen.

On the basis of these preliminary findings;

- scheduled, additional surveys are necessary to augment (August 2007) knowledge of species distributions;
- at the Spinifex Ridge Project Area, further study is required to confirm the local distribution and abundance of *Leicandona quasihalsei*;
- if Woodie Woodie and De Grey borefields are commissioned, abstraction should be managed and monitored to minimise impact to the aquifer, and therefore stygofauna.

Given that adequate sampling frequency has yet to be achieved, and considering the rapid increase in knowledge of stygofauna and their known distributions in the Pilbara over the past few years, the conservation significance of at least two of the species (i.e. those not deemed to be locally unique - *Leicandona quasihalsei* and possibly *Mesocyclops* cf. *kieferi* n. sp) may be revised in the future.

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1.0 INTRODUCTION

1.1 Project Background

Moly Mines Limited (Moly Metals) is currently undertaking a Definitive Feasibility Study (DFS) for the design, construction, and operation of a molybdenum mine in the Pilbara region of Western Australia. Spinifex Ridge is the proposed location for the development. It is situated approximately 50kms north-east of Marble Bar within the pastoral lease of Yarrie Station, where Moly Mines currently holds an Exploration Licence of approximately 20km² (E45/2226), with an interest in an extended footprint area immediately to the north, within EA45/2825.

For this Project, a mining and processing operation will be developed at Spinifex Ridge, including the development of an open pit mine, transport tunnel, processing plant, utilities, services and infrastructure associated with a nominal twelve year life-of-mine (**Figure 1**). To facilitate mining, the diversion of Coppin Creek and dewatering of the open pit will be required, and borefields will be commissioned.

A borefield adjacent to the De Grey River area, approximately 25km north of the project, will provide the initial water source, as well as supplement peak demand (**Figure 3**). The main water source for the project will be either from a borefield in the Canning Basin (Canning), approximately 70km north of the site, or from an abandoned mining void at the Woodie Woodie mine approximately 180km from the project to the east and south (**Figure 2**).

1.2 Scope and Objectives of this Assessment

This report documents the results of subterranean fauna assessments over the Project Area and proposed water supply areas of the De Grey borefield and Woodie Woodie open pit. At the time of writing, assessments over the Canning borefield have been planned but not commenced. This report will be updated at the conclusion of Canning sampling.

Sampling was consistent with guidance and methodologies outlined in Environmental Protection Authority (EPA) Guidance Statement Number 54 (EPA, 2003), and according to methods recommended by the Department of Environment and Conservation (DEC) and other authors such as Eberhard *et al.* (2004).

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- Lodge specimens with the WA Museum as required;
- Use available hydrological information to determine potential impacts to aquifers, and therefore stygofauna.

1.3 Locations sampled

Project Area

The Spinifex Ridge Project Area is located on the Yarrie Station pastoral lease, approximately 50 kilometres north-east of Marble Bar, about 1500 kilometres north north-east of Perth (**Figure 1**). The Spinifex Ridge deposit was discovered in 1970 and exploration has continued through to the present day by a succession of companies.

Woodie Woodie Borefield

The Woodie Woodie Manganese Mine (Woodie Woodie) is located about 310km east south-east of Port Hedland, and 50km west of the Nifty Copper Mine (**Figure 2**) (Groundwater Resource Management, 2006). Moly Mines proposes to abstract water from the Cracker Pit at Woodie Woodie to contribute to process water requirements for the Spinifex Ridge project. Abstraction of approximately 600L/s (approx 19GL/annum) will occur over a twelve year mine life. Potential impact will be measured in adjacent bores.

De Grey Borefield

The De Grey borefield is located about 25km north of the Spinifex Ridge deposit, near the Muccan-Shay Gap Road crossing of the De Grey River (**Figure 3**) (Rockwater, 2006). Moly Metals proposes to commission a borefield near the De Grey River to supply water for use in construction of the ore treatment plant, and for mineral processing. The proposed abstraction is 4GL/annum over a ten year life-of-mine.

Figure 1 Location of the Moly Mines Limited Spinifex Ridge Molybdenum Project.

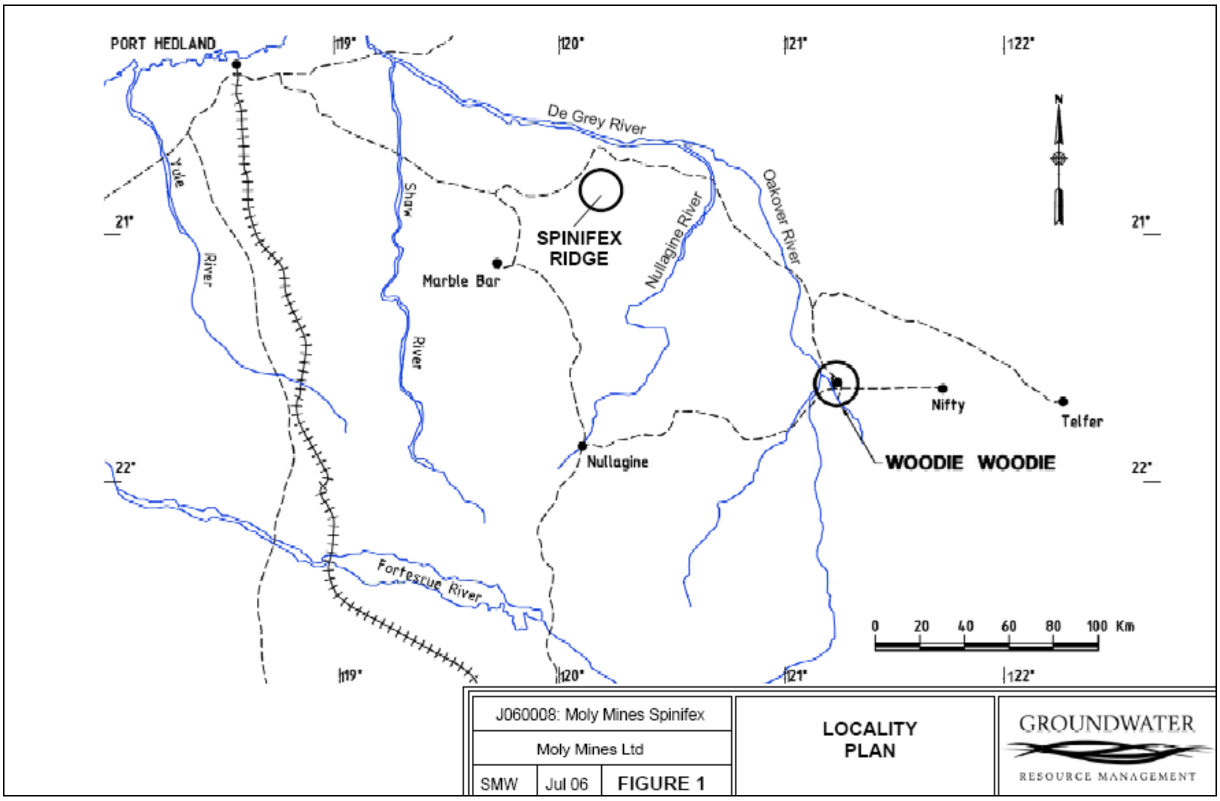

Figure 2 Location of the Consolidated Minerals Limited Woodie Woodie Manganese Mine (Source: Groundwater Resource Management 2006).

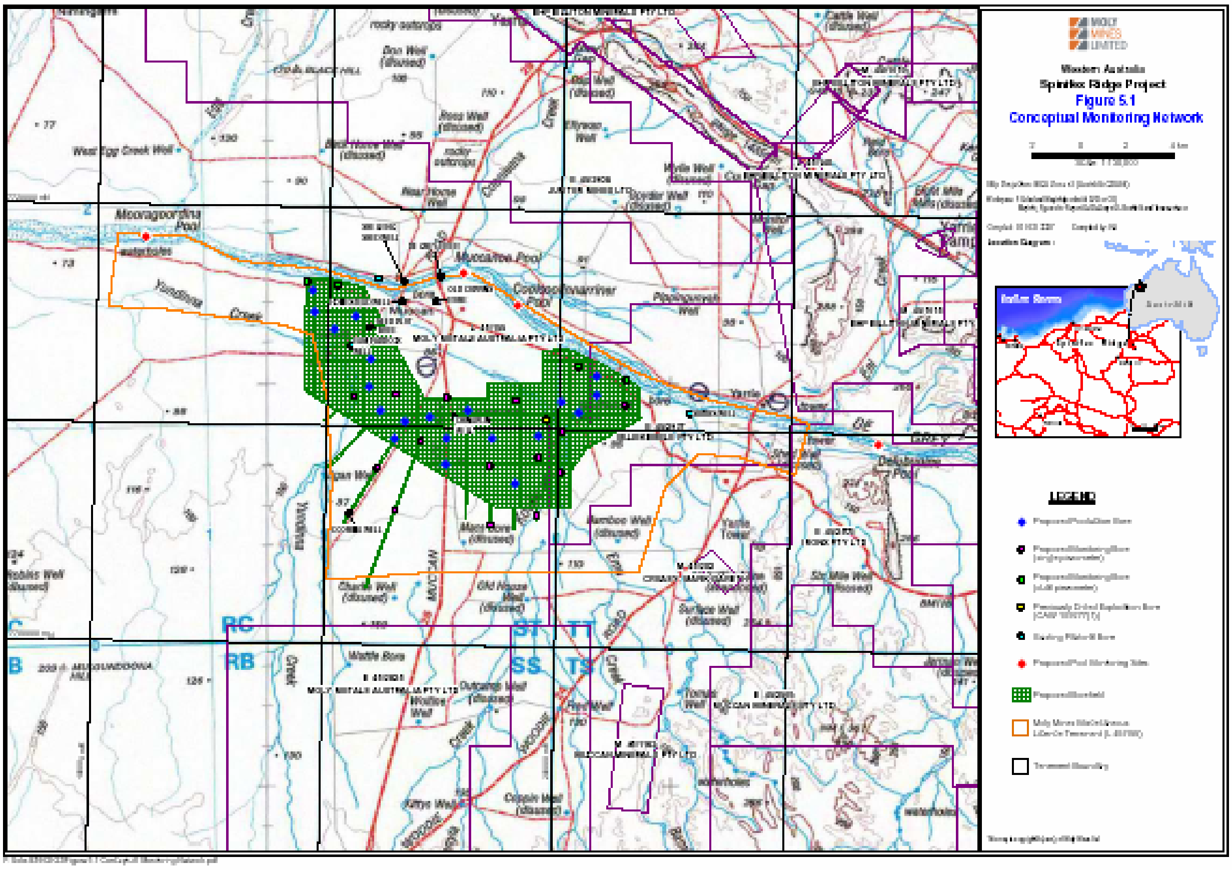

Figure 3 Location of the De Grey River Catchment Borefield.

1.4 Subterranean Fauna

Subterranean fauna are divided into two groups; stygofauna and troglofauna. Stygofauna are subterranean animals that only live in groundwater, while troglofauna occur in air chambers in underground caves or voids (EPA, 2003). Most of the subterranean fauna identified in Western Australia are invertebrates, although subterranean fish and snakes are known.

1.4.1 Stygofauna

Stygofauna fulfil their entire lifecycle below ground. They display characteristics that enable them to adapt to an existence below ground (reduction or absence of pigment, eyes reduced or absent, extended locomotory and sensory appendages) (Thurgate *et al.,* 2001). They are an ancient group with Pangaean and Gondwanan affinities (Humphreys, 2001). Within the Pilbara region, the amphipods are the richest group of stygal crustaceans (Bradbury, 2000), and have the greatest biogeographic significance.

Subterranean ecosystems are more diverse within classic karst systems, such as the Tertiary systems found in the Cape Range, Western Australia, and until recently, it was perceived that stygal species were confined to such systems. Recent studies have shown that calcrete aquifers associated with paleovalleys of the Australian arid zone also contain a diverse stygofauna population (Humphreys, 2006).

An increase in research and therefore understanding of stygofauna in the last decade has revealed that Western Australia, in particular, has exceptional diversity within stygal communities (Humphreys *et al.,* 2004). This has been strengthened by a regional-scale survey conducted by the DEC, as yet unpublished, which has shown the Pilbara to be an important region for stygal biodiversity. Despite an increasing knowledge of taxonomy, further study is required on the diversity, abundance, dispersal and functional roles of the stygofauna (Boulton, 2006).

The groundwater habitats that stygofauna are typically found in are megavoids, such as large caves, mesocaverns in karst and basalts, and in the interstitial spaces of alluvial aquifers. They are mostly restricted to the upper parts of these subterranean ecosystems, but can also be found at depths of up to 1 km in karst systems. Subterranean fauna have a greater affinity for groundwater when they are further from epigean influence. The distance from influence is defined in four dimensions; vertical depth in groundwater, distance from the bank in parafluvial aquifers, and distance or time along groundwater hyporheic flowpaths (Humphreys, 2002).

Stygofauna distribution appears to be primarily affected by hydrological stability, groundwater quality, energy sources, dispersal routes and habitat space (Boulton, 2006). Consequently, impacts on these aspects may affect the diversity, abundance and distribution of stygofauna.

1.4.2 Troglofauna

Troglofauna are obligate inhabitants of caves and other subterranean voids and are dominated by the arthropods which include insects, arachnids, crustaceans and myriapods. Troglofauna require humid micro-environments and are commonly found under rocks, and in crevices or small cavities (EPA, 2003). Within Western Australia, troglofauna have been recorded from caves in Tertiary limestone at Cape Range, Barrow Island and along the Nullarbor Plain (Playford 2001; Gray and Thompson 2001; Harvey 2002). Recent (2006) surveys indicate that there are locally endemic species present in the Robe Valley, associated with mesa formations (Robe River, 2007) belonging to seven orders of troglofauna (EPA, 2007). Troglobites have also been recorded from Pleistocene aeolian limestone on the coastal strip south from Shark Bay and the Devonian limestone in the Kimberley (Playford 2001).

1.5 Subterranean fauna in the Pilbara

The Western Australian arid zone, and in particular the Pilbara, is recognised as having one of the world's most diverse and notable subterranean fauna (Humphreys 2001; Karanovic 2006). Work by the WA Museum shows that calcrete and alluvial aquifers of both the Pilbara and Yilgarn regions are rich in stygofauna by global standards (EPA, 2003).

Historically, local endemism was thought to be high with each aquifer presumed to be supporting a unique community. The lack of connectivity between aquifers may contribute to *in situ* speciation and therefore endemism (EPA, 2003). However, recent, intense sampling has found that the distribution of taxa within the Pilbara is more widespread, with many species having a broader geographical distribution than previously thought.

The DEC's Pilbara bioregional survey has documented at least 322 occurrences of 78 species thus far, although sampling has been predominantly from bores or wells, with less than 4% of samples representing springs and hyporheic habitats (Eberhard *et al.,* 2005; Eberhard and Halse, 2004). While a variety of habitats were sampled in that survey (porous, karstic and fractured-rock aquifers, springs and hyporheic habitats), the karstic aquifers, karst springs and porous alluvial aquifers contained the highest species richness. The richest aquifer in the region is Millstream, with 16 species present. Species richness in the Pilbara region appears roughly proportional to sampling effort (Eberhard *et al*, 2005).

Within the Pilbara, the amphipods are the dominant group of stygal crustaceans (Bradbury 2001). Several faunal groups with poor representation world-wide are well represented in the Pilbara, including two of the four known species of Spelaeogriphacea. Some groups are comparatively richer in the Pilbara, such as the Ostracoda (comprising 27% of Pilbara stygofauna compared to 3% of the world's stygofauna) and Copepoda (comprising 39% of Pilbara stygofauna compared to 17% of the world's stygofauna). A high proportion of the species identified in the Pilbara have Tethyan, Pangean and/or Gondwanan affinities (Eberhard *et al.,* 2005).

The Pilbara can be distinguished from the Cape Range and Barrow Island areas by the occurrence of several freshwater groups, which appear to be absent from younger Tertiary karst systems. Sixteen freshwater genera, to date, have only been recorded in the Pilbara. This represents 59% of the Pilbara genera.

1.6 Relevant legislation

Stygofauna and troglofauna are protected under the same legislation as that of terrestrial fauna, and its protection is governed under three acts:

1. the *Wildlife Conservation Act (1950-1979)*;
2. the *Environmental Protection Act (1987)* (EP Act); and
3. the *Environmental Protection and Biodiversity Conservation Act (1999)* (EPBC Act).

The *Wildlife Conservation Act 1950 – 1979* provides protection for all native fauna species, and is administered by the Department of Environment and Conservation (DEC). Special provision is provided for fauna that are considered rare, threatened with extinction or with high conservation value. This includes subterranean biota, which is currently considered to be Schedule 1 taxa (rare or likely to become extinct).

The *Environmental Protection Act (1987)* is administered by the Environmental Protection Authority (EPA) and includes guidelines for reviewing the environmental factors of proposals that might impact the environment. The Act states that any operation that could potentially have a significant impact on stygofauna or troglofauna habitat will be subject to formal Environmental Impact Assessment (EIA) under the EP Act. The EPA's *Position Statement No. 54* provides specific assessment and management requirements for subterranean fauna.

The *Environmental Protection and Biodiversity Conservation Act (1999)* is administered by the Commonwealth, to regulate protection of matters of national environmental significance. Any action (including projects, developments, undertakings, activity or series of activities) that is likely to have a significant impact on any matter included in Part 3 of the Act, must be referred to the Minister for decisions on whether the proposed action triggers the EPBC Act, and an appropriate level of assessment for approved actions.

1.7 Importance of Subterranean Fauna

Though stygofauna are poorly understood, ongoing research has revealed their importance in the maintenance of surface and groundwater quality (Boulton, 2001), including in wetlands within arid regions (Hatton and Evans, 1998). Stygofauna may be indicators of aquifer health, reflecting their preferences and tolerances of parameters such as nutrient content and dissolved oxygen.

Many Western Australian species of stygofauna and troglofauna are considered scientifically important and have conservation significance because;

- there is evidence of localised patterns of distribution as a result of short range endemism, which may be related to lack of connectivity between habitats, and
- they provide a link to a time when Australia was part of Gondwanaland, bordered by the Tethys Sea (Humphries, 1999, 2000, in EPA Guidance Statement 54).

1.8 Potential Impacts to Stygofauna

The EPA Guidance Statement 54 states that mining proposals may "impact stygofauna or troglofauna habitat by:

- lowering the water table sufficiently to dry out the zone in which some species live, or otherwise artificially change 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 temperature and humidity)".

In that regard, the design of sampling programs must address these criteria as relevant. The EPA (2003) states that proponents of proposed projects must demonstrate a lack of threat by:

- showing that species within the potential impact zone also occur outside this area, and are not restricted to the impact zone;
- providing evidence that likely impacts will not significantly affect species within the potential impact zone;
- producing a management plan for the potential impact zone and species within it, to ensure persistence of those species.

Previous sampling at Spinifex Ridge has identified stygofaunal communities which occur over the Project Area in the vicinity of the ore body, and in the vicinity of the proposed Woodie Woodie and De Grey borefields. In the context of potential impacts listed above, the risks to subterranean fauna relevant and specific to the three areas described in this report relate principally to lowered water tables, altered water quality and loss of habitat (**Table 1**).

Table 1 Sources of potential impact at Spinifex Ridge Project Area and Borefields, in the context of impacts listed in EPA Guidance Statement 54

	Potential Risks to Stygofauna		
Risk	**Project Area**	**Woodie Woodie**	**De Grey**
Lowered water table	Drawdown due to dewatering in the vicinity of the pit	Drawdown due to abstraction	Drawdown due to abstraction
Altered water quality	Exposure and mobilisation of metals in soils. Leachate/seepage from TSF/landforms Hydrocarbon/other spills Incursion of saline water	No potential sources	No potential sources
Loss of habitat through mining	Pit development	Not relevant	Not relevant
Destruction/damage to caves	No caves identified to date	No caves identified to date	No caves identified to date

2.0 MATERIALS & METHODS

2.1 Sample Site Identification, in the Context of the Proposed Mine

2.1.1 Stygofauna

A preliminary baseline survey of subterranean fauna was conducted within the Spinifex Ridge Project Area in July 2005, in the vicinity of the proposed mining void (OES, 2005). This survey, which formed part of Moly Mines' Pre-Feasibility Studies (PFS), confirmed the presence of stygofauna.

In this context, and with the progression of the project to Bankable Feasibility Studies (BFS) in 2006, further studies of subterranean fauna were required to identify the stygofauna present and the potential impacts of pit development. As part of the BFS, Moly Mines were required to identify and investigate potential sites that would provide process water for the life of the Spinifex Ridge project. The potential areas include;

- the decommissioned Cracker Pit at the Consolidated Minerals Limited's Woodie Woodie Manganese Mine (Woodie Woodie),
- an existing borefield within the De Grey River catchment area (De Grey),
- a potential new borefield (Canning).

The Canning borefield is currently being investigated as a potential resource, and bores have only recently been installed (June 2007). At present there is no stygofauna data available for this area, but surveys will be undertaken in September/October 2007 and January/February 2008.

In designing an appropriate sampling program in accordance with the *EPA Guidance Statement 54* (EPA, 2003), the estimated footprints of the pit and borefields, and estimated extent of potential impact in all areas, were considered. Appropriate bores within the potentially-impacted areas of the Project Area and borefields were identified via desktop review, verified during field surveys, GPS co-ordinates recorded, and photographed. Details of the bores sampled in the Project Area and borefields are provided in **Appendix A**, and their locations are presented in **Figure 4 – 6**. Where possible, additional regional groundwater bores located in areas not likely to be directly impacted (control bores) were identified and sampled.

Appropriate bores for sampling of the Project Area and borefields were determined on the basis of:

- the presence of slotted bore casing
- vertical rather than angled holes
- the presence of groundwater
- no siltation or blockage, and
- at least three months had passed since construction, preferably six.

Where bores numbers were limited, poorer quality bores were sampled.

2.1.2 Troglofauna

Three potential troglofauna habitats were identified within the Project Area. They were the:

- external fractures, fissures and caves of the Talga Range;
- internal void spaces within the Talga range;
- subterranean voids not necessarily associated with the Talga Range.

The Talga Range is comprised of a banded iron formation (BIF) and cherts that form part of the Gorge Creek Group. A section of the range which will be removed for pit development and thus the range will form the northern boundary of the pit.

The southern and northern sides of the ridge are characterised by steep (50 - 70°) cliffs of resistive silica-rich chert and BIF which are 10 to 20 m in height. These sub-vertical cliffs are typically fractured along their edges, forming deep fissures and caves, though the fractures do not penetrate beyond the ridge face to any significant extent (more than a few metres).

Geotechnical drilling of the Talga Range to date has shown it to be highly competent and extremely hard. It lacks any significant porosity or void space and for geotechnical purposes it is considered massive, albeit with minor internal fracturing (B. Cummins, Moly Mines, pers comm.). Troglofauna sampling was therefore limited to:

- hand-searching of external fissures, overhangs and caves as part of a separate short-range endemic survey (OES, 2006), and
- bores within the Project Area that were also identified for the stygofauna survey.

No potential troglofauna habitats were identified within the Woodie Woodie or De Grey borefields.

2.2 Sampling Subterranean Fauna

2.2.1 Stygofauna Sampling and Identification

Sampling of subterranean fauna was consistent with the methodologies outlined in EPA Guidance Statement Number 54 (EPA, 2003), as well as methods recommended by DEC and other experts, for example Eberhard *et al.* (2004).

Water from each bore was collected by lowering a disposable plastic bailer on a 200 m rope and reel device. Each sample was collected from below the standing water level (SWL) in the bore. Bores were not purged by Outback Ecology prior to sampling.

Electrical conductivity (EC), pH, dissolved oxygen (DO) and temperature (^{o}C) were recorded down-hole using calibrated, hand-held field meters prior to sampling stygofauna (**Appendix B**). For some bores, parameters were measured in water samples collected with plastic bailers. Meters and bailers were washed thoroughly between bores to avoid cross-contamination.

For sampling stygofauna:

- Samples were collected using two weighted nets, with mesh sizes of 150 µm and 50 µm.
- The 150 µm net was lowered first to near the bottom of the hole
- The net was then gently raised up and down three times, over a distance of about 1m (approximately 1m off the bottom)
- The net was then raised slowly to minimise the 'bow wave' effect that may result in the loss of specimens
- This process was conducted three times with the 150 µm net
- The same procedure was then repeated using the 50 µm net.
- To prevent cross-contamination between bores, all sampling equipment was washed thoroughly with Decon 90 (detergent) and then rinsed with clean water after sampling each bore.

For preservation and identification of the specimens:

- Samples were placed in 120mL polycarbonate vials and preserved with 100% undenatured ethanol in the field. Undenatured ethanol was used to allow for later allozyme electrophoresis and mitochondrial DNA sequencing, if required.
- Samples were couriered back to Outback Ecology's laboratory in Perth
- Preserved samples were hand-sorted and identified microscopically in the laboratory to family, genus and/or species level by Erin Thomas of Outback Ecology, and/or Mike Scanlon.
- As required, identifications to species level were confirmed by specialist stygofauna taxonomists, namely:
    - Harley Barron (DEC),
    - Stefan Eberhard (Subterranean Ecology),
    - Ivana Karanovic (School of Zoology, University of Tasmania),
    - Tom Karanovic (School of Zoology, University of Tasmania).

2.2.2 Troglofauna Sampling

Prior to trap installation, available drill logs were reviewed in an attempt to identify potential fractures or cavities in the profile. No definitive information had been recorded regarding fractures or cavities and as a result, it was decided to suspend all traps near to, but at least 1 m above, the standing water level (SWL).

Litter traps were constructed from 60 mm PVC pipe, cut to lengths of 120 mm. Traps were filled with microwave-sterilised *Eucalyptus* leaf litter. The use of non-local leaf litter has been verified as often preferential to local litter by personnel at the WAM (M. Scanlon, pers. comm.). After traps were filled, the ends of each trap were covered with cleaned, reinforced birdcage wire mesh with ample room for invertebrates to enter traps. Each of the traps was then placed in a sealed ziplock bag to retain moisture and prevent contamination.

Troglofauna traps were suspended in established groundwater bores by attaching the trap to the top of the casing. Some of the traps were installed in bores that previously been sampled for stygofauna.

Following installation, bore openings were capped to maintain humidity and restrict the entry of terrestrial fauna. On collection, traps were sealed in ziplock bags and stored on ice for transport to Outback Ecology's laboratory in Perth.

The leaf litter from the troglofauna traps was hand sorted by Erin Thomas with the aid of a stereomicroscope. Invertebrate specimens were sent to Brian Heterick of the Entomology Section, Department of Environmental Biology, Curtin University of Technology. All invertebrate specimens collected were identified as terrestrial. Some terrestrial specimens were also sent to Mark Harvey at the WA museum for specialized taxonomy, but these have not been returned, to date.

2.3 Sampling Effort

Species accumulation curves for stygofauna were plotted to determine the adequacy of sampling frequency at each surveyed area. Species accumulation curves show the number of new species identified with each successive sample (Clarke and Warwick, 2001). An adequate sampling frequency is deemed to have been reached when the number of species collected reaches a plateau, which indicates that subsequent samples have a low likelihood of identifying new species.

2.3.1 Project Area

Stygofauna

Following the preliminary baseline survey (OES, 2005), Outback Ecology conducted three surveys of subterranean fauna in the Project Area for the BFS; March 2006, August 2006 and February 2007. These surveys encompassed 22 bores in the impact area with a total effort of 44 samples (**Figure 4**), and three control bores with a total sampling effort of 4 samples (**Figure 4b**) (**Table 2,**

Appendix A). While more than 22 bores were present in the area, many of these were less than six months old at the time of sampling and were therefore excluded from the sampling program.

The paucity of control bores was related to a lack of accessible wells in the Project Area. To compensate, regional data was sourced where available, and DEC provided regional context for species identified from the Project Area.

Table 2 Spinifex Ridge impact and control bores sampled prior to May 1, 2007

	Number of bores sampled for stygofauna				Total Sampling Effort at Feb 07
Area Sampled	**July 2005**	**Mar 2006**	**Aug 2006**	**Feb 07**	
Impact Area (22 bores)	4	21	14	4	43
Controls (3 bores)	n/s	1	3	n/s	4

Troglofauna

Troglofauna surveys were conducted in 18 bores within the Project Area (**Table 3**; **Appendix A**), with a single sampling event occurring in June 2006. Traps were collected in August 2006. No fauna were trapped during this sampling event, and therefore no subsequent surveys were conducted.

Table 3 Spinifex Ridge impact and control bores sampled prior to May 1, 2007

	Number of bores sampled for troglofauna	Total Sampling Effort at Feb 07
Area Sampled	**Aug 2006**	
Impact Area (18 bores)	18	18
Controls (1 bore)	1	1

2.3.2 Woodie Woodie Borefield

Bores adjacent to the Cracker Pit were sampled by Outback Ecology in September 2006 and February 2007. A total of 16 bores in the impact area (**Figure 5**) have been sampled for a total effort of 17 samples to date, and three local control bores (**Figure 5b**) have been sampled for a total effort of three samples to date. Additional sampling of 16 impact bores and three control bores is scheduled for July/August 2007 (**Table 4**).

Table 4 Woodie Woodie impact and control bores sampled prior to May 1, 2007

	Number of bores sampled for stygofauna			Total Sampling Effort at Feb 07
Area	**Sept 2006**	**Feb 2007**	**August 2007**	
Woodie Woodie (16 bores)	7	10 *	*16 bores in impact area and 3 controls to be sampled*	17
Woodie Woodie control bores (3 bores)	3	N/S		3

** includes two bores that were dry at the time of sampling*

Due to the paucity of suitable control bores and the absence of fauna from those sampled, regional data was sourced where available, and DEC provided regional context for species identified from the Woodie Woodie borefield.

2.3.3 De Grey Borefield

Bores within the De Grey borefield were sampled by Outback Ecology in October 2006 and February 2007. A total of eight bores in the impact area have been sampled for a total effort of 14 samples to date, and five local control bores have been sampled for a total effort of five samples to date (**Figure 6**). Additional sampling of eight impact bores and five control bores is scheduled for August 2007 (**Table 5**).

Due to the paucity of local control bores and the absence of fauna from those sampled, regional data was sourced where available, and DEC provided regional context for species identified from the De Grey borefield.

Table 5 De Grey impact and control bores sampled prior to May 1, 2007

	Number of bores sampled for stygofauna			Total Sampling Effort at Feb 07
Area	**Oct 2006**	**Feb 2007**	**June 2007**	
De Grey (8 bores)	6	8	*8 bores in impact area and 5 controls to be sampled*	14
De Grey control bores (5 bores)	2	3		5

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Figure 4 Location of stygofauna and troglofauna sites at the Spinifex Ridge Project Area

Figure 5 Location of stygofauna control sites at the Woodie Woodie borefield

Figure 6 Sample sites for stygofauna in the De Grey borefield

3.0 Potential Habitat

Potential habitat for stygofauna should be considered in the context of geology and hydrogeology. For the Spinifex Ridge Project Area and the borefields included in this study, these aspects have been described by Rockwater (2006), Groundwater Resource Management (2006) and Aquaterra (2007a, 2007b).

Subterranean habitats may be characterised in terms of their chemistry, their porosity and their connectedness to surrounding systems. The chemical dimension of the subterranean habitat relates both to average chemical conditions (for example, the salinity or acidity of the groundwater), but also to the variability of key chemical attributes over time.

Eberhard *et al.* (2005) have defined three main groundwater habitat types in the Pilbara, based upon the geological character of the aquifer. They are:

- Unconsolidated sedimentary deposits, including alluvial aquifers on coastal plains and occurring further inland as “valley fill” systems;
- Chemically-deposited calcretes or pisolites; and
- Fractured rock systems, where flow occurs through fracturing and jointing within a less permeability rock mass.

Stygofauna may occur within any of these aquifer types. To date, most sampling effort has focussed on alluvial and “chemically-deposited” systems because these usually are associated with higher water yields than the fractured rock systems, and are consequently more frequently considered as part of mine dewatering or water supply studies.

3.1 Project Area

Spinifex Ridge generally consists of Archaean rocks, overlain by recent alluvial deposits housing modern drainage systems (**Figure 7, Figure 7b**). There are two defined granitoid complexes to the north and south, known as the Muccan Granitoid Complex and the Mt Edgar Granitoid Complex, respectively. The interleaved sequence consists of rocks related to the Warrawoona and Gorge Creek Groups. The area is structurally complex, with extensive shearing and faulting. The rocks of the two Groups are tightly folded, forming an east-west trending syncline known as the Coppin Gap Syncline (Aquaterra, 2007a).

The De Grey River catchment is the main drainage system in the north eastern Pilbara, and is one of the largest river systems in the Pilbara, extending as far east as the Great Sandy Desert. Several major rivers feed into the De Grey River. The Spinifex Ridge catchment drains north into Kookenyia Creek, which discharges to the De Grey (Aquaterra, 2007a).

The groundwater system at Spinifex Ridge is broadly defined by the three surface water catchment boundaries. Two of these three catchments drain through Coppin Gap and directly influence the groundwater in the vicinity of the proposed mine void. There are three aquifer types identified within the Spinifex Ridge catchment:

- fractured bedrock; high-yielding, sustainable aquifers of this type are unlikely in the vicinity of the proposed pit;
- in-situ calcretes overlying ultramafic bedrock; observed within the creek systems of the catchment to a depth of approximately 10m, with the calcretes being more permeable than the ultramafic rocks below; and
- alluvial sediments associated with recent drainage lines; comprising poorly sorted gravel and poorly sorted sandy silts in the creeks. Alluvium thickness is typically 2–10m

The dominant habitat type at Spinifex Ridge consists of a fractured rock flow system developed in the weak to moderately-weathered bedrock. Because of the intense metamorphosis that has occurred in the Spinifex Ridge area, the rock mass has very little preserved primary porosity and flow through the rock mass typically relies upon the secondary porosity associated with features such as faults, shears, joints and fractures. Alluvial-type subterranean habitats do not occur to any significant degree within the part of the saturated subsurface area directly impacted by mining activities at Spinifex Ridge.

As noted in Aquaterra (2007a) carbonate accumulations occur in parts of the project area, forming weak calcrete deposits which typically occur at depths of less than 10m. According to Aquaterra, the calcrete zones are best developed where drainage lines overlie ultramafic units (Euro Basalt Formation) and in close proximity to the Bamboo Creek Shear Zone. The calcrete zones are characterised by relatively higher hydraulic conductivities than the surrounding rock mass (horizontal hydraulic conductivity in the order of 10 m/day). The ultramafic rocks encountered beneath the calcrete are weakly weathered to fresh and of very low permeability ($<10^{-4}$ m/day).

Detailed geological descriptions were available for twenty-four of the Spinifex Ridge boreholes that were sampled for stygofauna. It was observed that approximately 75% of the sampled Spinifex Ridge bores which had calcrete mineralisation in the upper 50 m contained stygofauna on one or more occasions, compared to only 31% of the bores which did not show calcrete mineralisation. This difference was statistically significant at the 95% confidence level.

There are insufficient data to demonstrate whether the association between calcrete and stygofauna occurrence relates to a physical aspect of the subterranean habitat (that is, stygofauna occur in regions of higher porosity and connectivity) or to a chemical aspect of the habitat. The limited available groundwater chemistry data for bores that were sampled for stygofauna do not indicate any clear differences in the chemistry of groundwater in “habitat bores” versus “non-habitat” bores. The average groundwater composition was slightly fresher and less alkaline in the bores in which stygofauna occurred, possibly reflecting the influence of seasonal recharge of meteoric water into the shallow calcretised rock.

3.2 Woodie Woodie Borefield

The Woodie Woodie aquifer system is highly permeable and is located within the Oakover Syncline, a large synclinal basin. The Syncline is a large structure of platform carbonate overlying the Jeerinah Formation. The primary lithology is Carawine Dolomite, which underlies Pinjian Chert Breccia. Both of these host manganese deposits. Waltha Woora Sandstone, comprising a medium to coarse-grained sandstone, overlies the Pinjan Chert Breccia in places. Overlying Cainozoic sedimentary units include calcareous sandstones and laterite (**Figure 8**) (Groundwater Resource Management, 2006). Regional geological data indicates that the basin housing the Woodie Woodie aquifer extends for over 100km. Groundwater flow is east to west toward the Oakover River, which is considered to be the major natural discharge area in the region (Groundwater Resource Management, 2006).

The two main aquifers in the area are the Pinjian Chert Breccia and the Upper Carawine Dolomite (**Figure 8**). The Pinjian Chert Breccia is a major aquifer which ranges from confined to unconfined, and is often vuggy, with voids either open or infilled with clay or fine-grained sediments. It is unknown whether the vughs are ubiquitous through the unit. The Upper Carawine Dolomite is an unconfined aquifer within the region and is highly permeable due to discontinuities and vughs. These two aquifers provide the main hydraulic link between all the pits in the Woodie Woodie area. Three aquitard units also occur in the area, broadly consistent with the Paterson Formation, Lower Carawine Dolomite and the Jeerinah Formation. The aquitards store large volumes of water but do not transmit it readily (Groundwater Resource Management, 2006).

In the vicinity of the Cracker Pit, manganese ore is associated with major groundwater inflows, indicating locally-high permeability associated with a significant zone of faulting between the Cracker, Big Mac and possibly Radio Hill pits. Inflow rates at the Cracker pit may be partly associated with ungrouted drill holes which may link the pit to highly-permeable manganese ore zones and Upper Carawine Dolomite.

In the event that the Cracker Pit is used as a water source, abstraction of approximately 600L/s (approx 19GL/annum) is anticipated over a twelve year mine life. Groundwater modelling shows that the aquifer system is highly permeable and is laterally extensive, and that it is possible to pump an additional 600L/second of additional groundwater from a single source location, such as the proposed Cracker Pit, for a period of the life of the mine with no significant change to the system. The extent of the 5m drawdown contour may increase by 600m laterally, but would be constrained to areas of high permeability (Groundwater Resource Management, 2006). Only minor drawdown of the aquifer will occur, leaving a large saturated zone remaining.

At Woodie Woodie, favourable habitats for stygofauna may be provided by the Upper Carawine Dolomite aquifer, and the overlying Cainozoic sedimentary units. The Carawine Dolomite aquifer is unconfined and highly permeable. Around the Cracker Pit, there is locally high permeability and major groundwater inflows associated with faulting.

Detailed bore logs were not available for this area at the time of writing. Therefore, only general comments can be provided about potential stygofauna habitat at this stage.

3.3 De Grey Borefield

Most of the De Grey River exploration area comprises basement granite rocks of the Muccan Granitoid Complex and Pilbara Supergroup formations which form a depositional basin, overlain by quaternary sediments (Aquaterra, 2007b). While most of the ridges, granite outcrops and creeks in the region are north trending, parallel to basement granite, the De Grey River cross-cuts this trend, following a linear westerly trend. There is a major bend in the river where it diverts around shallow granite near the crossing with the Muccan-Shay Gap Road. Most exploration holes intersect grey clay and sandy clay up to 30 m thick, appearing to be mainly derived from weathered granite (**Figure 9**) (Rockwater, 2006).

The Quarternary alluvial deposits of the De Grey and its tributaries are the most locally-significant aquifers, providing water to both pastoralists and mining companies. Grey and sandy clay zones of up to 30m thick separate two aquifers (**Figure 10**):

1. a widespread, mostly continuous and shallow alluvial aquifer (6 – 10m deep) consisting of coarse sand and gravel, with variable clay, with a standing water level of 3.4 – 7.1m, and salinity usually exceeding 1800mg/L; and
2. a deeper alluvial aquifer, comprised of poorly-sorted gravel and sand overlying granite basement rock, with variable water quality of known range 1187 – 3887uS/cm.

The shallow aquifer is in hydraulic connection with pools in the De Grey River, and is separated from the deeper aquifer which is discontinuous. It is recharged via direct infiltration of rainfall, run-off and river flow, with groundwater levels expected to rise to near-ground level during high flow events (Rockwater, 2006; Aquaterra, 2007b). The deeper aquifer is semi-confined and is constrained laterally to the paleochannel (Aquaterra, 2007b).

Modelling of groundwater abstraction rates of 4GL, 6GL and 8GL show that 4GL/annum is achievable. The borefield design will comprise bores sited to manage sustainable drawdown across the borefield and limit impacts on the upper aquifer and associated pools in the De Grey River. The risk of impact to groundwater dependent habitats that may be affected by abstraction is considered low, with the implementation of appropriate management of the upper alluvial aquifer, and because the paleochannel aquifer is fully confined or saturated (Aquaterra, 2007b).

At De Grey, two potential stygofauna habitats were identified. These were a deep, semi-confined alluvial aquifer overlying granite basement rock; and a shallow, widespread and mostly continuous alluvial aquifer. While both aquifers are considered alluvial, the dominant rock types are granites and weathered granites, which may be less favourable habitats than other rock types, such as calcretised rock. Detailed bore logs were not available for this area at the time of writing. Therefore, only general comments can be provided about potential stygofauna habitat at this stage.

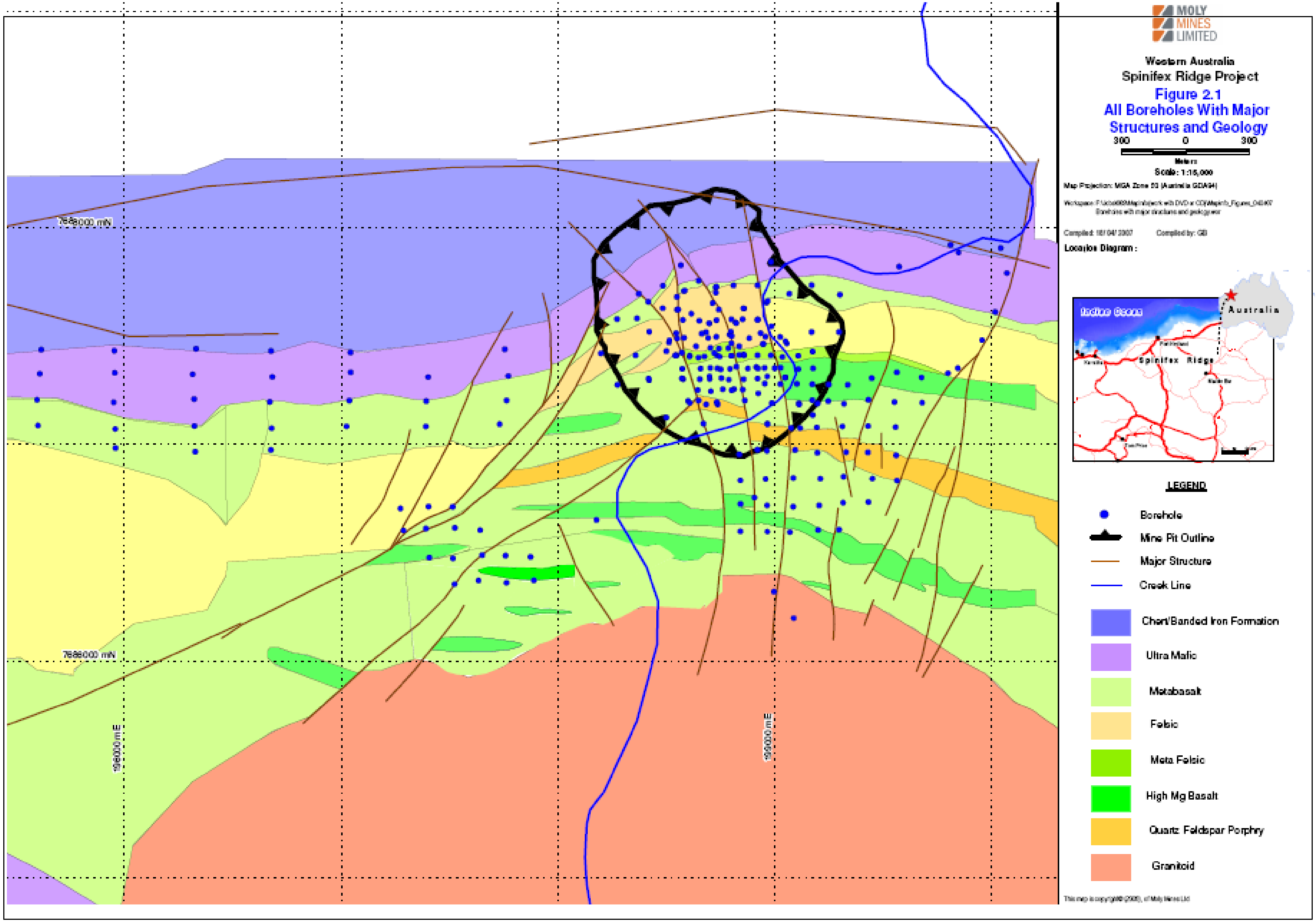

Figure 7 Geology of the Spinifex Ridge Project Area (source: Aquaterra, 2007a)

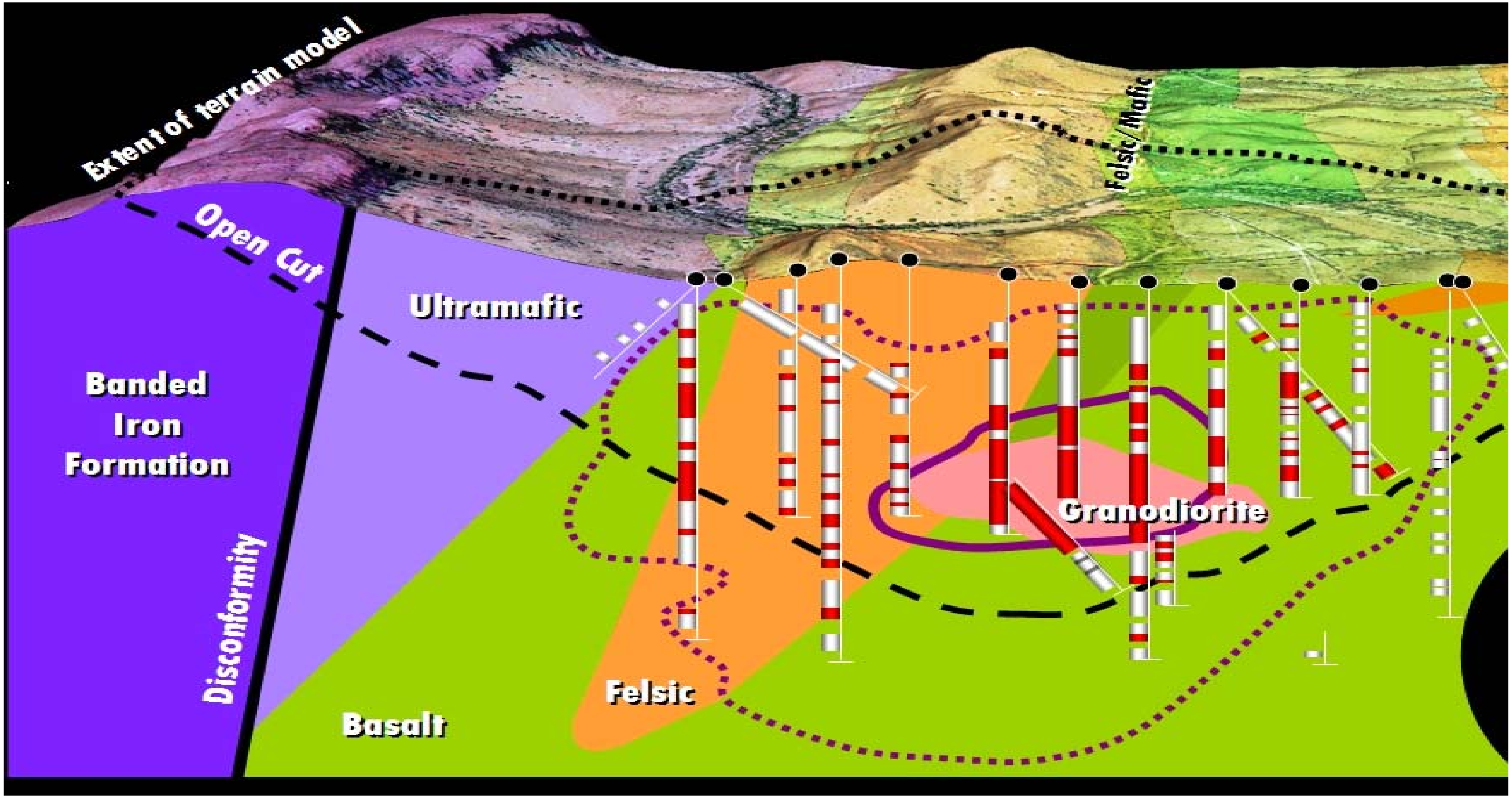

Figure 7b **Schematic geological profile of the Spinifex Ridge Project Area (source: Moly Mines, 2007)**

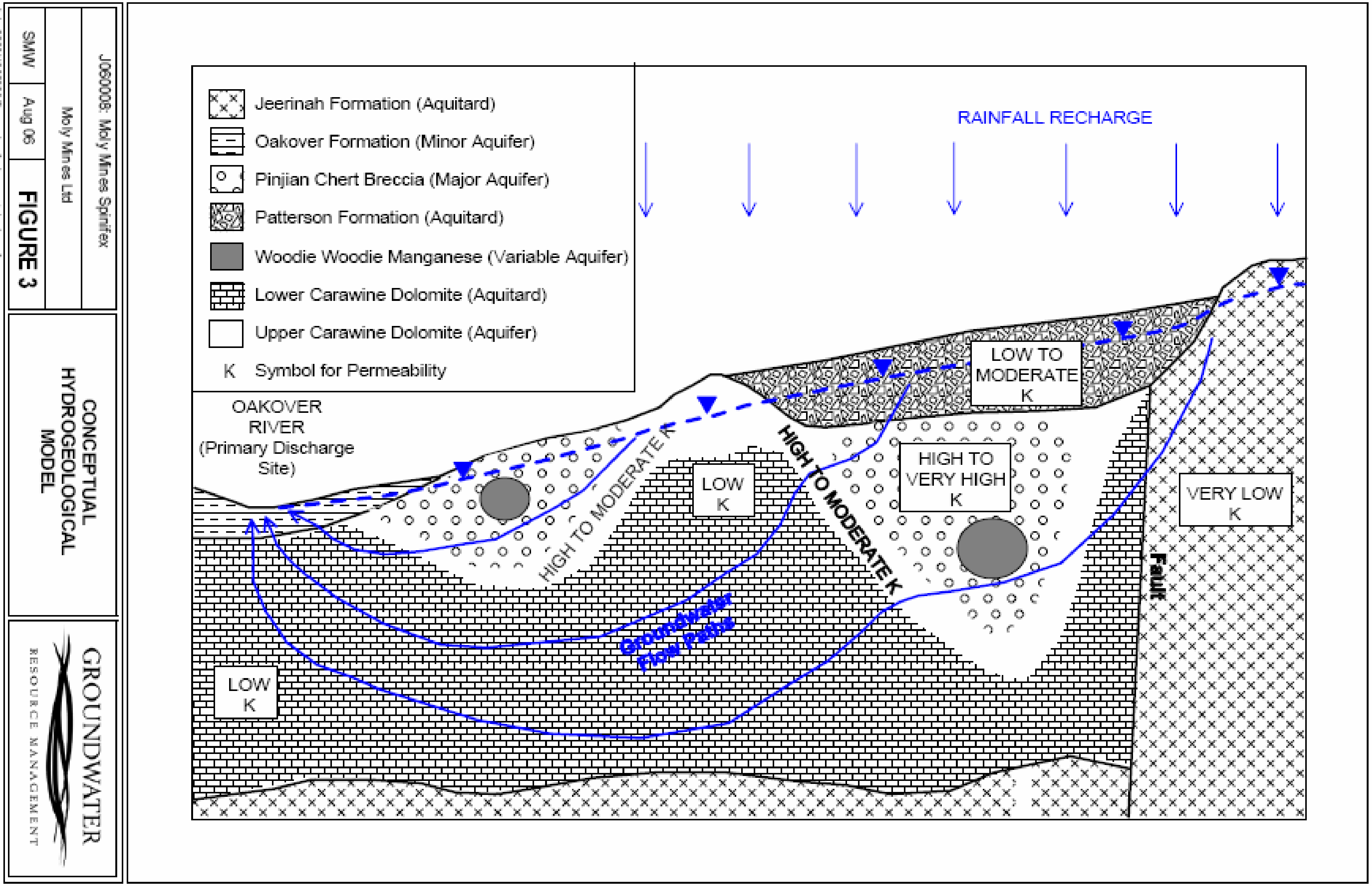

Figure 8 **Conceptual hydrogeology of the Woodie Woodie borefield (source: Groundwater Resource Management, 2006)**

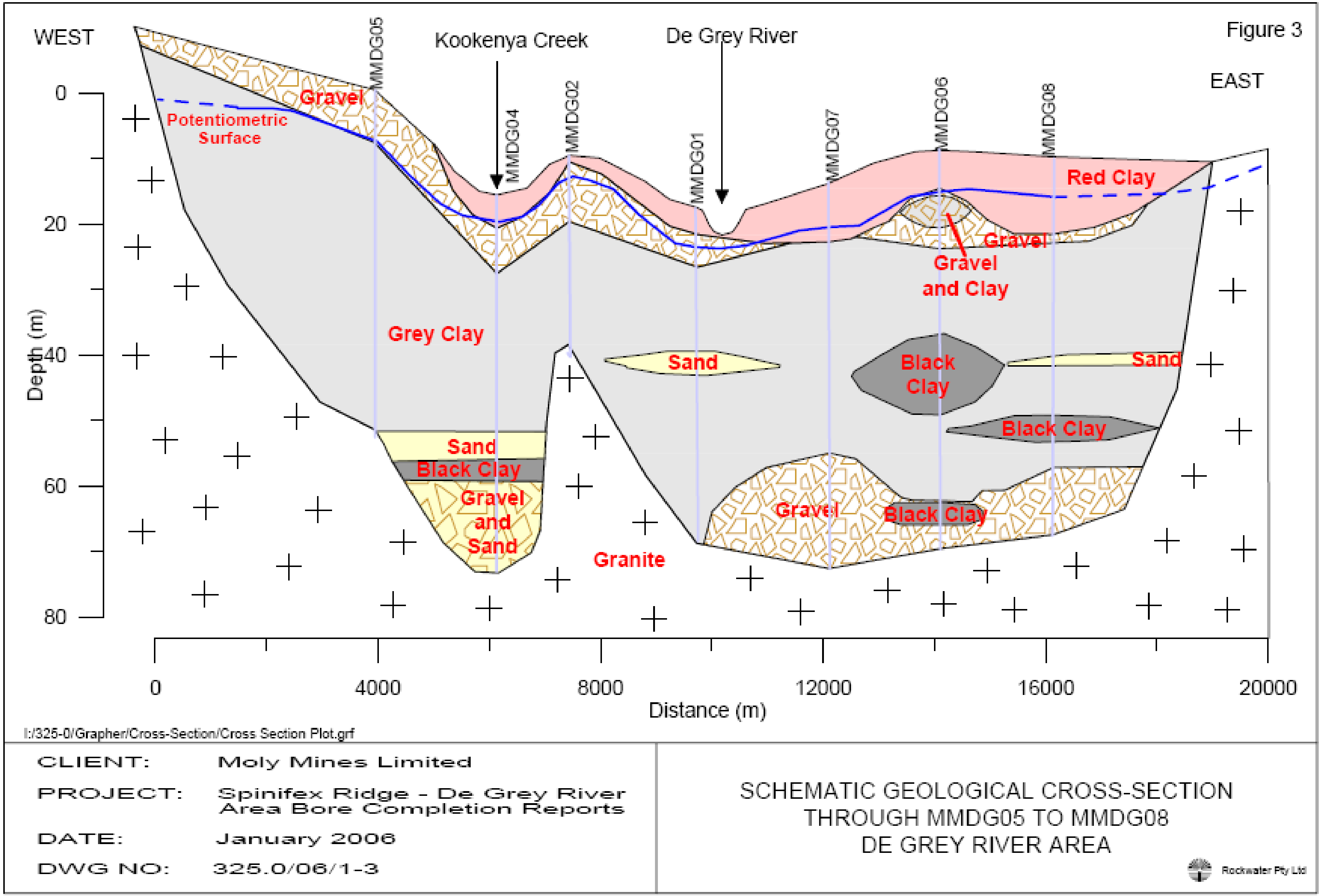

Figure 9 **Geology of the De Grey borefield (source: Rockwater, 2006)**

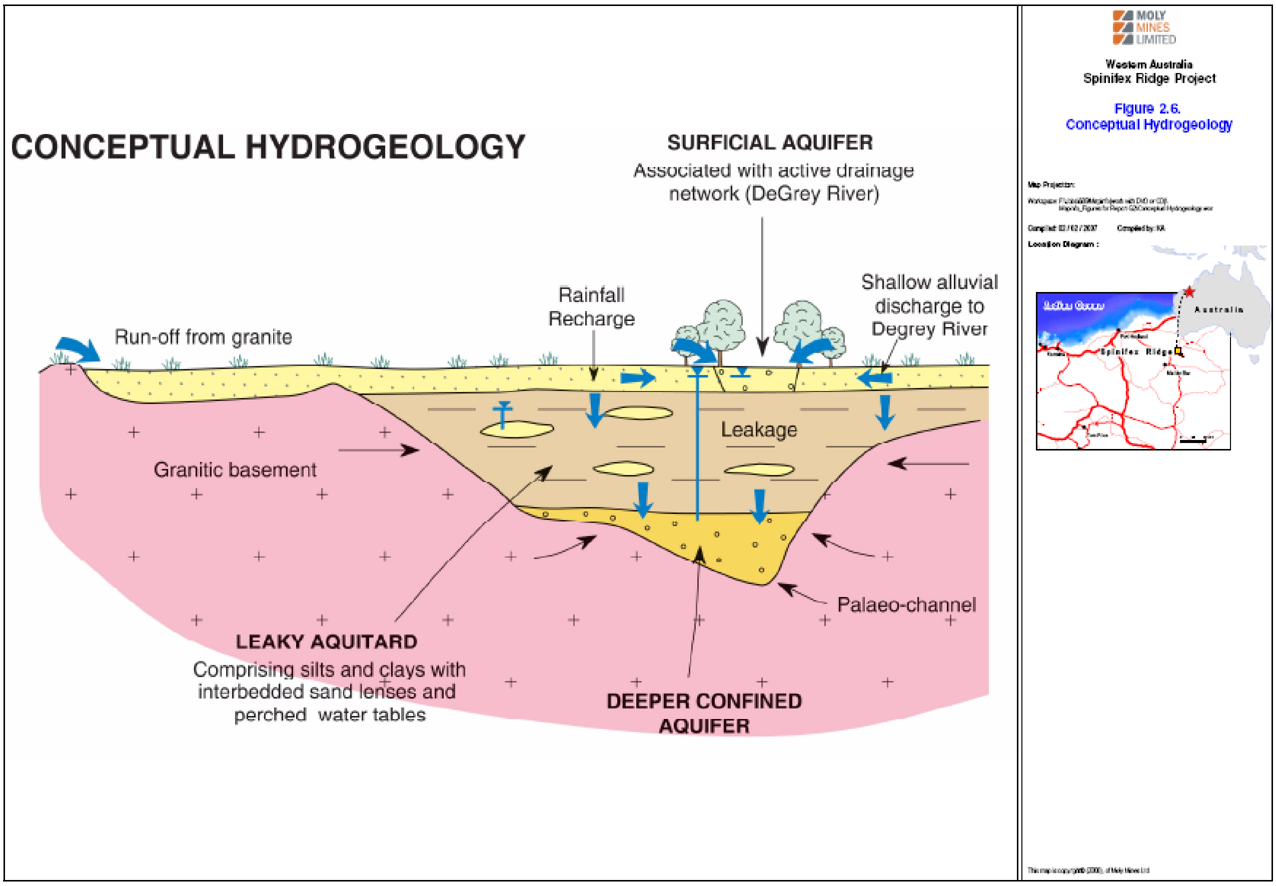

Figure 10 **Conceptual hydrogeology of the De Grey River area (source: Aquaterra, 2007b)**

4.0 RESULTS

4.1 Water Chemistry

The complete results of water chemistry sampling during field assessments are presented in **Appendix B**.

Project Area

Generally, the 22 impact bores within the Project Area recorded water temperatures of 25.0 – 33.0°C, compared to the 3 control bores whose average water temperatures were 26.4 – 31.7°C. The control bores recorded a mean pH of 7.44, compared to a slightly lower mean pH of 7.28 in the impact bores. In terms of salinity, the control bores recorded a mean electrical conductivity (EC) of 2927µS/cm, which was approximately double the mean EC of the impact bores (1428 µS/cm). Despite this difference, bore water quality was considered hyposaline, or 'fresh to brackish', in both impact and control bores. A mean DO value of 3.69 ppm was recorded for the control bores, and 4.26 ppm for the impact bores. Both values were considered relatively low to moderate compared to other sites in the study. Records for other parameters (redox potential, turbidity) were limited due to equipment malfunction or non-availability.

There were observable differences between the control and impact bores, but the lack of replicates and data records for each (22 impact, 3 control) may have contributed to these apparent differences.

Woodie Woodie

At Woodie Woodie, water quality data for 3 control bores and 16 impact bores was obtained (excluding 2 impact bores that were dry at the time of sampling). As for the Project Area, the difference in number of replicates and data records for each has influenced the robustness of the data. Bore water quality of the control and impact bores was similar in terms of mean pH (7.15 and 7.13, respectively), and mean temperature (30.5°C for each). There were marked differences between the two areas in terms of EC and DO, although records for both were limited. The control bores recorded lower mean EC (970µS/cm) compared to the impact bores (1683µS/cm), and water quality was considered fresh to brackish. Limited records for DO showed low mean value in the control bores (0.03 ppm) compared to the impact bores (8.11 ppm), where DO was considered high.

De Grey

The De Grey water quality data provided comparison between 5 control bores and 8 impact bores, so the data sets were more comparable than at other sites. The pH of water from the two areas was similar, with a mean pH of 7.65 from control bores, and 7.71 from impact bores. In terms of EC, the control bores recorded a mean value of 3914 µS/cm compared to 3769 µS/cm for the impact bores. In terms of salinity, the bores were considered highly variable (Rockwater, 2006) ranging from hyposaline to mesosaline, or 'brackish to saline'. The mean temperature of bore water for the two areas was similar, being 31.6°C for control bores and 31.73°C for impact bores. The number of DO readings were limited, but were higher for control bores (2.16 ppm) compared to impact bores (1.77 ppm). DO was considered low overall.

4.2 Subterranean Fauna

4.2.1 Stygofauna

Spinifex Ridge Project Area

A species accumulation curve indicates that further sampling is required for the Project Area and this has been scheduled for August 2007 (**Appendix C**).

All stygofauna families identified in four separate sampling events have a known distribution outside the Project Area. According to information available to date, no species of conservation significance were recorded in the project area (Table 6; **Appendix D**). One damaged specimen (Copepoda) could not be identified below Order. Of interest was the identification of *Leicandona quasihalsei* in bore SRC057, from the most recent survey (February 2007). This species was recently described, based on a male specimen, from the type locality of Skull Spring on the Davis River, in the upper De Grey catchment. The distribution of this species is considered limited at present. The specimen found in the Project Area is the first female *L. quasihalsei* recorded from the Pilbara. Further sampling is required to verify the distribution of this species, and its conservation significance.

Key findings in terms of yield were:

- Of the 22 bores sampled in the impact area, 14 (64%) contained stygofauna in at least one sampling event (**Figure 11**),
- Of the 43 samples collected from 22 bores in the impact area over four sampling events, 49% (21 samples of 43) contained stygofauna,
- Of the four samples collected from three bores outside the impact area (control bores), none contained stygofauna. In this context, data from the survey was supplemented by data from other sites within the region and/or advice from DEC.

All specimens in the Project Area belong to the Class Crustacea. Key findings in terms of taxa identified were:

- Due to current taxonomic limitations, and the immaturity of some specimens, identification to species levels was not possible for all taxa,
- The dominant Subclass Copepoda, represented 50% of taxa identified, and within this:
  - The Order Cyclopoida displayed the highest diversity with eight taxa, the ostracod *Diacyclops humphreysi humphreysi* being numerically dominant,
  - The Order Harpacticoida recorded four taxa (15%).
- Within the remaining Crustacea;
  - The second dominant group was the Order Syncarida, representing 15% of taxa identified,
  - Ostracoda accounted for 9% of taxa identified,
  - Amphipoda accounted for 6% of taxa identified,
  - Isopoda accounted for 4% of taxa identified.

Table 6 Stygofauna collected from the Project Area between July 2005 and February 2007.

Order	Lowest ID	Bore Code	Count	Comments
Amphipoda	Melitidae sp. 1 CALM	SRC055	1	New genus of Melitidae that occurs commonly throughout the western Pilbara. Similar to Paramelitidae sp. 2 CALM which occurs in Fortescue and Ashburton catchments.
	Paramelitidae cf. sp. 2 CALM	SRC053	4	Occurs throughout the De Grey catchment. Similar to Paramelitidae sp. 2 CALM, which occurs in Fortescue and Ashburton catchments.
	Pilbarus millsi	WB001	1	Common and widespread, all catchments
Cyclopoida	Cyclopoida	WB001	4	Not identified further as specimen was incomplete
	Diacyclops cf. humphreysi humphreysi	SRC053, SRC057, SRD073	8	Occurs throughout the Pilbara, Exmouth and SW Australia.
	Diacyclops humphreysi humphreysi	SRC044, SRC053, SRC055, SRC057, SRC061, SRD065, SRD072, SRC073	85	Common, all catchments.
	Diacyclops scanloni	SRC054, SRC055	13	Common, all catchments.
	Diacyclops sobeprolatus	SRC055	6	Common, all catchments.
	Fierscyclops (Pilbaracyclops) cf *frustratio*	SRC052, SRC053, SRC054, SRC055	16	Known from Lake Disappointment and Telfer, Bulloo Downs Station, Ilgarari creek and Great Sandy Desert Basin. This represents the westward range of the species extension if the identification is correct.
	Microcyclops varicans	SRD079	2	Common, all catchments.
Harpacticoida	Canthocamptidae sp.	SRC052, SRC053, SRC054, SRC057	11	Family widespread in fresh water and contains ~700 described species, is well represented in Australia. Identification and formal description can be difficult when found in low numbers.
	Elaphoidella humphreysi	SRD059	1	Known from western Pilbara and most of De Grey catchment. Possibly another two undescribed species occur across the Pilbara.
	Parastenocaris sp.	SRD073	1	Several species recorded in Australia in the past 30 years. *Parastenocaris jane* appears restricted to the southern Pilbara, and two other undescribed species are known from the Pilbara including one from ~40 km SE of Marble Bar.
	Stygonitocrella trispinosa	SRC057	105	Known from locations in Pilbara including De Grey Station, Carlindi Creek, West Strelley, Yule River.
Isopoda	*Coxicerberus* sp.	SRC052	1	This genus was created in the early 1990's to accommodate coastal microcerebid species in N. America, and most Pilbara species would be classified within this genus based on a generic diagnosis. Taxonomy is controversial and may be revised. There are three undescribed species from the Pilbara, mostly from De Grey and Port Hedland.
	Microcerberidae sp.	SRC054	1	Family is cosmopolitan and collected throughout the Pilbara, including De Grey. Several species occur in the Pilbara but have not been differentiated. This is the same species as one found by Wedgetail Mining Ltd. Formal identification to species level is pending.
Ostracoda	Candonidae sp.	SRC053	2	84 species known from the Pilbara, family is abundant in the region.
	Kencandona harleyi	SRC055	3	Found in CALM Pilbara survey
	Leicacandona mookae	SRC053	1	Found in CALM Pilbara survey
	Leicacandona quasihalsei	SRC057	4	Recently described for Pilbara by a single male specimen from the type locality at Skull Spring on the Davis River, in the upper De Grey catchment. This is first female found. Further sampling required.
Syncarida	Bathynellidae sp.	SRC053, SRC061	3	Family is known from a variety of sites in the western Pilbara, from Ashburton to the De Grey, despite few published records. Published distribution for the family is listed as WA, Vic, Tas and NSW. The records appear to represent several species and there is a record from 40 km south east of Marble Bar.
	Atopobethynella sp.	SRC053	1	Found across the Pilbara, including Fortecue, Robe and DeGrey Catchments, still to be described. Second morphotype (more common) also to be described.

Comments were provided by specialist taxonomists

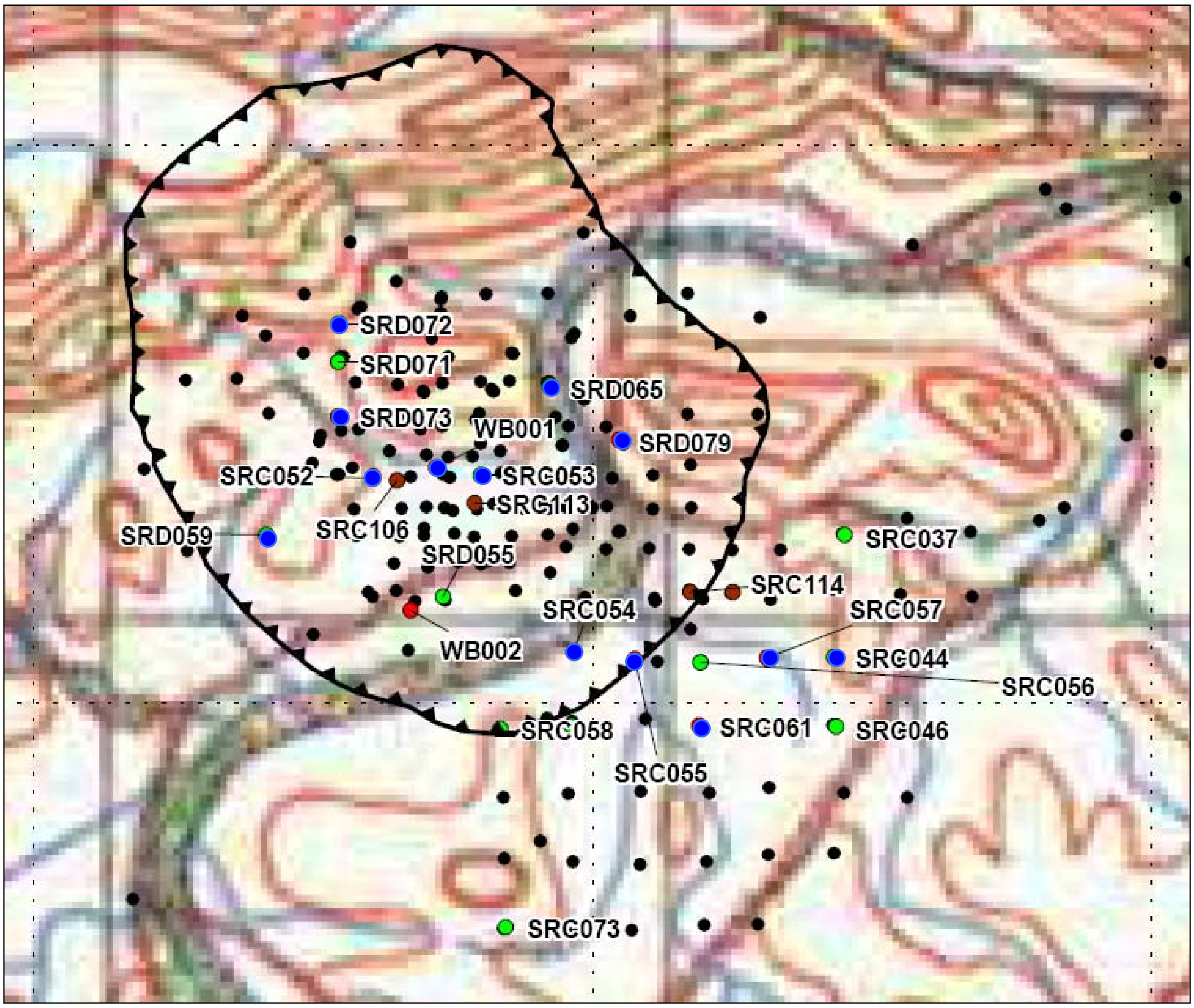

Figure 11 **Impact bores containing stygofauna in the Project Area (dark blue dots). None of the control bores in the area contained stygofauna.**

On average, the species richness within the impact bores in the Project Area, was two species per bore. Bore SRC053 had the greatest richness with ten species, and the most abundant taxa in this bore for all sampling events were *Diacyclops* cf. *humphreysi humphreysi* and *Fierscyclops (Pilbaracyclops)* cf *frustratio*. Across all impact bores in the Project Area, bore SRC057 had the highest abundance, with 105 *Stygonitocrella tripinosa*, and 53 *Diacyclops humphreysi humphreysi*. Generally all other bores had less than 12 specimens per bore.

Specimens of interest that were collected in the Project Area will be lodged with the WA Museum once returned from specialist taxonomists (Tom and Ivana Karanovic).

Woodie Woodie

At Woodie Woodie, the nomination of 'control' and 'impact' bores is based on current hydrological knowledge. The bores within the Woodie Woodie leases (all bores apart from those labelled Braeside) have all been subjected to impacts from mining and/or dewatering, and are therefore considered 'impact' bores for the purposes of this study. In discussion of the findings of this study, 'impact' is more specifically discussed in the context of potential impacts of Moly Mines' proposed dewatering of the Cracker Pit. Further sampling of Woodie Woodie borefield is required as indicated by the species accumulation curve (**Appendix C**). Additional sampling has been scheduled for August 2007.

Data from the bores assessed over two separate sampling events (**Table 7**, **Figure 12**, **Appendix D**) showed that the majority of species identified were common in the Pilbara region, according to the information available to date. However, two of the bores sampled in February 2007 contained species of significance, as follows:

- *Goniocyclops* sp. 1 n. sp. (Karanovic), in bore DEPH02; this is the first record of this genus in the Pilbara. It is known from the Murchison (published records), the Kimberley and Queensland (unpublished records). It is closely related to *Goniocyclops uniarticulatus* Karanovic 2004. Bore DEPH02 was located near the >5 m drawdown contour of Cracker Pit, and has been subjected to previous mining and dewatering impacts (**Figure 13**).
- *Halophytophilus* sp. 1 n. sp. (Karanovic), in bore DEPH01. This is the first record of this genus in continental waters, and in mainland Australia. Only five species have been identified in this genus thus far, and are marine. Bore DEPH01 was located near the > 5 m drawdown contour of the Cracker Pit, and has been subjected to previous mining and dewatering impacts (**Figure 13**).

A Paramelitidae n. sp. cf. DEC sp. 6 was collected from control bore Braeside 4. It is considered to be consistent with material found in DEC surveys of the Pilbara, and is therefore not considered locally unique or limited in distribution.

Two bores sampled in February 2007 were dry, and although they were incorporated in the calculation of sampling effort (Section 2), they were not included in the calculations for yield. Key findings in terms of yield were:

- Due to current taxonomic limitations, and the immaturity of some specimens, identification to species level for all specimens was not possible.
- The stygofauna identified belonged to either the Crustacea (Arthropoda) or the Oligochaeta (Annelida), the highest diversity was displayed by the Cyclopoida (Crustacea: Copepoda) with five taxa,
- Of the 16 impact bores sampled, stygofauna were recorded from seven (44%) (**Figure 12**),
- Of the 17 samples collected from 16 bores in the impact area over two sampling events, stygofauna were recorded in eight samples (47%)
- Of the three control bores sampled, stygofauna were recorded in two (67%).

- Four of the five samples (80%), collected from three control bores over two sampling events, contained stygofauna.

The Woodie Woodie samples were dominated by taxa belonging to the Class Crustacea, with a few Oligochaetes also recorded. Key findings were:

- The dominant Order was Cyclopoida (Crustacea: Copepoda), representing 53% of taxa identified
- The Order Amphipoda (Crustacea) represented 26% of taxa identified
- The Order Tubificida (Annelida: Oligochaeta) accounted for 16% of taxa identified
- The Order Harpacticoida (Crustacea: Copepoda) accounted for 5% of taxa identified.

Table 7 Stygofauna collected from Woodie Woodie between September 2006 and February 2007.

Order	Lowest ID	Bore Code	Count	Comments
Amphipoda	Bogidiellidae sp. 1 CALM	KTRC20	1	Found in DEC Pilbara survey, known by at least two morpho-species
	Paramelitidae n. sp. cf. DEC sp. 6 (PSS)	Braeside 4*	29	Found at Ragged Hills Mine - consistent with material previously collected by DEC.
	Paramelitidae sp. 6 CALM	EARC32, Cracker Pit	6	Found in DEC Pilbara survey in the De Grey catchment.
	Pilbarus millsi	DEPH01	2	Common and widespread, all catchments
Cyclopoida	*Diacyclops humphreysi humphreysi*	Braeside 5*, DEPH01, RBM02	32	Very common, all catchments.
	Diacyclops scanloni	Cracker Pit, DEPH01, KTRC20, RMB03	164	Very common, all catchments.
	Mesocyclops sp.	RMB02	11	Genus represented in Pilbara from several locations.
	Microcyclops varicans	EARC32	1	Very common, all catchments.
	Goniocyclops sp 1 n sp	DEPH02	51	**First record of genus in Pilbara, closely related to *G. uniarticulatus* Karanovic 2004. Known from Murchison, Kimberley, Qld.**
Harpacticoida	*Halophytophilus* sp 1 n sp	DEPH01	11	**First record of genus in continental waters, first in Australia**
Tubificida	Enchytraeidae	RMB03	1	Group needs more description. Possibly same as those in other Pilbara surveys.
	Phreodrilidae with dissimilar ventral chaetae	Cracker Pit	3	Found in DEC Pilbara survey
	Phreodrilidae with similar ventral chaetae	RMB03	1	Found in DEC Pilbara survey

** control bores*

Comments were provided by specialist taxonomists

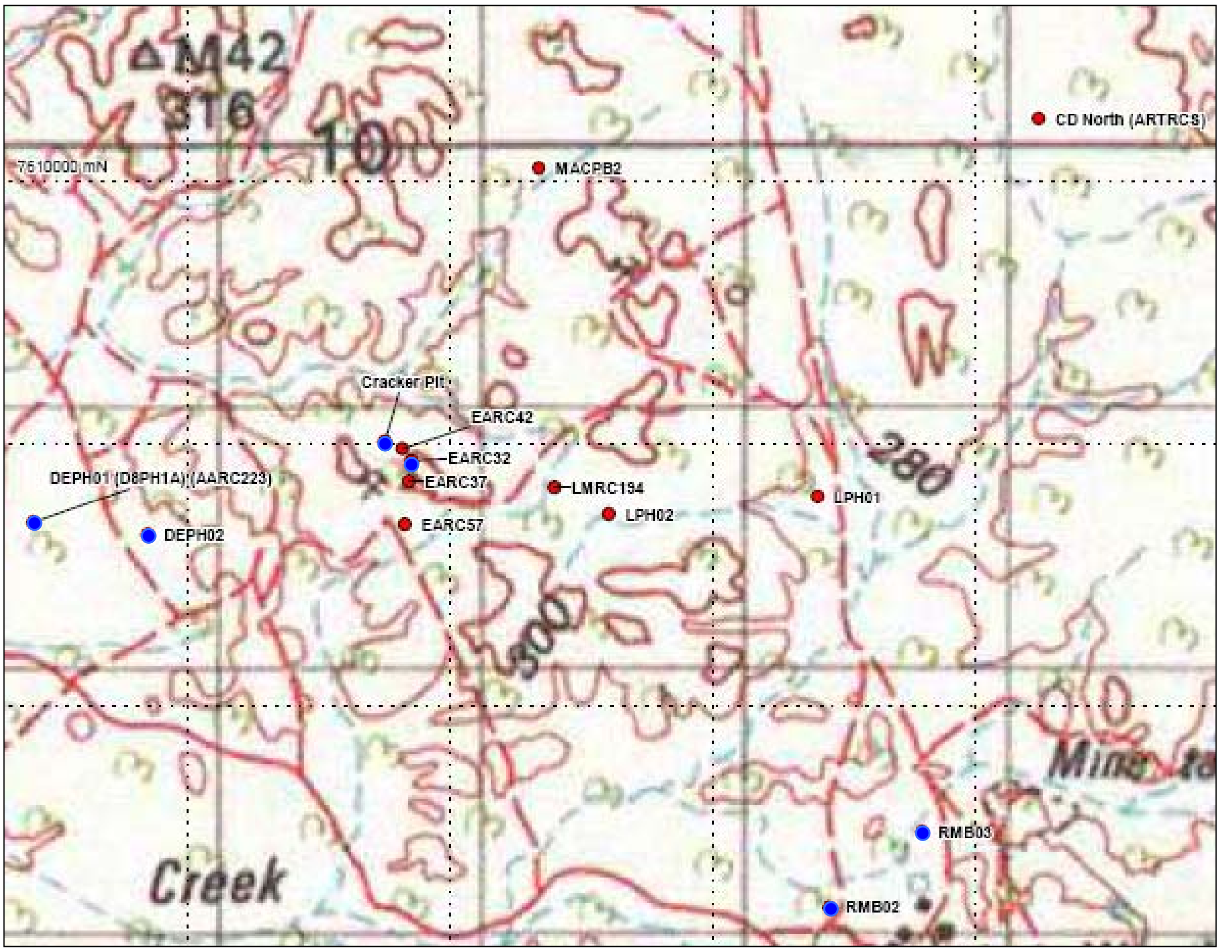

Figure 12 Impact bores containing stygofauna at Woodie Woodie (dark blue dots) (note KTRC20 and control bores are not shown at this scale, but contained stygofauna).

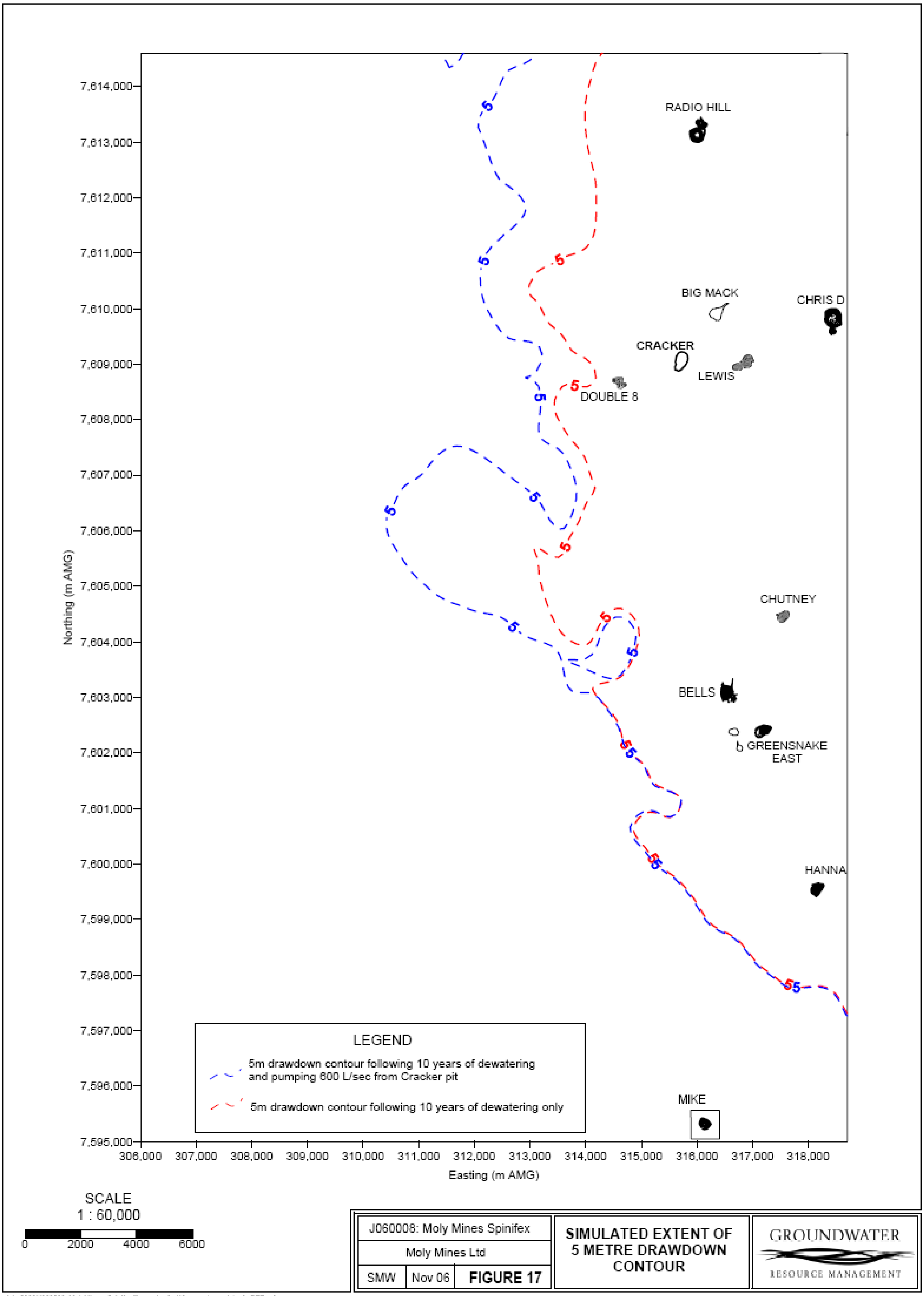

Figure 13 Simulated 5 m drawdown contour for 600L/s (approx 19GL/annum) dewatering around Cracker Pit, in relation to bores DEPH01 and DEPH02 (not shown), located near the Double 8 Pit.

At Woodie Woodie, average stygal richness within the impact bores was 0.86 species per bore, compared to 1.4 species per control bore.

Bore DEPH01 had the highest richness with four species recorded. Within this bore, *Halophytophilus* sp. 1 n. sp. was the most abundant in one sampling event, with 11 individuals recorded. Nearby, a relatively high number of *Goniocyclops* sp. 1. n. sp were collected from bore DEPH02 with 51 individuals recorded from a single sampling event. Both of these species will be lodged with the WA Museum once received from specialist taxonomists

The high abundance of the two new species, *Halophytophilus* sp. 1 n. sp. and *Goniocyclops* sp. 1 n. sp. in these bores was of interest, given that both bores are located around the Double 8 mining void, which has previously been mined and de-watered.

The Cracker Pit bore located on the perimeter of the Cracker mining pit, had the highest stygal abundance of all Woodie Woodie samples, with 150 *Diacyclops scanloni* recorded. All other bores generally recorded less than 30 individuals.

De Grey

At De Grey, the nomination of ‘control’ and ‘impact’ bores is based on reasonable certainty, to current hydrological knowledge. In that regard, changes to bore classifications are possible, but unlikely.

According to the species accumulation curve further sampling is required for the De Grey borefield (**Appendix C**), and is scheduled for August 2007.

Data from bores assessed over two separate sampling events (**Table 8**, **Appendix D**) showed that the majority of species identified were common in the Pilbara region, according to current knowledge. However, one of the bores sampled in February 2007 contained species of potential significance, as follows:

- *Mesocyclops* cf. *kieferi* n. sp.? (Karanovic), in pastoral bore Chinablin Well. This may be a new species, but requires more study. If it is a new species then it would be closely related to *M. kieferi*. *Mesocyclops* is represented in the Pilbara by three species.

Key findings in terms of yield were:

- Due to current taxonomic limitations, and the immaturity of some of the specimens, not all could be identified to species level,
- All stygofauna identified belonged to the Crustacea (Arthropoda) and Oligochaeta (Annelida), with the highest diversity being displayed by oligochaetes with four taxa within two families (Tubificidae and Naididae),
- Of the 8 impact bores sampled, 1 (13%) contained stygofauna (**Figure 14**),

- Of the 14 samples collected from 8 bores in the impact area over two sampling events, 1 of 14 (7%) contained stygofauna,
- Of the 5 control bores sampled, 4 (80%) contained stygofauna (**Figure 14**),
- Of the 5 samples collected from 5 control bores over two sampling events, 4 of 5 (80%) contained stygofauna,
- According to water level data, the shallow (6 – 10 m), continuous aquifer has yielded all specimens identified to date, with none collected from the basal (~70 m), semi-confined aquifer (**Appendix A**).

The De Grey samples were dominated by taxa belonging to the Class Crustacea, with a few oligochaetes also recorded. Key findings in terms of taxa identified were:

- The taxa present were equally distributed between the three orders Cyclopoida (Crustacea), Ostracoda (Crustacea) and Tubificida (Oligochaeta), with each accounting for one third of the taxa.

In terms of species richness, the average was 0.13 species per bore for impact bores, and 2.2 species per bore for control bore. The bores with the greatest diversity were two of the control bores (Chinablin Well and Collapsed Well), recording four different species in each. Chinablin Well recorded the highest abundance of *Mesocyclops* cf. *kieferi* n. sp. (110 individuals from one sampling event). This also represented the highest abundance of all bores at De Grey. Abundance records for all other bores were commonly less than 30 individuals.

It was interesting to note that Chinablin Well housed the most diverse and abundant stygofauna population, and contained a potential new species, as this bore is a pastoral bore in poor condition, with collapsing sides and susceptibility to overland flow. This bore does not fit the criteria established to determine ‘appropriateness’ for sampling but was sampled due to the limited number of bores in the area.

Table 8 Stygofauna collected from De Grey between October 2006 and February 2007.

Order	Lowest ID	Bore Code	Count	Comments
Cyclopoida	*Mesocyclops* cf. *kieferi* n sp ?	Chinablin Well*	110	**May be a new species. Genus represented by three species in the Pilbara.**
	Diacyclops humphreysi humphreysi	Collapsed Well*	2	Very common, all catchments.
	Mesocyclops sp.	Collapsed Well*	1	Genus represented in Pilbara from several locations.
	Microcyclops varicans	Collapsed Well*	60	Very common, all catchments.
Ostracoda	*Cypretta seurati*	Chinablin Well*, Regional 2	32	Very common throughout Pilbara, numerous records for De Grey catchment
	Humphreyscandona sp. DEC	Regional 3*	2	Found in DEC Pilbara survey
	Strandesia sp.	Regional 3*	7	Genus represented in Pilbara
Tubificida	*Dero furcata*	Chinablin Well*	1	
	Pristina longiseta	Chinablin Well*	2	
	Monopylephorus n. sp. WA 29	Collapsed Well*	10	Widespread in eastern Pilbara
	Tubificidae	Collapsed Well*	1	indeterminate, immature
	Tubificidae	MMDG04B	2	Further description of group required

** control bores*

Comments were provided by specialist taxonomists

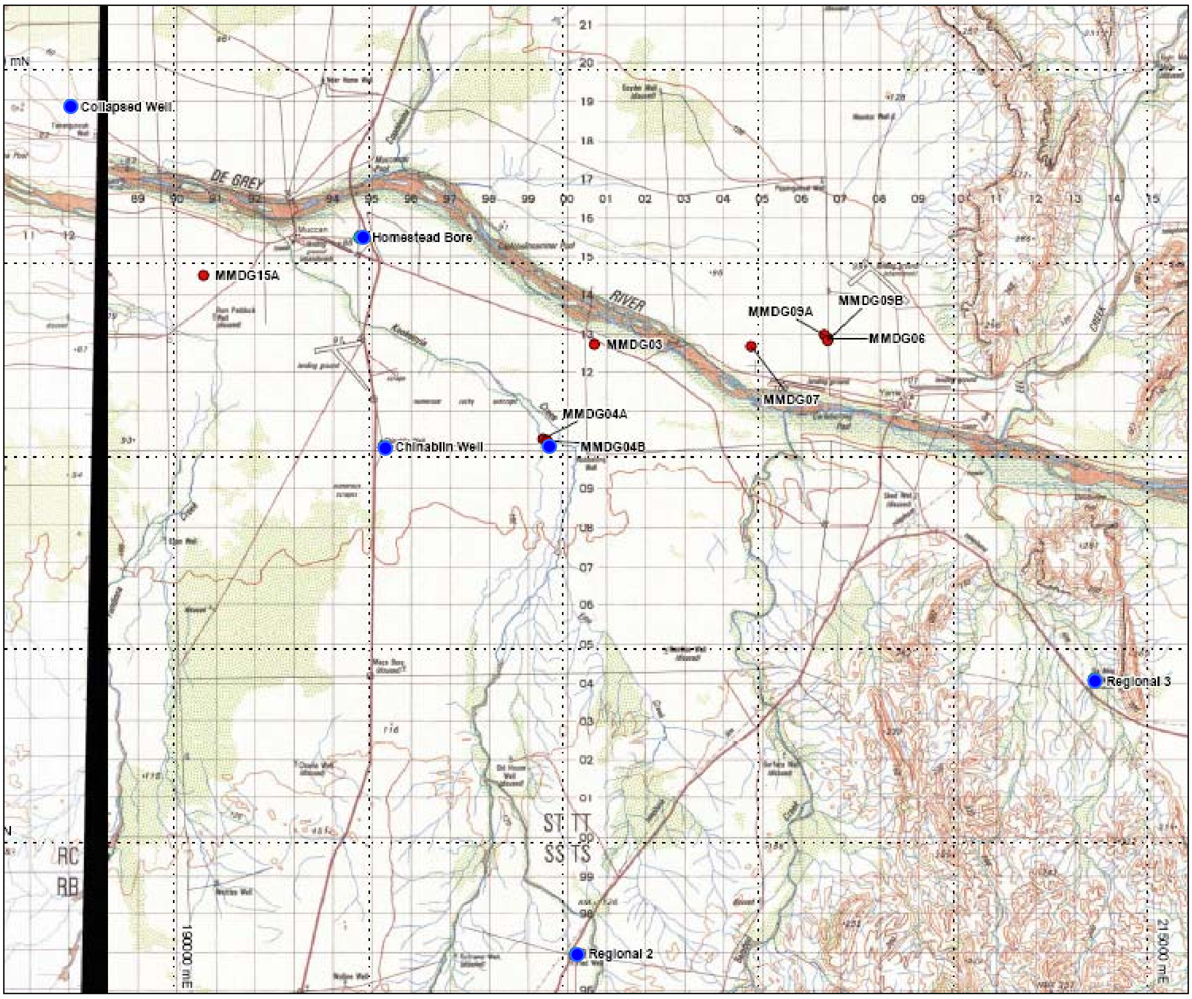

Figure 14 Control and impact bores containing stygofauna at De Grey (dark blue dots). Note that the only impact bore containing stygofauna to date, is MMDG04B.

Specimens of interest from De Grey (specifically, *Mesocyclops* cf. *kieferi* n. sp.? (Karanovic)) will be lodged with the WA Museum once received from specialist taxonomists.

4.2.2 Troglofauna

Spinifex Ridge Project Area

No troglofauna were trapped during the six week survey of 18 cased groundwater bores. A few non-target species (ants and mites) were recorded, with none displaying any troglomorphic characteristics.

A separate short-range endemic survey including the Talga Range (OES, 2006) did not identify any troglofauna taxa.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Stygofauna

Potential habitat was determined for each of three survey areas; Spinifex Ridge Project Area, Woodie Woodie, and De Grey. Within the Project Area, alluvial-type subterranean habitats are not significantly represented within the area of impact by pit dewatering. Limited data on stygofauna/habitat associations suggests that in the Project Area, stygofauna were more commonly encountered in bores where calcrete mineralisation was evident. There is insufficient data to determine the influence of porosity and connectivity on the presence or absence of stygofauna. Data was too limited at Woodie Woodie and De Grey to draw strong conclusions about stygofauna/habitat associations, although at De Grey, the data indicates that stygofauna may be limited to the shallow, unconfined aquifer, as no stygofauna were collected from the deeper aquifer samples.

Stygofauna yields were highest at the Spinifex Ridge Project Area, with 64% of impact bores containing fauna in at least one survey, compared to 44% of impact bores at Woodie Woodie and 13% of impact bores at De Grey. These results may reflect the greater sampling effort in the Project Area, although higher salinity and lower dissolved oxygen at De Grey may have contributed.

During the survey 24 stygofauna species were recorded from Spinifex Ridge, 13 species from Woodie Woodie, and 13 species from De Grey. During these surveys, species identification and definitive comment regarding species distribution and endemism has been limited due to:

- The condition of specimens sampled (some samples contained damaged or incomplete specimens, which limited identification);
- The presence of juveniles which cannot be used to conclusively identify to species level;
- The lack of detailed, formally-described taxonomy for some groups; and
- The dynamic state of knowledge about stygofauna in the Pilbara.

In addition, the surveys of Spinifex Ridge and the Woodie Woodie and De Grey borefields show that adequate sampling of the areas has not been achieved to date, therefore further sampling of the three areas is required. This sampling is scheduled for mid-2007.

Adequacy of sampling effort is partly related to the number of bores that are suitable for sampling. DEC recommends that 20 impact bores should be sampled, and at Woodie Woodie and De Grey only 16 and 8 bores, respectively, were available in the potential impact areas. In this circumstance, higher sampling frequency is required to obtain adequate sampling effort. Additionally, the nomination of ‘control’ and ‘impact’ bores is based on reasonable certainty in accordance with current hydrogeological knowledge. More hydrogeological investigation and monitoring is scheduled, and therefore, there is a possibility that bore classifications may change.

With regard to the Woodie Woodie borefield, the bores sampled within Consolidated Minerals’ mining leases (all bores except those labelled Braeside) have been subjected to impacts from mining and/or dewatering, and are therefore considered ‘impact’ bores for the purposes of this study. This study also considers the specific, potential impacts of abstracting water from the Cracker Pit as proposed by Moly Mines.

A preliminary assessment of conservation significance was undertaken on the basis of data from these partially-completed surveys, and in consideration of current knowledge. The outcomes of this assessment are that:

- One bore located near the edge of the > 5 m drawdown contour (related to the proposed 600L/s abstraction) at Woodie Woodie supports an endemic species (*Goniocyclops* sp. 1 n. sp. (Karanovic), and this species has previously been subjected to impacts from mining and dewatering.
- One bore at the proposed Woodie Woodie borefield supports a species not previously recorded from the Australian mainland (*Halophytophilus* sp. 1 n. sp. (Karanovic) and is therefore endemic. The bore housing this species has previously been subjected to impacts from mining and dewatering;
- One bore at the proposed De Grey borefield supports a species which may be new and locally-endemic (*Mesocyclops* cf. *kieferi* n. sp) but requires further work. The bore hosting this species is in poor condition and has been used previously as a pastoral bore;
- One bore within the Spinifex Ridge Project Area hosts *Leicandona quasihalsei*, a species previously only represented in the Pilbara by a recent record of a male specimen. The distribution of this species is not well understood at the time of writing.

On the basis of these preliminary findings;

- the scheduled, additional surveys may augment current (August 2007) knowledge of species distributions;
- at Spinifex Ridge project area, further study is required to confirm the local distribution and abundance of *Leicandona quasihalsei*;
- at Woodie Woodie and De Grey, abstraction should be managed and monitored to minimise impact to the aquifer, and therefore styogfauna.

Given that adequate sampling frequency has not been achieved, and considering the rapid increase in knowledge of stygofauna and their known distributions in the Pilbara over the past few years, the conservation significance of at least two of the species (i.e. those not deemed to be locally unique - *Leicandona quasihalsei* and possibly *Mesocyclops* cf. *kieferi* n. sp) may be revised.

5.2 Troglofauna

No further work is recommended for troglofauna, given that no troglofauna were found at the Spinifex Ridge Project Area, and the lack of suitable habitat at Woodie Woodie and the De Grey borefield.

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Appendix A

Details of Bores Sampled

Table A1 Spinifex Ridge stygofauna bore summary

Site Name	Bore Code	Impact Area/ Control	Sample Date				Easting	Northing	Casing Type	Internal Bore Diamter (mm)	Typical Standing Water Level (m)*	Depth to End of Hole (m)*
			Jul-05	Mar-06	Aug-06	Feb-07						
Spinifex Ridge	Box Soak	Control			X		809500	7682897	Cement	1200	~15	n/a
Spinifex Ridge	Kitty's Well	Control			X		196938	7684896	Cement	1200	~15	n/a
Spinifex Ridge	SRC033	Control		X	X		195606	7687321	P.V.C.	150	8.60	50.00
Spinifex Ridge	SRC037	Impact Area		X	X		199448	7687301	P.V.C.	150	33.65	50.00
Spinifex Ridge	SRC044	Impact Area		X	X		199431	7687084	P.V.C.	150	11.60	50.00
Spinifex Ridge	SRC046	Impact Area		X	X		199440	7686962	P.V.C.	150	13.98	50.00
Spinifex Ridge	SRC052	Impact Area		X	X		198606	7687404	P.V.C.	150	4.97	50.00
Spinifex Ridge	SRC053	Impact Area		X	X		198799	7687409	P.V.C.	150	7.35	50.00
Spinifex Ridge	SRC054	Impact Area		X	X		198966	7687093	P.V.C.	150	3.15	50.00
Spinifex Ridge	SRC055	Impact Area		X	X		199075	7687076	P.V.C.	150	5.76	50.00
Spinifex Ridge	SRC056	Impact Area		X	X		199192	7687074	P.V.C.	150	8.31	50.00
Spinifex Ridge	SRC057	Impact Area		X	X	X	199311	7687082	P.V.C.	150	4.92	50.00
Spinifex Ridge	SRC058	Impact Area		X			198835	7686956	P.V.C.	150	22.78	50.00
Spinifex Ridge	SRC059	Impact Area		X	X		198961	7686961	P.V.C.	150	14.53	50.00
Spinifex Ridge	SRC061	Impact Area		X			199190	7686961	P.V.C.	150	8.75	50.00
Spinifex Ridge	SRC073	Impact Area		X	X		198840	7686599	P.V.C.	150	8.99	50.00
Spinifex Ridge	SRD055	Impact Area		X			198732	7687192	P.V.C.	150	10.37	403.60
Spinifex Ridge	SRD059	Impact Area	X	X			198416	7687303	P.V.C.	150	18.25	450.60
Spinifex Ridge	SRD065	Impact Area		X		X	198913	7687572	P.V.C.	150	1.54	495.00
Spinifex Ridge	SRD071	Impact Area		X		X	198544	7687611	P.V.C.	150	20.68	450.36
Spinifex Ridge	SRD072	Impact Area	X	X	X		198545	7687681	P.V.C.	150	19.36	60.00
Spinifex Ridge	SRD073	Impact Area		X	X	X	198543	7687516	P.V.C.	150	10.22	60.00
Spinifex Ridge	SRD079	Impact Area		X			199046	7687473	P.V.C.	150	2.78	474.40
Spinifex Ridge	WB001	Impact Area	X				198720	7687422	P.V.C.	150	30.00	72.00
Spinifex Ridge	WB002	Impact Area	X	X	X		198686	7687176	P.V.C.	150	2.97	54.00

* Standing water level varies over time, so an approximate average value is provided

Depth to End of Hole is >100m for some holes. These holes were initially drilled to ~80m and were sampled when at that depth, but later drilled deeper and could not be sampled.

Table A2 Spinifex Ridge troglofauna bore summary

Bore Code	Impact Area/ Control	Sample Date Aug-06	Easting	Northing	Casing Type	Internal Bore Diamter (mm)	Typical Standing Water Level (m)*	Depth to End of Hole (m)*
SRC033	Control	X	195606	7687321	P.V.C.	150	8.60	50.00
SRC037	Impact Area	X	199448	7687301	P.V.C.	150	33.65	50.00
SRC044	Impact Area	X	199431	7687084	P.V.C.	150	11.60	50.00
SRC046	Impact Area	X	199440	7686962	P.V.C.	150	13.98	50.00
SRC053	Impact Area	X	198799	7687409	P.V.C.	150	7.35	50.00
SRC056	Impact Area	X	199192	7687074	P.V.C.	150	8.31	50.00
SRC058	Impact Area	X	198835	7686956	P.V.C.	150	22.78	50.00
SRC059	Impact Area	X	198961	7686961	P.V.C.	150	14.53	50.00
SRC062	Impact Area	X	199320	7686960	P.V.C.	150	n/a	50.00
SRC073	Impact Area	X	198840	7686599	P.V.C.	150	8.99	50.00
SRC106	Impact Area	X	198650	7687400	P.V.C.	150	n/a	50.00
SRC113	Impact Area	X	198789	7687359	P.V.C.	150	n/a	50.00
SRC114	Impact Area	X	199175	7687200	P.V.C.	150	9.92	50.00
SRC115	Impact Area	X	199250	7687200	P.V.C.	150	n/a	50.00
SRD055	Impact Area	X	198732	7687192	P.V.C.	150	10.37	403.60
SRD059	Impact Area	X	198416	7687303	P.V.C.	150	18.25	450.60
SRD071	Impact Area	X	198544	7687611	P.V.C.	150	20.68	450.36
SRD072	Impact Area	X	198545	7687681	P.V.C.	150	19.36	60.00

* Standing water level varies over time, so an approximate average value is provided

Bore codes listed in plain text were also sampled for stygofauna. Bore codes listed in bold italic font were only sampled for troglofauna.

Depth to End of Hole is >100m for some holes. These holes were initially drilled to ~80m and were sampled when at that depth, but were later drilled deeper and could not be sampled.

Table A3 Woodie Woodie bore summary

Bore Code	Impact Area/Control	Sample Date		Easting	Northing	Casing Type	Internal Bore Diamter (mm)	Typical Standing Water Level (m)*	Depth to End of Hole (m)*
		Sep-06	Feb-07						
Braeside 1	Control	X		307654	7643821	Steel	150	n/a	n/a
Braeside 4	Control	X		307626	7643892	Steel	150	33	n/a
Braeside 5	Control	X		307609	7643899	Steel	250	70	n/a
CD East	Impact Area		dry	318238	7610240	P.V.C.	50	n/a	~50
CD North	Impact Area		X	318238	7610240	P.V.C.	50	~50	78
CD South	Impact Area		dry	318665	7609145	P.V.C.	50	n/a	82
Cracker Pit	Impact Area		X	315749	7609011	Steel	300	4.32	44.6
DEPH01 (AARC223)	Impact Area	X	X	314411	7608702	P.V.C.	50	9.66	70
DEPH02	Impact Area		X	314846	7608656	P.V.C.	50	22	76
DEPH03	Impact Area		X	n/a	n/a	P.V.C.	50	23.75	50
EARC32	Impact Area	X		315852	7608934	P.V.C.	150	n/a	n/a
EARC37	Impact Area	X		315840	7608857	P.V.C.	150	n/a	n/a
EARC42	Impact Area	X		315816	7608982	P.V.C.	150	n/a	n/a
EARC57	Impact Area	X		315964	7608853	P.V.C.	150	n/a	n/a
KTRC20	Impact Area	X		315910	7609391	P.V.C.	150	n/a	n/a
MRC194	Impact Area	X		316396	7608836	P.V.C.	150	n/a	n/a
LPH01	Impact Area		X	317395	7608800	P.V.C.	50	28.9	50
LPH02	Impact Area		X	316602	7608733	P.V.C.	50	n/a	50
MACPB2	Impact Area		X	316335	7610050	P.V.C.	300	n/a	72
RMB02	Impact Area		X	317439	7607235	P.V.C.	150	24.41	42
RMB03	Impact Area		X	317795	7607524	P.V.C.	50	23.75	40

* Standing water level varies over time, so an approximate average value is provided

Table A4 De Grey bore summary

Bore Code	Impact Area/Control	Sample Date		Easting	Northing	Casing Type	Internal Bore Diamter (mm)	Typical Standing Water Level (m)*	Depth to End of Hole (m)*
		Oct-06	Feb-07						
Chinablin Well	Control		X	195404	7710256	Concrete	1500 - 2000	4.20	8.10
Collapsed Well	Control		X	187350	7719078	Concrete	1000	6.60	9.50
Homestead Bore	Control		X	194780	7715674	P.V.C.	150	2.50	10.50
Regional 2	Control	X		200321	7697116	Concrete	1500 - 2000	11.50	~15.0
Regional 3	Control	X		213619	7704226	Concrete	1500 - 2000	16.50	~20.0
MMDG03A	Impact Area	X	X	200803	7712901	P.V.C.	50	6.25	59.40
MMDG04A	Impact Area	X	X	199464	7710437	P.V.C.	50	5.40	57.80
MMDG04B	Impact Area		X	199464	7710437	P.V.C.	50	4.20	12.00
MMDG06A	Impact Area	X	X	206788	7713067	P.V.C.	50	7.70	61.30
MMDG07A	Impact Area	X	X	204814	7712854	P.V.C.	50	8.34	59.00
MMDG09A	Impact Area	X	X	206783	7713067	P.V.C.	50	7.50	66.00
MMDG09B	Impact Area		X	206783	7713067	P.V.C.	50	7.10	12.00
MMDG15A	Impact Area	X	X	190741	7714763	P.V.C.	50	7.60	42.00

* Standing water level varies over time, so an approximate average value is provided

Appendix B

Bore Water Chemistry Data

Table B1 Spinifex Ridge Project Area Bore Water Chemistry Data

Bore Code	Impact Area/ Control	Sample Date	pH [+]	EC (uS/cm)	Temperature (°C)	Turbidity (NTU)	DO (ppm)	DO (%)	Redox (mV)
Box Soak	Control	Aug-2006	7.39	2398	28.2	n/a	0.01	0.1	n/a
Kitty's Well	Control	Aug-2006	7.77	1804	26.4	n/a	5.21	65.1	n/a
SRC033	Control	Mar-2006	7.16	4580	31.7	n/a	5.84	n/a	n/a
SRC037	Impact Area	Mar-2006	7.16	774	32	n/a	6.24	n/a	n/a
SRC044	Impact Area	Mar-2006	7.23	1041	32.8	n/a	5.37	n/a	n/a
SRC044	Impact Area	Aug-2006	7.31	998	31.5	n/a	0.02	0.2	n/a
SRC046	Impact Area	Mar-2006	7.05	792	31.9	n/a	6.71	n/a	n/a
SRC052	Impact Area	Mar-2006	7.51	789	31.4	n/a	9.24	n/a	n/a
SRC052	Impact Area	Aug-2006	7.3	1329	29.6	n/a	0.01	0.1	n/a
SRC053	Impact Area	Mar-2006	7.26	369	31.6	n/a	7.2	n/a	n/a
SRC053	Impact Area	Aug-2006	7.18	1114	30	n/a	0.01	0.1	n/a
SRC054	Impact Area	Mar-2006	7.27	1618	32.1	n/a	6.14	n/a	n/a
SRC054	Impact Area	Aug-2006	7.22	1514	29.9	n/a	0.01	0.1	n/a
SRC055	Impact Area	Mar-2006	7.15	1540	31.9	n/a	8.44	n/a	n/a
SRC056	Impact Area	Mar-2006	7.33	1920	31.1	n/a	5.33	n/a	n/a
SRC056	Impact Area	Aug-2006	7.49	2006	30.2	n/a	0.02	0.2	n/a
SRC057	Impact Area	Mar-2006	7.35	715	31.8	n/a	9.26	n/a	n/a
SRC057	Impact Area	Aug-2006	7.36	1225	30.5	n/a	0.02	0.2	n/a
SRC057	Impact Area	Feb-2007	6.65	1588	n/a	520	-1.4	-10	471
SRC058	Impact Area	Mar-2006	7.02	983	31.9	n/a	4.17	n/a	n/a
SRC059	Impact Area	Mar-2006	7.13	1550	29.5	n/a	3.82	n/a	n/a
SRC061	Impact Area	Mar-2006	7.29	858	32.7	n/a	5.14	n/a	n/a
SRC073	Impact Area	Mar-2006	7.1	770	32.4	n/a	4.45	n/a	n/a
SRD055	Impact Area	Mar-2007	8.14	2750	29.7	n/a	8.42	n/a	n/a
SRD059	Impact Area	Jul-2005	7.55	1464	25	n/a	4.3	n/a	n/a
SRD059	Impact Area	Mar-2006	7.13	1850	29.8	n/a	3.82	n/a	n/a
SRD065	Impact Area	Mar-2006	7.22	1379	32	n/a	5.11	n/a	n/a
SRD065	Impact Area	Feb-2007	6.98	1794	n/a	17.2	-10	-1.4	16
SRD071	Impact Area	Feb-2007	6.68	1862	n/a	47.2	-1.4	-10	94
SRD072	Impact Area	Jul-2005	7.17	1065	25	n/a	5.41	n/a	n/a
SRD072	Impact Area	Aug-2006	6.92	1320	30.6	n/a	0.03	0.3	n/a
SRD073	Impact Area	Aug-2006	7.12	1343	30.6	n/a	0.03	0.4	n/a
SRD073	Impact Area	Feb-2007	6.94	1771	n/a	27.3	-1.4	-10	497
SRD079	Impact Area	Mar-2006	8.22	787	33	n/a	9.9	n/a	n/a
SRD079	Impact Area	Feb-2007	7.03	2067	n/a	50	-1.4	-10	77
WB001	Impact Area	Jul-2005	7.39	1376	25	n/a	5.58	n/a	n/a
WB002	Impact Area	Jul-2005	7.67	2375	25	n/a	3.69	n/a	n/a
WB002	Impact Area	Aug-2006	7.65	2380	31.8	n/a	0.02	0.2	n/a
WB002	Impact Area	Mar-2007	7.75	2330	32.3	n/a	n/a	98.8	n/a

Table B2 Woodie Woodie Bore Water Chemistry Data

Bore Code	Impact Area/ Control	Sample Date	pH	Salinity (g/L)	EC (uS/cm)	Temp (°C)	Turbidity (NTU)	DO (ppm)	DO (%)	Redox (mV)
Braeside 1	Control	Sep-2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Braeside 4	Control	Sep-2006	7.18	0.59	906.00	31.00	n/a	0.03	0.40	n/a
Braeside 5	Control	Sep-2006	7.12	0.68	1034.00	30.00	n/a	0.03	0.40	n/a
RMB02	Impact Area	Feb-2007	6.90	1.16	2008.00	n/a	17.50	-1.40	-10.00	505.00
RMB03	Impact Area	Feb-2007	6.85	86.00	1535.00	n/a	600.00	-1.40	-10.00	477.00
DEPH01 (AARC223)	Impact Area	Sep-2006	7.13	2.55	2545.00	31.00	n/a	0.06	0.80	n/a
EARC37	Impact Area	Sep-2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
KTRC20	Impact Area	Sep-2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
EARC32	Impact Area	Sep-2006	7.50	0.66	1006.00	30.00	n/a	0.01	0.20	n/a
EARC42	Impact Area	Sep-2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MRC194	Impact Area	Sep-2006	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CD East	Impact Area	Feb-2007	dry	dry	dry	dry	dry	dry	dry	dry
CD North	Impact Area	Feb-2007	7.24	0.75	1314.00	n/a	57.30	9.60	65.50	474.00
CD South	Impact Area	Feb-2007	dry	dry	dry	dry	dry	dry	dry	dry
Cracker Pit	Impact Area	Feb-2007	7.08	0.94	1644.00	n/a	170.40	-1.40	-10.00	418.00
DEPH01 (AARC223)	Impact Area	Feb-2007	6.98	2.03	3466.00	n/a	35.40	-1.40	-10.00	487.00
DEPH02	Impact Area	Feb-2007	7.18	0.94	1676.00	n/a	276.00	20.00	300.00	425.00
DEPH03	Impact Area	Feb-2007	7.21	1.00	17.80	n/a	17.00	-0.90	-10.00	493.00
LPH01	Impact Area	Feb-2007	7.05	1.05	1862.00	n/a	403.40	-1.40	-10.00	392.00
LPH02	Impact Area	Feb-2007	7.36	0.91	1626.00	n/a	44.70	10.90	75.10	502.00
MACPB2	Impact Area	Feb-2007	7.11	0.86	1508.00	n/a	21.10	-1.40	-10.00	245.00

Table B3 De Grey Bore Water Chemistry Data

Bore Code	Impact Area/ Control	Sample Date	pH [+]	EC (uS/cm)	Temperature (°C)	Turbidity (NTU)	DO (mg/L)	DO (%)	Redox (mV)
Chinablin Well	Control	Feb-2007	7.85	5910	n/a	1.3	0.9	7.2	488
Collapsed Well	Control	Feb-2007	8.48	6206	n/a	12.5	-1.4	-10	460
Homestead B Bore	Control	Feb-2007	6.96	3975	n/a	8.3	-1.4	-10	n/a
Regional 2	Control	Oct-2006	7.83	2750	32.6	n/a	0.05	0.7	n/a
Regional 3	Control	Oct-2006	7.14	733	30.6	n/a	5.54	75.2	n/a
MMDG03	Impact Area	Oct-2006	7.45	1715	32.9	n/a	0	0	n/a
MMDG03	Impact Area	Feb-2007	7.11	2244	n/a	20.1	-1.4	-10	380
MMDG04A	Impact Area	Oct-2006	7.86	3018	30.3	n/a	0.03	0.4	n/a
MMDG04A	Impact Area	Feb-2007	7.86	3880	n/a	20.9	-1.4	-10	344
MMDG04B	Impact Area	Feb-2007	8.61	8000	n/a	5.7	-1.4	-10	357
MMDG06	Impact Area	Oct-2006	8.03	4480	32.5	n/a	0.03	0.4	n/a
MMDG06	Impact Area	Feb-2007	8.99	5865	n/a	25.7	-1.4	-10	465
MMDG07	Impact Area	Oct-2006	7.41	1873	33	n/a	0.04	0.5	n/a
MMDG07	Impact Area	Feb-2007	7.37	2457	n/a	11.9	-1.4	-10	457
MMDG09A	Impact Area	Oct-2006	7.5	2024	30.2	n/a	0	0	n/a
MMDG09A	Impact Area	Feb-2007	7.05	2494	n/a	10.3	1.9	13.1	517
MMDG09B	Impact Area	Feb-2007	7.32	2503	n/a	600	12.1	83	479
MMDG15A	Impact Area	Oct-2006	7.56	5280	31.5	n/a	0.03	0.4	n/a
MMDG15A	Impact Area	Feb-2007	7.85	6937	n/a	36	-1.4	-10	220

Appendix C

Species Accumulation Curves

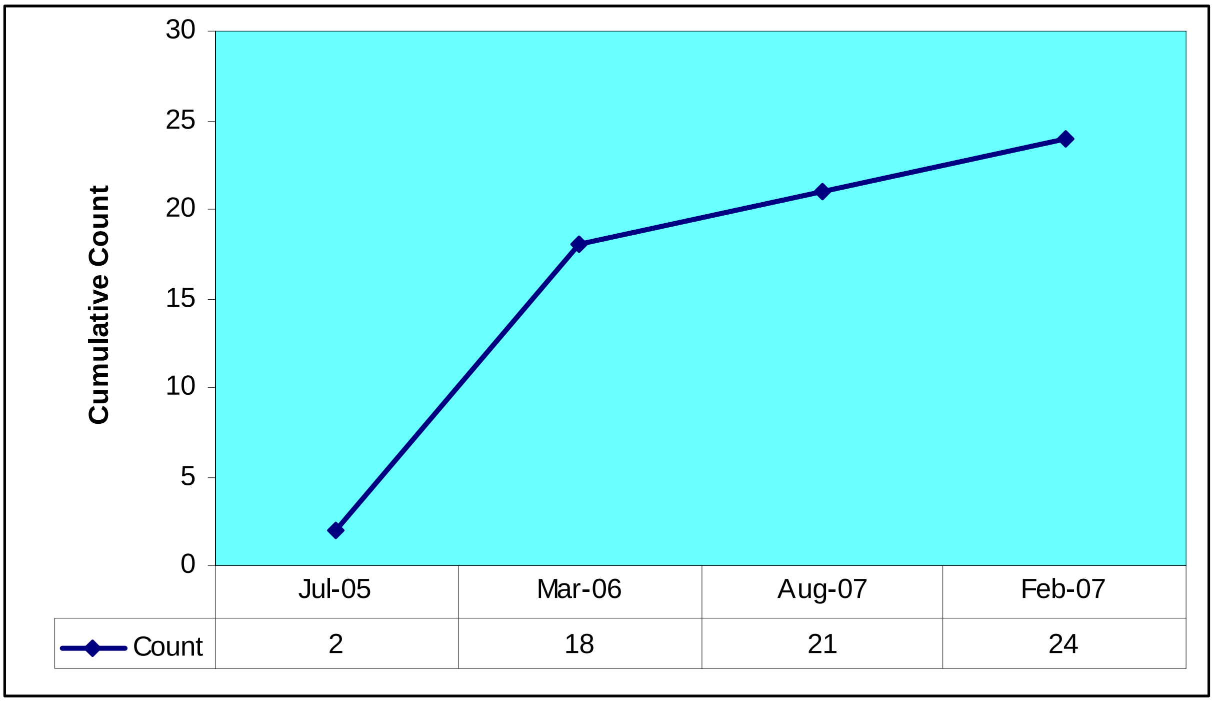

Figure C1 **Species accumulation curve for impact bores in the Spinifex Ridge Project Area, July 2005 – February 2007**

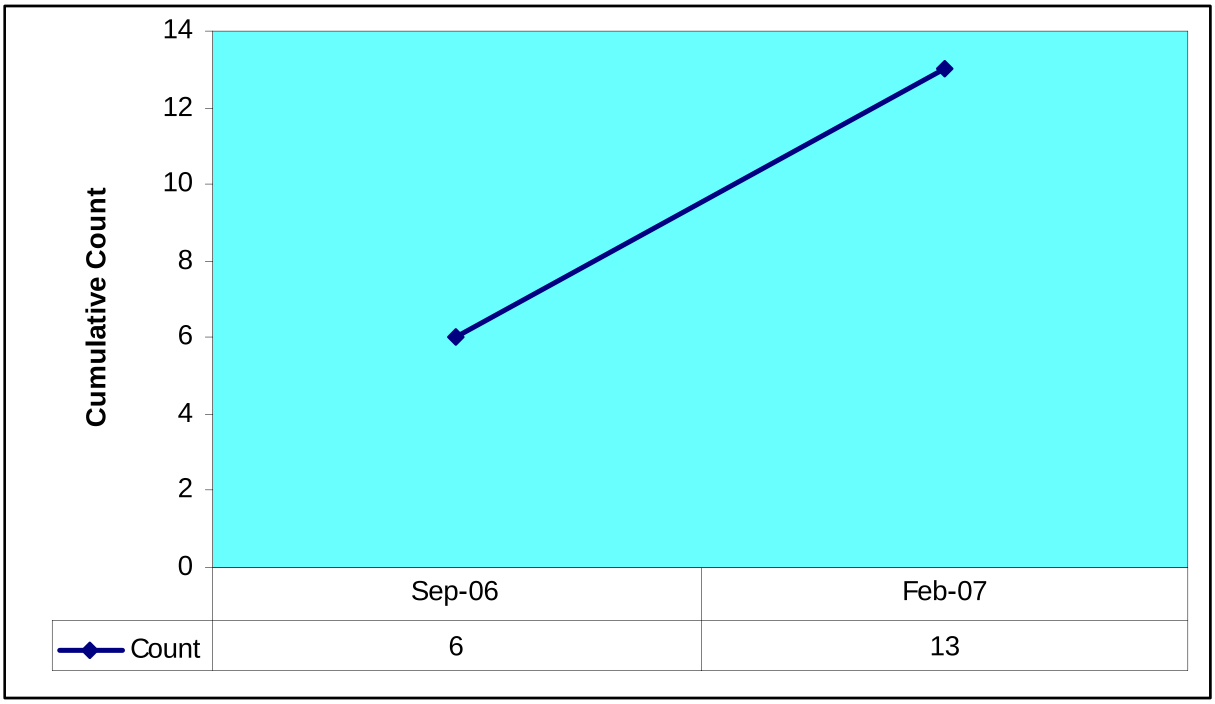

Figure C2 **Species accumulation curve for impact bores in the Woodie Woodie borefield, September 2006 – February 2007. The curve indicates that a plateau has not been reached and therefore further sampling is required.**

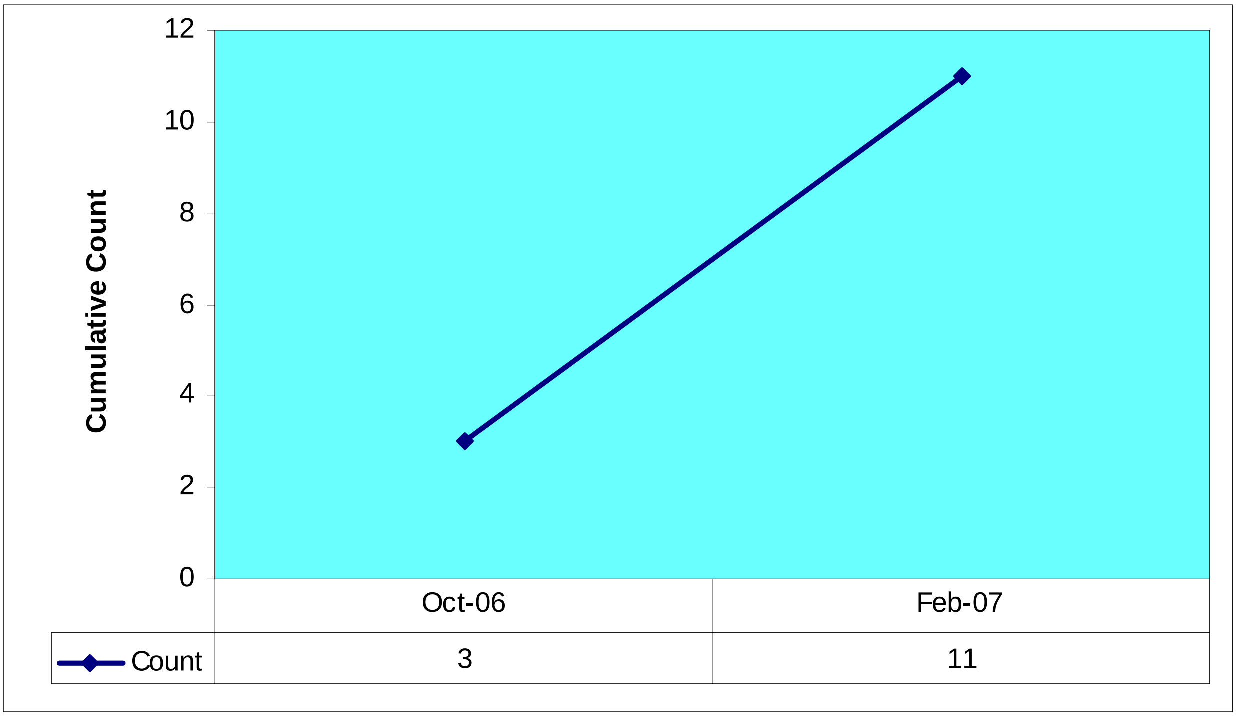

Figure C3 Species accumulation curve for impact bores in the De Grey borefield, October 2006 – February 2007. The curve indicates that a plateau has not been reached and therefore further sampling is required.

Appendix D

Stygofauna Results

Table D1 Spinifex Ridge Project Area Stygofauna Results

Bore Code	Sample Date	Class	Order	Family	Lowest ID	Count	Identifier
SRC044	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	SME
SRC052	Mar-2006	Crustacea	Harpacticoida	Canthocamptidae	Canthocamptidae sp.	1	HJB
SRC052	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Meridiescyclops* sp.	1	HJB
SRC052	Aug-2006	Crustacea	Isopoda	Microcerberidae	*Coxicerberus* sp.	1	SME
SRC053	Mar-2006	Crustacea	Syncarida	Parabathynellidae	*Atopobathynella* sp.	1	SME
SRC053	Mar-2006	Crustacea	Syncarida	Bathynellidae	Bathynellidae sp.	2	SME
SRC053	Mar-2006	Crustacea	Harpacticoida	Canthocamptidae	Canthocamptidae sp.	1	HJB
SRC053	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops cf. humphreysi humphreysi* Karanovic	6	HJB
SRC053	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Fierscyclops (Pilbaracyclops)* cf *frustratio* Karanovic	4	HJB
SRC053	Mar-2006	Crustacea	Syncarida	Parabathynellidae	*Notobathynella* sp.	1	SME
SRC053	Mar-2006	Crustacea	Amphipoda	Paramelitidae	Paramelitidae *cf. sp. 2 CALM **	4	SME
SRC053	Aug-2006	Crustacea	Ostracoda	Candonidae	Candonidae sp.	2	SME
SRC053	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	HJB
SRC053	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	HJB
SRC053	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Fierscyclops (Pilbaracyclops)* cf *frustratio* Karanovic	3	HJB
SRC053	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Fierscyclops (Pilbaracyclops)* cf *frustratio* Karanovic	4	HJB
SRC053	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Fierscyclops (Pilbaracyclops)* cf *frustratio* Karanovic	1	HJB
SRC053	Aug-2006	Crustacea	Ostracoda	Candonidae	*Leicacandona mookae*	1	IK
SRC054	Mar-2006	Crustacea	Harpacticoida	Canthocamptidae	Canthocamptidae sp.	1	HJB
SRC054	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	7	HJB
SRC054	Mar-2006	Crustacea	Isopoda	Microcerberidae	Microcerberidae sp.	1	SME
SRC054	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni* Karanovic	5	HJB
SRC054	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Fierscyclops (Pilbaracyclops)* cf *frustratio* Karanovic	1	HJB

ET = Erin Thomas, HJB = Harley Barron, SME = Stefan Eberhard, MDS = Mike Scanlon, TK = Tom Karanovic, IK = Ivana Karanovic

Table D1 Continued   Spinifex Ridge Project Area Stygofauna Results

Bore Code	Sample Date	Class	Order	Family	Lowest ID	Count	Identifier
SRC055	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops sobeprolatus*	6	HJB
SRC055	Mar-2006	Crustacea	Ostracoda	Candonidae	*Kencandona harleyi*	3	IK
SRC055	Mar-2006	Crustacea	Amphipoda	Melitidae	*Melitidae sp. 1 CALM **	1	SME
SRC055	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Meridiescyclops* sp.	2	HJB
SRC055	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	HJB
SRC055	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	1	HJB
SRC057	Mar-2006	Crustacea	Harpacticoida	Canthocamptidae	Canthocamptidae sp.	8	HJB
SRC057	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	3	SME
SRC057	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops* cf. *humphreysi humphreysi* Karanovic	1	SME
SRC057	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	53	TK
SRC057	Feb-2007	Crustacea	Ostracoda	Candonidae	*Leicacandona quasihalsei*	4	MDS
SRC057	Feb-2007	Crustacea	Harpacticoida	Ameiridae	*Stygonitocrella trispinosa*	105	MDS
SRC061	Mar-2006	Crustacea	Syncarida	Bathynellidae	Bathynellidae sp.	1	SME
SRC061	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	11	HJB
SRD059	Mar-2006	Crustacea	Harpacticoida	Canthocamptidae	*Elaphoidella humphreysi*	1	HJB
SRD065	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	HJB
SRD072	Jul-2005	Crustacea	Syncarida	Parabathynellidae	*Chilibathynella australiensis*	2	SME
SRD072	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	HJB
SRD072	Aug-2006	Crustacea	Syncarida	Parabathynellidae	*Notobathynella* sp.	8	SME
SRD073	Aug-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops* cf. *humphreysi humphreysi* Karanovic	1	HJB
SRD073	Aug-2006	Crustacea	Syncarida	Parabathynellidae	*Notobathynella* sp.	1	SME
SRD073	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	12	MDS
SRD073	Feb-2007	Crustacea	Harpacticoida	Parastenocarididae	*Parastenocaris* sp.	1	TK
SRD079	Mar-2006	Crustacea	Cyclopoida	Cyclopidae	*Microcyclops varicans*	2	HJB
WB001	Jul-2005	Crustacea	Cyclopoida		Cyclopoida	4	ET
WB001	Jul-2005	Crustacea	Amphipoda	Paramelitidae	*Pilbarus millsi*	1	SME

ET = Erin Thomas, HJB = Harley Barron, SME = Stefan Eberhard, MDS = Mike Scanlon, TK = Tom Karanovic, IK = Ivana Karanovic

Table D2 Woodie Woodie Stygofauna Results

Bore Code	Sample Date	Class	Order	Family	Lowest ID	Count	Identifier
Braeside 4	Sep-2006	Crustacea	Amphipoda	Paramelitidae	Paramelitidae n. sp. cf. CALM sp. 6 (PSS)	29	SE
Braeside 5	Sep-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	MDS
Cracker Pit	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	150	MDS
Cracker Pit	Feb-2007	Oligochaeta	Tubificida	Phreodrilidae	Phreodrilidae with dissimilar ventral chaetae	3	MDS
Cracker Pit	Feb-2007	Crustacea	Amphipoda	Paramelitidae	Pilbarus millsi	5	MDS
DEPH01	Sep-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	1	MDS
DEPH01	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	7	MDS
DEPH01	Feb-2007	Crustacea	Harpacticoida	Ectinosomatidae	*Halophytophilus* sp 1 n sp	11	MDS
DEPH01	Feb-2007	Crustacea	Amphipoda	Paramelitidae	*Pilbarus millsi*	2	MDS
DEPH02	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Goniocyclops* sp 1 n sp	51	TK
EARC32	Sep-2006	Crustacea	Cyclopoida	Cyclopidae	*Microcyclops varicans*	1	SE
EARC32	Sep-2006	Crustacea	Amphipoda	Paramelitidae	Paramelitidae sp. 6	1	SE
KTRC20	Sep-2006	Crustacea	Amphipoda	Bogidiellidae	Bogidiellidae sp. 1	1	SE
KTRC20	Sep-2006	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	1	TK
RMB02	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	30	MDS
RMB02	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Mesocyclops* sp.	11	MDS
RMB03	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops scanloni*	6	MDS
RMB03	Feb-2007	Oligochaeta	Tubificida	Enchytraeidae	Enchytraeidae	1	MDS
RMB03	Feb-2007	Oligochaeta	Tubificida	Phreodrilidae	Phreodrilidae with similar ventral chaetae	1	MDS

ET = Erin Thomas, HJB = Harley Barron, SME = Stefan Eberhard, MDS = Mike Scanlon, TK = Tom Karanovic, IK = Ivana Karanovic

Table D3 De Grey Stygofauna Results

Bore Code	Sample Date	Class	Order	Family	Lowest ID	Count	Identifier
Chinablin Well	Feb-2007	Crustacea	Ostracoda	Cyprididae	*Cypretta seurati*	30	TK
Chinablin Well	Feb-2007	Oligochaeta	Tubificida	Naididae	*Dero furcata*	1	MDS
Chinablin Well	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Mesocyclops* cf. *kieferi* n sp ?	110	TK
Chinablin Well	Feb-2007	Oligochaeta	Tubificida	Naididae	*Pristina longiseta*	2	MDS
Collapsed Well	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Diacyclops humphreysi humphreysi* Karanovic	2	TK
Collapsed Well	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Mesocyclops* sp.	1	TK
Collapsed Well	Feb-2007	Crustacea	Cyclopoida	Cyclopidae	*Microcyclops varicans*	60	TK
Collapsed Well	Feb-2007	Oligochaeta	Tubificida	Tubificidae	Monopylephorus n. sp. WA 29	11	MDS
Regional 2	Oct-2006	Crustacea	Ostracoda	Cyprididae	*Cypretta seurati*	2	IK
Regional 3	Oct-2006	Crustacea	Ostracoda	Candonidae	*Humphreyscandona 'capillus'*	2	IK
Regional 3	Oct-2006	Crustacea	Ostracoda	Cyprididae	*Strandesia* sp.	7	IK
MMDG04B	Feb-2007	Oligochaeta	Tubificida	Tubificidae	Tubificidae	2	MDS

ET = Erin Thomas, HJB = Harley Barron, SME = Stefan Eberhard, MDS = Mike Scanlon, TK = Tom Karanovic, IK = Ivana Karanovic