KOOLANOOKA/BLUE HILLS DSO MINING PROJECT

SHORT RANGE ENDEMIC BIOLOGICAL ASSESSMENT

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Executive Summary

Midwest Corporation Limited (Midwest) is proposing to reopen and expand the previously mined ore bodies at Koolanooka and Blue Hills in Western Australia. The project will include mining operations, processing and associated infrastructure. Approximately 2 Mtpa of direct shipping grade iron ore will be mined from three separate pits at Koolanooka and Blue Hills.

The DSO Mining Project will impact on a total of 3.8ha of vegetation immediately abutting the existing Koolanooka pit, which is part of the Koolanooka System Threatened Ecological Community. Granite outcrops and she-oak woodlands have been recorded within this area, which may harbour potential Short Range Endemic (SRE) species.

In order to limit disturbances to short range endemic species of conservation value potentially inhabiting the project area, ecologia Environment was commissioned to undertake a survey that satisfied the requirements documented in EPA's Guidance Statement 56 and Position Statement No. 3. The desktop review revealed two SRE invertebrate species previously recorded near or within the project area. These comprised the Shield-backed trapdoor spider *Idiosoma nigrum* Main 1952 and the tree-stem trapdoor spider *Aganippe castellum* Main 1986. Both of these species are listed as threatened under commonwealth and state legislation.

Initially the proposed impact areas at Mungada East and Mungada West at Blue Hills were estimated to be 20.9ha and 13.6ha respectively. These areas were then expanded to 27.3ha and 25.2ha. Phase 1 of sampling occurred in the initial impact areas at Koolanooka and Blue Hills between the 17th January and the 27th February 2007. Phase 2 of sampling was conducted in the extended impact areas between the 26th June - 25th July 2007 (i.e. Mungada East and Mungada West). A combination of pitfall trapping and invertebrate foraging techniques were employed during this time.

One hundred and seventeen potential SRE specimens were recorded during the survey. These individuals represented six classes, 12 families, 17 genera and 21 species of invertebrates. Each specimen was identified to the lowest possible taxonomic level (i.e. species level being the lowest). The majority of species were identified to family and genus level. A lack of biological information for most of the individual species made it difficult to determine wether they were endemic to the Koolanooka / Blue Hills project area, however based on studies of related species it is likely that some of these species have restricted distributions and may be classified as short range endemics.

1.0 PROJECT BACKGROUND

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

The Koolanooka/Blue Hills DSO Mining Project involves the recommencement of open pit mining in the existing open pit at the Koolanooka mine. A shallow pit will be extended at the south east end of the pit and mining of the pisolitic scree ore will occur in the south west. Most work will be conducted in areas that have previously been disturbed by mining activities. Crushing and screening facilities for processing and blending the various ore types and grades of DSO will be conducted at the Koolanooka site which has also been previously disturbed.

At Blue Hills, depth extensions will occur into the existing East and West Mungada pits. These extensions will require small cutbacks to the existing pits. Run-of-mine ore from Blue Hills will be crushed and screened on site then transported on the pre-existing Mt Karara / Mungada haul road by a road-train to Koolanooka. Blending of ore from Koolanooka and Blue Hills will be required to achieve an average DSO quality threshold of 58% Fe. Lump and fine products will be produced from the Mungada ore.

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

The Koolanooka/Blue Hills DSO Mining Project was referred to the EPA under Section 38 of the Environmental Protection Act 1986 in September 2006. The EPA will formally assess the project on the basis of the potential environmental impacts of the project and has set the level of assessment as a Public Environmental Review (PER) (Assessment No 1653).

The Koolanooka DSO Mining Project was also referred to the Department of Environment and Heritage (DEH) and it was determined that the project was not considered to be a Controlled Action under the Environmental Protection and Biodiversity Conservation Act 1999 (Referral No 2004/1886).

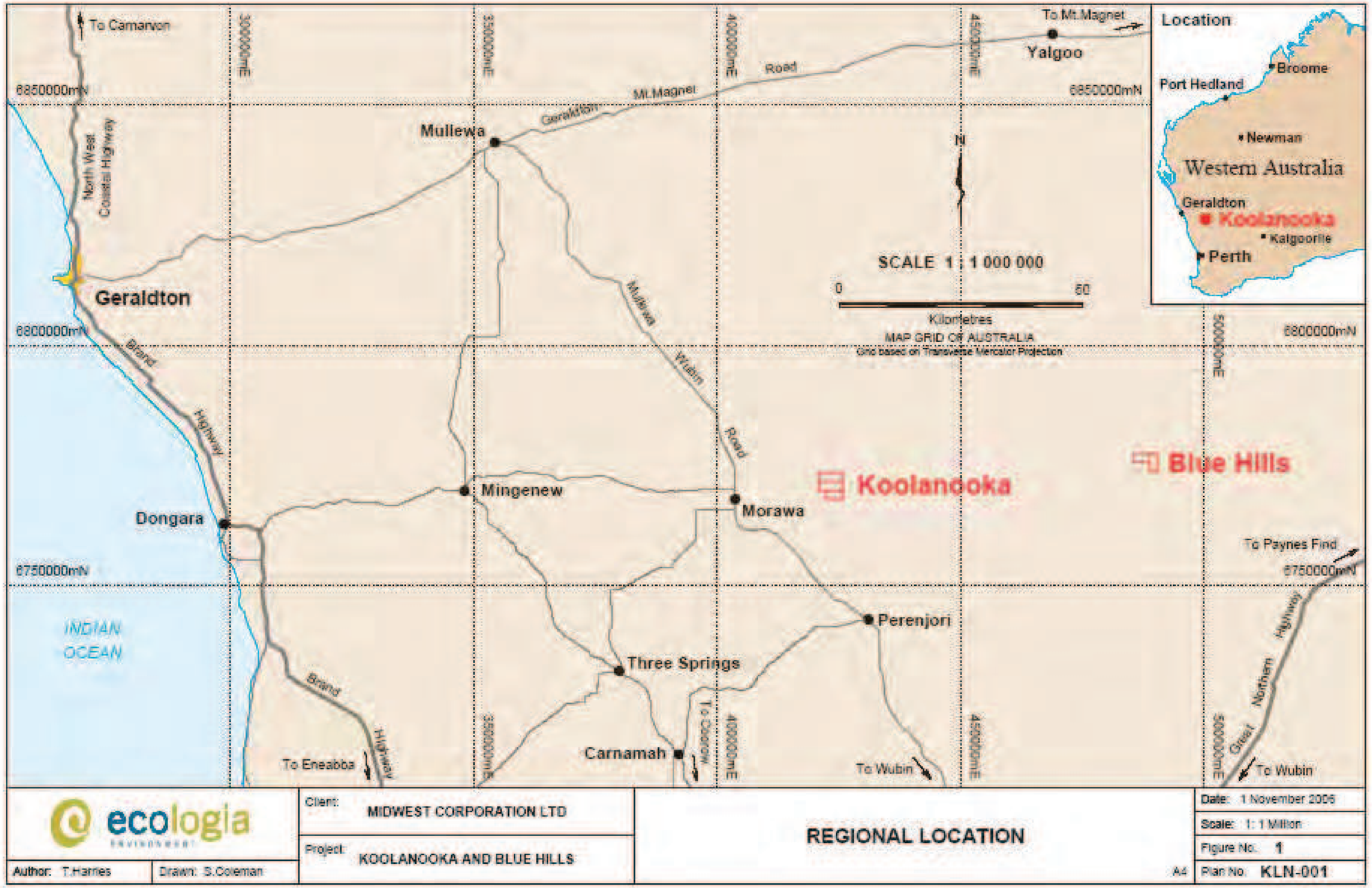


Figure 1.1 Map of the Geraldton, Koolanooka and the Blue Hills Local Area

1.1 LEGISLATIVE FRAMEWORK

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

- *The Precautionary Principle*

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

- *The Principles of Intergenerational Equity*

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

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

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

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

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

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

The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the Government Gazette, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection. The current listing was gazetted on the 1 December 2006.

1.2 SURVEY OBJECTIVES

Midwest commissioned ecologia Environment (ecologia) to undertake a baseline biological survey of the 'Short Range Endemic' (SRE) invertebrate fauna of the Koolanooka / Blue Hills study area as part of the environmental impact assessment for the project.

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

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

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of the project on the SRE invertebrate fauna of the area and to satisfy the requirements documented in EPA's Guidance Statement 56 and Position Statement No. 3, thus providing:

- A review of background information (including literature and database searches);
- An inventory of SRE fauna species occurring (i.e. or likely to occur) in the study area, incorporating recent published and unpublished records;
- A map and detailed description of fauna habitats occurring in the study area;
- A description of the characteristics of the faunal assemblage;
- An appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area which are relevant to the current study;
- A review of regional and biogeographical significance, including the conservation status of species recorded in the project area; and
- A risk assessment to determine likely impacts of threatening processes on SRE fauna within the study area.

1.3 OVERVIEW OF SHORT RANGE ENDEMISM IN WESTERN AUSTRALIA

Endemism refers to the restriction of species to a particular area, whether it be at the continental, national or local level (Allen et al. 2002). Short range endemism refers to endemic species with restricted ranges, which in Western Australian is currently defined as less than 10,000 km^2 (100 km x 100 km) (Harvey 2002). Such taxa are often invertebrates which display poor dispersal abilities and have more defined or restrictive biology that promotes their isolation and eventual speciation. It is important to note that the potential SRE groups listed in this review are not exhaustive and that invertebrates are historically understudied (i.e. in many cases lacking formal descriptions). Reliable taxonomic evaluation of these species began relatively recently and thus the availability of literature relevant to SREs remains scarce. It must also be stressed that the precautionary principle, as adopted by the EPA / DoE under Section 4a of the Environmental Protection Act 1986, is currently a guiding principle of this literature review.

1.3.1 Processes promoting short range endemism

Short-range endemism (SRE) is influenced by numerous processes which generally contribute to isolation of a species. A number of factors, including the ability and opportunity to disperse, life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions and historical conditions may influence not only the distribution of a taxon, but also the tendency for differentiation and eventually speciation (Ponder and Colgan 2002).

Species occurring in isolated populations tend to differentiate both morphologically and genetically because they are often influenced by locally specific selective pressures. Additionally, a combination of novel mutations and genetic drift may promote the accumulation of genetic differences between isolated populations. Conversely, a maintenance of genetic similarity is promoted by a lack of isolation between populations through migration, repeated mutation and balancing selection (Wright 1943). The amount of differentiation and speciation between populations will be determined by the relative magnitude of these factors, with the amount of migration generally being the strongest determinant. Migration is hindered by poor dispersal ability of the taxon and also by geographical barriers. Thus, those taxa that exhibit short-range endemism are generally characterised by poor dispersal, low growth rates, low fecundity and a reliance on habitat types that are discontinuous (Harvey 2002).

Many short range endemic species in Australia occur in habitats that have geographic barriers. Islands are a classic example, where the terrestrial fauna is surrounded by a marine environment which impedes migration and thus gene flow. Similarly, habitats such as mountains, aquifers, lakes and caves are essentially islands exhibiting unique environmental conditions. Species that survive in these habitats are often isolated because the outer surrounding environmental conditions are inhospitable. At a first glance the Koolanooka-Blue Hills landscape appears to be a homogenous landscape. However, closer examination of the geology, topography, flora and fauna, reveals a mosaic of habitats including She-oak scrub, open acacia thickets and laterite ridges. Each of these habitats has the potential to contain unique assemblages of short range endemic species (SREs).

Many SREs are considered to be relictual taxa (i.e. rare extant taxa derived from once widespread extinct ancestors). Some rare relictual species are believed to have descended from extinct species that were once abundant and widespread.

In Western Australia, relictual taxa generally occur in fragmented populations, from lineages reaching back to historically wetter periods. During the Miocene period (from 25 million to 13 million years ago), the xerification of Australia resulted in the contraction of many areas of moist habitat and the fragmentation of flora and fauna (Hill 1994). Relictual taxa also include species which have Gondwanan ancestors (165-180 million years ago). With the onset of progressively dryer and more seasonal climatic conditions, suitable habitats have become increasingly fragmented. Relictual species now generally persist in habitats characterised by permanent moisture and shade, maintained by high rainfall and/or prevalence of fog, whether induced by topography or coastal proximity, or areas associated with freshwater courses (e.g. swamps or swampy headwater of river systems), caves, or microhabitats associated with southern slopes of hills and ranges, rocky outcrops, deep litter beds, or various combinations of these features (Main 1996, 1999). As a result, these habitats support only small, spatially isolated populations such as SREs.

1.3.2 Current knowledge of the SRE species in the Midwest with emphasis on the study area

Groups or organisms which display short range endemism include (but are not limited to) molluscs (e.g. camaenid land snails), onychophorans (i.e. velvet worms), myriapods (i.e. millipedes and centipedes), arachnids (e.g. mygalomorph spiders scorpions, pseudoscorpions and schizomids) and some crustaceans (i.e. isopods) (Harvey 2002).

The current state of knowledge on short range endemism of invertebrate species in Australia, and indeed the Northern Yilgarn and Murchison Regions, is relatively poor. The paucity of targeted collections makes assessing the likely occurrence and the distribution of SRE fauna very difficult. There are currently SRE surveys underway at Jack Hills, Weld Range, Blue Hills, Karrara, Mt Gibson and also at Oakajee, all of which have recorded Mygalomorph trap-door spiders, land snails, pseudoscorpions and millipedes which are still being examined by taxonomic experts. Thus at this stage the conservation significance of these species can not be commented upon with certainty, but it can be said with a fair degree of confidence that the Mygalomorphae spiders from Jack Hills and Weld Range are new species (i.e. taxonomically undescribed). These species are often restricted to habitats with greater moisture availability such as south facing slopes.

Currently there is no literature related to SRE species specific to Northern Yilgarn and Murchison Regions. However, a search of the DEC Threatened and Priority Fauna Database recorded the presence of the Shield-backed Trapdoor spider *Idiosoma nigrum* Main 1952 and *Aganippe castellum* Main 1986. These species are listed by the Department of Environment and Conservation as Schedule 1 species (i.e. rare fauna that is likely to become extinct).

The study area is located within one of several vegetation systems associated with the Perenjori Botanical District, known as the Koolanooka System (Beard, 1976). The DSO Mining Project will impact on a 84.1ha area (i.e. a large proportion of which has already been disturbed by previous mining activities) and 3.8ha of vegetation immediately abutting the existing Koolanooka pit. This vegetation is a part of the Koolanooka System Threatened Ecological Community.

Areas in the vicinity of Koolanooka that have the potential to contain SRE species include areas with greater than average moisture retention such as drainage lines and south facing slopes. Studies show that granite outcrops also have the potential to harbour large assemblages of SREs (Harvey 2002; Hopper et al. 1997; Johnson et al. 2004; Main 1997; Withers and Edward 1997a).

In the Northern Agricultural Region (NAR) granite outcrops are an important biological resource. Due to their hard, rocky, upland nature, granite outcrops were generally not cleared for agriculture and granite breakaways represent key vegetated islands in an otherwise cleared landscape (NACC 2002). The Schedule 1 trap-door spider species *Kwonkan eboracum* (Nemesiidae) Main, 1983 is known to be associated with granite outcrops in the north eastern Wheatbelt (Main 2000; Withers and Edward 1997b).

Another potential SRE habitat is the Koolanooka (TEC) open she-oak woodland (*Allocasuarina campestris*). Records of the Schedule 1 trap-door spider species *Aganippe castellum* (Idiopidae) Main, 1986 were recently bolstered by the discovery of a population in the Moningarin Nature Reserve from within *Allocasuarina campestris* woodland (Davis 2005b). Only twelve small populations of *Aganippe castellum* are known the northern and eastern wheatbelt regions of Western Australia, however new populations have been recorded.

In addition, a search of the DEC Threatened Fauna Database suggested that the shield-backed spider, *Idiosoma nigrum* Main 1952, may be present at Koolanooka. This species is in decline because of its patchy distribution through the northern and central wheatbelt and coastal plain, where land clearing has reduced habitat availability. This long-lived species is very sensitive to disturbance (Main 2003). *Idiosoma nigrum* make their burrows in heavy clay soils in open York gum (*Eucalyptus oxophleba*), salmon gum (*E. salmonophloia*), wheatbelt Wandoo (*E. capillosa*) woodland, with Jam (*A. acuminata*) forming a sparse understorey. Some burrows have also been found in granite soils (Main 1982, 1987, 2003). It is believed that leaf litter such as leaves of *Eucalyptus, Casuarina* and *Acacia* is required, within which the spiders forage (Main 1987). If the litter layer is too thick the young spiders cannot dig through to establish burrows (Main 1992).

Figure 1.2 The Shield-backed trapdoor spider *Idiosoma nigrum.* A, burrow with open lid; B, adult spider

At least two habitats found at Koolanooka are likely to harbour SRE taxa: granite outcrops and She-oak woodlands. Furthermore, the presence of a TEC defined by the presence of a she-oak species (*Allocasuarina campestris*), from which a schedule 1 species has been recorded elsewhere, lends significant weight to the belief that SRE taxa are likely to be present in the Koolanooka and blue hills area.

1.4 TAXONOMIC GROUPS LIKELY TO SUPPORT SHORT RANGE ENDEMISM

1.4.1 Arachnids (Phylum: Arthropoda, Sub Class: Arachnida)

Four orders of arachnids can exhibit short range endemism: Pseudoscorpiones (false scorpions), Scorpiones (true scorpions), Schizomida (short-tailed whip spiders) and Araneae (i.e. Infraorder: Mygalomorphae or trap-door spiders). Many mygalomorph trap-door spider species are vulnerable to disturbance and exhibit short range endemism due to their limited ability to disperse. These spiders also have extreme longevity and the long-term persistence of females in a single burrow (Raven 1982). Mygalomorph spiders are largely considered 'old world' spiders and, as such, are generally adapted to past climatic regimes making them vulnerable to desiccation in arid environments. They use a variety of behavioural techniques to avoid desiccation, the most obvious of which is their burrow, which may reach up to 70 cm in depth (Main 1982). Mygalomorph groups are thus capable of surviving on the periphery of the great central desert region and minor habitats within the general arid regions of the continent.

Another member of the arachnid class, the Schizomida, is comprised entirely of SREs, with most recorded from single localities (Harvey 2002). Forty-six schizomid species have been described in northern Australia. Most are known to occur in the entrances to and inside caves, while the remainder occur in nearby habitats (Harvey, 2002). None are known to occur in the Midwest region of WA.

Scorpions (Scorpionida: *Urodacus* sp.) and pseudoscorpions (Pseudoscorpiones) also exhibit high degrees of endemism (Harvey 1996; Koch 1981; Harvey 1996). Scorpions are popularly thought of as desert animals although they can be found in most of Australia's climatic zones.

Currently, there is little published data regarding the distribution of these orders in Western Australia and particularly in the study area (Harvey 2002; Koch 1977). However, a review of the scorpion fauna of Western Australia is planned to commence early in 2007 which should substantially increase the knowledge of scorpion's distribution and endemism in the near future.

1.4.2 Millipedes and Centipedes (Phylum Arthropoda, Class Myriapoda)

Despite millipedes being highly abundant in soil and leaf litter, and highly diverse at the order level, they are inadequately studied and relatively little is known of their biogeography (Harvey, 2002).

Centipedes (Chilopoda) are not listed by Harvey (2002) as SRE species; however they have been shown to be endemic to small areas on the east coast (Edgecombe et al. 2002) and a recently described species has only been recorded from Albany (Jones 1996). Examination of the distributions of species featured in the CSIRO centipede webpage also reveals disjunct and isolated occurrences of many species (Colloff et al. 2005). A number of genera have Pangaean and Gondwanan affinities (Edgecombe et al. 2002). In general, these animals have a relatively cryptic biology, preferring moist habitats in deep litter accumulations, under rocks and in rotting logs, and they have relatively poor dispersal abilities (Lewis 1981). This suggests that they are potential candidates for designation as SREs.

1.4.3 Molluscs (Phylum: Mollusca)

Numerous species of freshwater and terrestrial molluscs belonging to many genera have been identified in Australia, with most being SREs (Harvey, 2002). Restricted ranges of the terrestrial molluscs of the drier northern and Western Australia were noted for a vast number of species (Solem 1997). Among these were seven endemic species of *Rhagada* from the Dampier Archipelago, five of which were found to occur sympatrically on one island. However, in a recent genetic study conducted on *Rhagada* (Johnson et al. 2004), allozyme analysis revealed little variation between taxa. Such a finding could indicate that there is merely high morphological diversity within one or a few species. It is also possible however, that there is a number of highly endemic species and that morphological diversity has taken place rapidly with little genetic change (Johnson et al. 2004).

1.4.4 Worms (Phylum: Annelida & Onychophora)

The taxonomic status of the earthworm family, Megascolecidae, in Western Australia was revised by Jamieson in 1971. As a result of this study, it was concluded that most of the earthworm genera are made up almost entirely of short-range endemics (Harvey, 2002). This is also the case with the velvet worms (Onychophorans). Due to several taxonomic revisions that have been conducted (see references within Harvey, 2002), the number of onychophoran species has expanded from six to over 70 species, and a number of species still remain undescribed (Harvey, 2002). Very few of these species exceed ranges of 200 km^2 and some are restricted to single localities and have high genetic differentiation, indicating very little mobility and dependence on their permanently moist habitats (Harvey, 2002).

Table 1.1 Conservation significant SRE fauna potentially occurring in study area

Area/Subject				**Location**			
Presence of Short Range Endemic Fauna				Koolanooka Hills and Blue Hills			
Risk Identification and Analysis				**Current Information**	**Risk Rating**		
#	**Risk Issue (Source / Event)**	**Taxa**	**Suitable Habitat in Study Area**	**Data Sources**	**Propensity to form SRE's**	**Likelihood of SRE forming conditions**	**Risk Rating**
1	Koolanooka Blue Hills Project results in adverse impact on 'unlisted' short range endemic fauna via land disturbance, introduction of exotic species (i.e. pests and weeds), increased noise and dust, changes in habitat (e.g. fire, drainage, contamination).	**Mygalomorphae** spiders: Idiopidae *Idiosoma nigrum*; Idiopidae *Aganippe castellum* and; Nemesiidae *Kwonkan eboracum* are all Schedule 1 species Ctenzidae rare; Dipluridae: Ischnothelinae: *Cethegus*; Actinopodidae: *Missulena* sp.	Granite Outcrop communities and She-Oak woodlands (*Allocasuarina campestris*); Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present at the base of *Acacia* species.	Desktop literature review, DEC/WAM Faunabase search, expert opinion (Davis 2005a, b; Main 1982, 1987, 2003), anecdotal evidence.	4	5	20
		Scorpions	Deep leaf litter accumulations in the larger Koolanooka and Blue hills, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees and under leaf litter accumulations	Desktop literature review, DEC/WAM Faunabase search, expert opinion, anecdotal evidence. Many specimens from Weld Range and Jack Hills of two Families presently being reviewed by WAM specialists.	3	3	9
		Pseudoscorpions	Deep leaf litter accumulations in the larger Koolanooka and Blue Hills, along southern facing slopes and under rocks and large debris. May also be present in the Plains at base of Acacia and other trees and under leaf litter accumulations	Desktop literature review, DEC/WAM Faunabase search, expert opinion, anecdotal evidence. Many specimens recorded using pitfall traps at Weld Range and Jack Hills	5	4	20
		Schizomida	Generally tropical taxa, deep caves would need to be present to support this group	Desktop literature review, DEC/WAM Faunabase search, expert opinion,	5	1	5

			of invertebrates	anecdotal evidence			
		Millipedes	Deep leaf litter accumulations in the larger Koolanooka and Blue Hills, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees.	Desktop literature review, DEC/WAM Faunabase search, expert opinion, anecdotal evidence. Despite WAM predictions many specimens were recorded opportunistically and with pitfall traps at Weld Range.	5	4	20
		Centipedes	Deep leaf litter accumulations in the larger Koolanooka and Blue Hills, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees.	Desktop literature review, DEC/WAM Faunabase search, expert opinion, anecdotal evidence. A number of specimens recorded at Jack Hills and Weld Range belong to undescribed species.	3	2	6
		Mollusca: Camaenidae, genus *Rhagada* and others	Deep leaf litter accumulations in the larger Koolanooka and Blue Hills, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees.	Desktop literature review, DEC/WAM Faunabase search, expert opinion, anecdotal evidence. Land snail specimens from Weld Range soon to be reviewed by WAM experts.	5	5	25
		Annelids: Megascolecidae.	Deep leaf litter accumulations in the larger Koolanooka and Blue Hills, along southern facing slopes and under rocks and large debris.	Desktop literature review, DEC/WAM Faunabase search, expert opinion (Harvey 2002), anecdotal evidence.	5	3	15

Table 1.2 The Risk Matrix Used in the Determination of SRE Presence in the Koolanooka Hills Project Area

Risk Matrix:

Taxa Group Propensity to form SREs	Risk Assessment Rating	Likelihood of SRE forming conditions: 5 ALMOST CERTAIN Habitats highly likely to lead to SREs Is expected to occur in most circumstance	4 LIKELY SREs will probably occur in most circumstance	3 POSSIBLE SREs Could occur	2 UNLIKELY SREs could occur but not expected	1 RARE SREs occur only in exceptional circumstances
	5 - VERY HIGH	25	20	15	10	5
	4 - HIGH	20	16	12	8	4
	3 - MODERATE	15	12	9	6	3
	2 - MINOR	10	8	6	4	2
	1 - LOW	5	4	3	2	1

21 - 25	High risk of unrecorded SRE taxa, site specific survey required, senior management attention needed
16 - 20	Medium risk, management responsibility must be specified. Site specfic survey recommended
1 - 5	Low risk, managed by routine procedures. Site specific survey not required.

Table 1.3 The Definitions Used in the Determination of the SRE Risk Assessment

Likelihood of SRE forming conditions:

Value	Description	Criteria
5	Almost Certain	SREs are expected to occur in most circumstance. Disjunct, microclimatic or relictual habitats are present: habitats highly likely to lead to the formation of SREs.
4	Likely	SREs will probably occur in most circumstance. Disjunct, microclimatic or relictual habitats are present or very little is known about the local environment and taxa present.
3	Possible	SREs Could occur. Disjunct, microclimatic or relictual habitats might be present but more importantly, very little is known about the local environment and taxa present.
2	Unlikely	SREs could occur but not expected. The majority habitat is homogenous regioanlly and locally. The taxa of the area are fairly well known. Disjunct, microclimatic or relictual habitats are absent or not previously known.
1	Rare	SREs occur only in exceptional circumstances. The majority habitat is homogenous regioanlly and locally. The habitats and resident taxa of the area are well known. New habitats such as permanent springs or caves would need to be discovered.

Propensity of Taxonomic Group to form SREs:

Value	Description	Criteria
5	Very High	The group is known to display SRE taxon. They are relictual species known from past climatic regimes, they have poor powers of dispersal coupled with single sex-biased dispersal , highly specialised habitat requirements, low fecundity and male-biased dispersal.
4	High	The group is known to display SRE taxon. They inlcude relictual species known from past climatic regimes, have poor powers of dispersal which may be coupled with single sex-biased dispersal, moderately specialised habitat requirements, moderate fecundity and male-biased dispersal.
3	Moderate	The group is suspected or known to display SRE taxon. They might inlcude relictual species known from past climatic regimes, have poor-moderate powers of dispersal, moderately specialised habitat requirements and moderate fecundity.
2	Minor	They might inlcude relictual species known from past climatic regimes, have moderate powers of dispersal, fairly general habitat requirements and moderate-high fecundity.
1	Low	They are unlikely to inlcude relictual species, have moderate-high powers of dispersal, general habitat requirements and moderate-high fecundity.

2.0 SURVEY METHODS

2.1 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

The survey methods adopted by ecologia have been developed in consultation with senior Western Australian Museum (WAM) staff and other local experts. Currently, the Environmental Protection Authority's Guidance Statement No. 56 (EPA 2004) and Position Statement 3 (EPA 2002) provide no specific instructions on the expected design of SRE surveys. Thus the temporal and spatial replication attained with the systematic pitfall trap approach and the effort attained with foraging activities, is at the discretion of the environmental consultant conducting the SRE survey.

Prior to the development of survey methods, a review of factors likely to influence survey design was undertaken. These factors included identifying landforms, local weather patterns, biology of likely SRE species, water/moisture sources, proposed impact areas and site access. This process ensures that sites within the impact area that are likely to harbour SRE species are targeted.

This survey was conducted over two phases. The first survey was designed to cover the proposed impact areas. However, a second phase of surveying was required when the proposed impact area was expanded at Blue Hills (i.e. specifically Mungada East and Mungada West). The second survey was conducted 4 months after the first phase of survey.

Table 2.1 SRE Trapping Timetable

Phase	Location	Traps set out	Traps collected	Trap Nights
1	Koolanooka	17th January 2007	26th February 2007	40
	Blue Hills	18th January 2007	27th February 2007	40
2	Blue Hills	26th-27th June 2007	25-27th July 2007	29

2.2 SAMPLING METHODS

The survey was undertaken using a variety of sampling techniques, including systematic sampling. Systematic sampling refers to data collected over a fixed time period in a discrete habitat type, using an equal or standardised sampling effort. The resulting information can be analysed statistically, facilitating comparisons between habitats and seasons. Opportunistic sampling includes data collected non-systematically at fixed sampling sites. Total survey effort is presented in Table 2.2 and Table 2.3.

Table 2.2 Summary of phase one and two survey effort

SITE	PERSON HOURS FORAGING	NUMBER OF PITFALL TRAPS
Koolanooka	4	20
Blue Hills	11	55
TOTAL	15	75

2.2.1 Systematic Sampling: Pitfall Trapping

A total of 17 pitfall trap sites were established. Each site comprised five invertebrate pitfall traps. Each trap was placed in suitable microhabitats within each habitat under investigation. Such microhabitats included areas under shade-bearing shrubs, up against the shady side of larger rocks and boulders and south facing slopes.

Each trap consisted of a two litre container, containing a 1000 ml solution of Ethylene Glycol (99.8 % conc.) / Formalin (2-4 % of total volume). This solution euthanizes collected animals and fixes tissues. To minimise the chance of vertebrate by-catch, each trap was roofed with a plastic bucket lid positioned 3 cm above the soil surface and weighed down with rocks and/or branches. Traps were left in the field for a minimum of 30 days.

2.2.2 Opportunistic Sampling: Hand foraging

Hand foraging was conducted at all 15 sites. These sites represented the majority of minor and major vegetation types. A site was considered completed after 30 minutes of foraging with two people (1 person–hour). Thus a total of 15 person hours was spent foraging in the project area. Each foraging site was contained within a 10 m by 10 m quadrat.

Specifically, foraging included lifting of rocks, raking leaf litter at the base of large shade bearing trees and old decaying logs and cracking open large logs and debris. These methods help uncover cryptic invertebrates such as mygalomorph spiders, scorpions, pseudoscorpions, snails, centipedes, millipedes and isopods. Many of these species are sedentary and are therefore unlikely to be collected in the pitfall traps (e.g. female mygalomorph spiders).

2.3 SITE SELECTION

As discussed in the literature review, SRE invertebrate taxa are generally found in specific microhabitats and such habitats are the focus of the survey effort while broad scale habitats are largely ignored. Refugia and microhabitats may include: hilltops and southern facing slopes, areas of deep leaf litter accumulation and permanent shade, under the bark of and in, large logs, caves and their entrances and, springs and permanent water bodies where present.

In order to narrow the focus of the sampling, aerial photographs are initially inspected for southern facing slopes, gullies and permanent water bodies. For example on-site personnel who know the area intimately are also asked about the presence of such habitats.

2.4 SITE DESCRIPTIONS

Table 2.3 Phase 1 site descriptions

Koolanooka Site 1 *Allocasuarina acutivalvis* subsp. *prinsepiana* / *Acacia acuminata* open to moderately dense tall shrubland, over *Acacia exocarpoides / Melaleuca fulgens* subsp. *fulgens* shrubs	
Koolanooka Site 2 *Allocasuarina acutivalvis* subsp. *prinsepiana* / *Acacia acuminata* open to moderately dense tall shrubland, over *Acacia exocarpoides / Melaleuca fulgens* subsp. *fulgens* shrubs	
Koolanooka Site 3 *Allocasuarina acutivalvis* subsp. *Prinsepiana* scattered tall shrubs, over sparse *Calycopeplus paucifolius / Acacia sclerosperma* subsp. *sclerosperma / Dodonaea inaequifolia*	

Koolanooka Site 4

Allocasuarina acutivalvis subsp. *Prinsepiana* scattered tall shrubs, over sparse *Calycopeplus paucifolius / Acacia sclerosperma* subsp. *sclerosperma / Dodonaea inaequifolia*

Blue Hills West Site 1

Melaleuca nematophylla / *Acacia ramulosa* var. *ramulosa* open low woodland/tall shrubland with *Calycopeplus paucifolius.*

Blue Hills West Site 2

Acacia ramulosa var. *ramulosa* (sometimes with scattered *A. aneura*), over *Calycopeplus paucifolius* / *Melaleuca nematophylla* tall shrubs.

Table 2.4 Phase 2 site descriptions

Blue Hills East Site 1

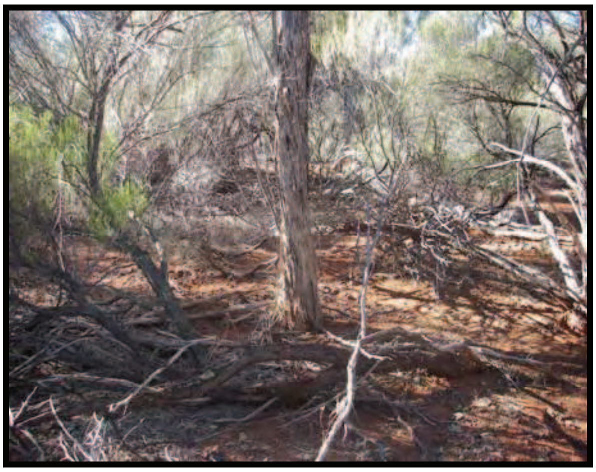
Allocasuarina acutivalvis subsp. *Prinsepiana* scattered tall shrubs, over sparse *Calycopeplus paucifolius / Acacia sclerosperma* subsp. *sclerosperma / Dodonaea inaequifolia*

Blue Hills East Site 2

Allocasuarina acutivalvis subsp. *Prinsepiana* scattered tall shrubs, over sparse *Calycopeplus paucifolius / Acacia sclerosperma* subsp. *sclerosperma / Dodonaea inaequifolia*

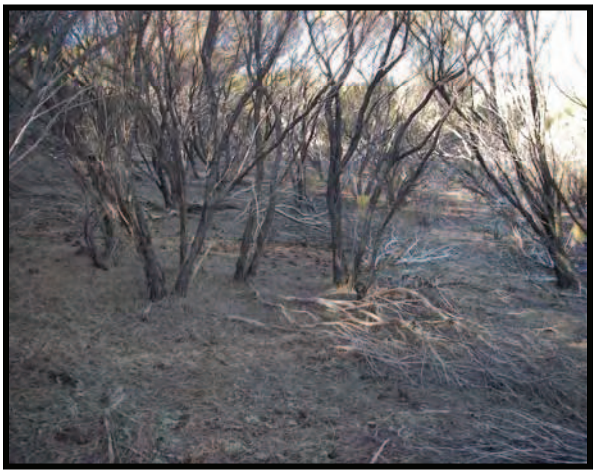
Blue Hills East Site 3

Melaleuca nematophylla / *Acacia ramulosa* var. *ramulosa* open low woodland/tall shrubland with *Calycopeplus paucifolius.*



Blue Hills East Site 4

Acacia ramulosa var. *ramulosa* (sometimes with scattered *A. aneura*), over *Calycopeplus paucifolius* / *Melaleuca nematophylla* tall shrubs.



Blue Hills East Site 5

Predominantly *Calycopeplus paucifolius* shrubland

Blue Hills East Site 6

Calycopeplus paucifolius, Acacia woodmaniorum (P2) & *Melaleuca nematophylla*

Blue Hills East Site 7

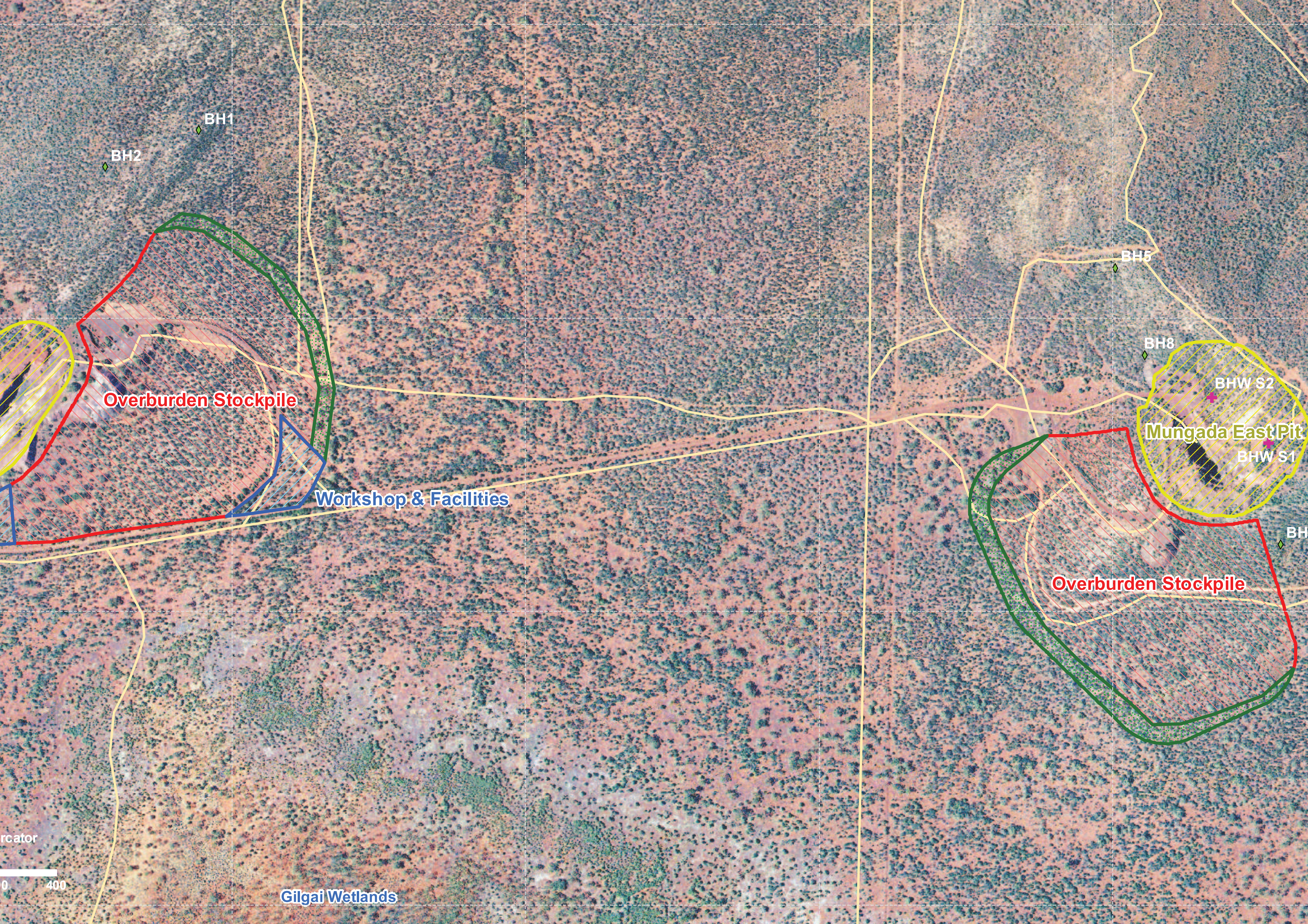
Calycopeplus paucifolius, Acacia woodmaniorum (P2) & *Melaleuca nematophylla*

Blue Hills East Site 8

Tall *Melaleuca nematophylla* / *Acacia ramulosa* var. *ramulosa* open low woodland/tall shrubland with *Calycopeplus paucifolius.*

Blue Hills East Site 9

Predominantly *A. aneura* shrubland


BH1
BH2
Overburden Stockpile
Workshop & Facilities
BH6
BH8
BHW S2
Mungada East Pit
BHW S1
Overburden Stockpile
Gilgai Wetlands
0
400

2.5 TAXONOMY AND CURATION

All biological material collected was immediately placed in 100 % absolute ethanol. All important material will be lodged with the WAM at the conclusion of the project.

The level of specimen identification achievable is dependent on the level of taxonomic knowledge and expertise currently available. Dr Mark Harvey at the Western Australian Museum (WAM) identified the scorpions. Shirley Slack-Smith (WAM) identified the Molluscs. Professor Barbara York Main from the University of Western Australia confirmed the Mygalomorphae spider identifications. Dr Simon Judd identified the Isopods. Ecologia scientists identified the centipedes, annelids (with the help of Rob Blakemore) and mygalomorph spiders.

Table 2.5 Summary of taxonomic experts and the groups of invertebrates they identified during the survey

Taxonomic Expert	Specimens Identified	Institution
Dr Mark Harvey	Millipedes Scorpions Pseudoscorpions	Western Australian museum
Shirley Slack-Smith	Molluscs	Western Australian museum
Professor Barbara York Main	Mygalomorph spiders	University of Western Australia
Dr. Simon Judd	Isopods	
Jarrad Clark	Centipedes Annelid worms	Ecologia

2.6 SURVEY TEAM

Table 2.6 Summary of team members who performed the survey

Name	Position	Qualifications
Magdalena Zofkova	Senior Environmental Biologist	PhD (Zoology)
Jarrad Clark	Senior Environmental Biologist	BSc. (Environmental Management)
Melissa White	Environmental Biologist	BSc. (Marine Biology & Zoology) Hons
Tom Rasmussen	Zoologist	
Gilbert Whyte	Environmental Biologist	BSc. Biological Sciences

2.7 SURVEY LIMITATIONS

Limitations of the current survey are summarised in Table 2.6 below.

Table 2.7 Summary of survey limitations

CONSTRAINT	RELEVANT (yes/no)	COMMENT
Competency/ experience of survey consultants.	no	All of the people who participated in the survey have the required qualifications and experience (Figure 2.5)
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	no	The sampling methods used were designed to target Invertebrate groups that are likely to be short range endemics. These methods were not affected by any constraints.
Proportion of fauna identified, recorded and/ or collected.	yes	Although pitfall trapping and hand foraging are efficient methods for collecting ground dwelling invertebrate species, it is important to note that only a proportion of the invertebrate fauna can be sampled in this way. Some species are likely to missed simply by chance such as cryptic species which are rarely active (see sections 2.1, 2.2 and 2.3).
Sources of information (previously available information as distinct from new data).	yes	There is a general lack of biological information for most invertebrate groups (i.e. especially those in isolated habitats), which makes it difficult to determine their distribution and abundance.
The proportion of the task achieved and further work which might be needed.	no	The survey provided what was required to meet our objectives.
Timing/ weather/ season/ cycle.	no	The scheduling of the survey, which accounted for the effects of weather and season, was not disrupted.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	no	No disturbances affected the results of the survey.
Intensity (in retrospect was the intensity adequate).	no	The intensity of the survey was adequate
Completeness (e.g. was relevant area well surveyed).	no	The area to be disturbed by mining operations was surveyed at a satisfactory level.
Resources (e.g. degree of expertise available in animal identification to taxon level).	yes	Although almost all of the SRE groups were identified to species level, there is a lack of expertise in Myriapod taxonomy in Western Australia. Some of these specimens were therefore identified to higher taxonomic levels.
Remoteness and/ or access problems.	no	All areas to be surveyed were accessible
Availability of contextual	no	All biogeographic informationation relating

(e.g. biogeographic) information on the region.		to the region was collected.
Efficiency of sampling methods (i.e. any groups not sampled by survey methods).	no	The sampling methods employed were sufficient to sample the majority of species in the area that are likely to be SREs.

3.0 RESULTS

3.1 ARACHNIDS

3.1.1 Mygalomorphae (Trapdoor spiders)

A number of Mygalomorph spiders were collected during this survey, however, many of these could not be identified to species level due to a lack of adult specimens. One Diplurid species was identified as belonging to the genus *Cethegus*. This species is unlikely to be an SRE species because most of the species in this genus are good dispersers during the early stages of their lifecycle. Two species belonging to the Barychelidae family were also collected but these could not be identified to species level due to a paucity of taxonomic information (*pers comm*.. Main 2007).

3.1.2 Schizomida (Micro whip scorpions)

No Schizomids were recorded.

3.1.3 Scorpionida (Scorpions)

Three adult male specimens of the scorpion, *Urodacus* sp. nov. Gairdner Range were recorded. This is the third record for this species with samples previously collected from Gairdner Range (200 km southeast of Geraldton) and Karara Station (situated near Koolanooka) (Harvey 2007).

3.1.4 Pseudoscorpiones (False scorpions)

A single specimen of the pseudoscorpion genus *Synsphyronus* was collected, however, being a juvenile the specimen it could not be identified to species level. Many species from the genus *Synsphyronus* are associated with rocky outcrops and are considered to be SRE species (Harvey, unpublished data).

Two unidentified pseudoscorpion species from the family Olpiidae were collected. However, the lack of information pertaining to the identification of individual species and their distributions makes the assessment of short range endemism difficult (Harvey 2007).

3.2 CRUSTACEANS

3.2.1 Isopoda (Slaters)

Two isopod species were collected which were identified as belonging to the genera *Buddelundia* and *Spherillo*. Neither of these species are likely to be SRE species.

3.3 MILLIPEDES AND CENTIPEDES

3.3.1 Chilopoda (Centipedes)

Several centipede species were identified and these represented three families (i.e. Scolopendridae, Scuttigeridae and Mecistocephalidae) and five genera. The species included *Arthrorhabdus* sp., *Arthrorhabdus mjobergi*, *Scolopendra* sp., *Scolopendra morsitans*, *Scolopendra laeta*, *Thereuopoda longicornis*, *Mecistocephalus* sp. and *Cormocephalus* sp.

Due to the paucity of knowledge regarding these species it is very difficult to determine if any are SRE species.

3.4 MOLLUSCS

3.4.1 Gastropoda (Snails)

Two species of land snail were identified from specimens collected during the survey. All of the specimens were dead and were identified by shell characteristics. The species were identified as *Sinumelon vagente* Iredale and *Bothriembryon* sp.

Two sub-adult shells and 1 juvenile shell of *S. vagente* were collected. This species is a member of the genus *Sinumelon*, which has a distributional range extending in an east-south-easterly direction from an area roughly east of Geraldton to the southern part of the South Australian-Western Australian border and into southern South Australia. This species has the most north-westerly range of the *Sinumelon* species, extending southwards to about 29°S, 118°E near Paynes Find. It seems likely that its distributional area might be more extensive than currently recorded in the discussion by Solem (1993) and from subsequently collected specimens because the majority of the records are taken from roadways and tracks. However, it is not likely that the distributional range of this species will be found to extend much further to the south-east (i.e. into the area inhabited by the closely related species S. kalgum Iredale, 1939).

One sub-adult specimen, freshly dead but with protoconch missing was identified as a species belonging to the *Bothriembryon* genus. Because this shell does not belong to any of the formally-named and described species it is likely to represent a new species. However, from the shape and surface sculpture of this sub-adult shell, the species appears to belong to the taxon currently identified in the collections of the Western Australian Museum by the informal name "Northern Wheatbelt". The WA Museum largely chance-encountered specimens grouped within the taxon, which have been collected from the area around Mingenew, Morawa and Canna. The shells of most of the known "Northern Wheatbelt" specimens are smaller and slightly more slender and more fragile than similar, poorly-known and largely undescribed taxa living in the area south, east and north of the Dongara-Geraldton area.

The paucity of available information on the distributions, abundances, habitat preferences and biology of these snails is due to a lack of directed surveys in the region. It is therefore difficult to determine their potential endemicity (*pers comm*. Smith 2007).

Table 3.1 Results of the SRE Invertebrate Survey (All sites: Phase 1 & 2)

			Koolanooka (Phase 1) sites				Blue Hills MW (Phase 1) sites			Blue Hills ME (Phase 2) sites								
Family	**Genus**	**Species**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
ARACHNIDS (Mygalomorphae)																		
Dipluridae	*Cethegus*	sp.	5															
Barychelidae	*?*	sp. A	1											1				
Barychelidae	*?*	sp. B													1			
MYRIAPODA (Centepedes)																		
Scolopendridae	*Scolopendra*	sp.	1											1				
Scolopendridae	*Scolopendra*	*laeta*	1								2							
Scolopendridae	*Scolopendra*	*morsitans*	1	1		3												
Scolopendridae	*Arthrorhabdus*	*mjobergi*		1		3												
Scolopendridae	*Cormocephalus*	sp.									1							
Mecistocephalidae	*Mecistocephala*	sp.									2							
Scutigeridae	*Thereuopoda*	*longicornis*	1	1							2	7		4				
ISOPODA																		
Armadillidae	*Buddelundia*	sp.	11	12	12	2	6	4										
Armadillidae	*Spherillo*	sp.				4												
MOLLUSCA																		
Bulimulidae	*Bothriembryon*	sp.									1							
Camaenidae	*Sinumelon*	*vagante*																3
PSEUDOSCORPIONS																		
Garypidae	*Synsphyronus*	sp.						1										
Olpiidae	*Beierolpium*	sp.	2	5														
Olpiidae	*Indolpium ?*	sp.		1			1	1										
SCORPIONS																		
Buthidae	*Lychas*	*splendens*	2															
Urodacidae	*Urodacus*	Indet. (juvenile)	1															
Urodacidae	*Urodacus*	sp. nov. Gairdner Range				1	1	1										

3.5 IMPACT RISK ASSESSMENT

A risk assessment (Table 3.2) was undertaken to determine potential impacts arising from the development on invertebrate fauna and the residual impacts following the implementation of management strategies identified in this document. The level of risks is classified as either "High" (site/issue specific management programmes required, advice/approval from regulators required), "Medium" (specific management and procedures must be specified) or "Low" (managed by routine procedures).

3.6 THREATENING PROCESSES

Three risk issues were identified in the course of conducting the risk assessment for the Midwest Corporation Koolanooka and Blue Hills projects. With respect to vegetation clearing four impacts were identified, all of which were associated with the removal of SRE invertebrate fauna habitat. In all four cases, with the implementation of the suggested controls, the residual risk was calculated to be low.

Similarly with the increased risk of dust arising from the proposal which could potentially result in damage to SRE fauna habitat via vegetation decline, the implementation of the suggested controls lowers the residual risk to low.

Lastly, the increased risk of fire resulting in degradation of SRE fauna habitat is considered low, once the suggested controls are implemented.

That being said, in the absence of information concerning SRE taxa in the study area it is difficult to accurately determine the impact of the proposal on such taxa. Although the proposal is expected to impact just 3.8 ha of Koolanooka Threatened Ecological Community (TEC), this community contains *Allocasuarina campestris* which is known to harbour the Schedule 1 trap-door spider species *Aganippe castellum*. The shield-backed trapdoor spider *Idiosoma nigrum* although not collected during this survey was found nearby at Karrara station. The approximately 39.5ha of naturally revegetated haul road to be cleared is considered unlikely to harbour SRE taxa and thus, this part of the proposal is unlikely to severely impact SRE taxa.

Table 3.2 Biological Environmental impact risk assessment

Project: Midwest Corp. DSO PER		*Location: Koolanooka and Blue Hills*									
			Inherent Risk					**Residual Risk**			
Risk Issue	**Aspect (Event)**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Mine Site											
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Loss of local SRE invertebrate fauna communities	3	4	12	**High**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	3	2	6	**Med**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Adverse impact to ecological function	1	5	5	**Low**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	1	2	2	**Low**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Habitat fragmentation	5	4	20	**High**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	5	1	5	**Low**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Reduction in SRE invertebrate fauna populations	5	4	20	**High**	Clearing of southern facing ridge slopes would be avoided where possible	5	2	10	**Med**
Dust	Dust emissions arising from mining operations	Damage to vegetation resulting in loss of SRE invertebrate fauna habitat	2	3	6	**Med**	Dust suppression measures should be implemented, including management of road speed on unsealed roads and the use of dust retardants	2	1	2	**Low**
Fire	Wildfire arising as a result of mining operations	Degradation of fauna habitat and populations	4	2	8	**Low**	A fire prevention strategy should be implemented. All vehicles should be fitted with fire extinguishers & all personnel trained in their use.	2	2	4	**Low**

Table 3.3 Risk Assessment Matrix used in the Determination of the Biological Impact Risk Assessment

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

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

Table 3.4 The definitions used in the determination of the biological impact risk assessment

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

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

4.0 MANAGEMENT RECOMMENDATIONS

The following management items are recommended to mitigate impacts of the development on native fauna:

- Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field.
- Cleared areas should be rehabilitated as soon as practical, clearing of southern facing ridge slopes should be avoided where possible.
- Dust suppression measures should be implemented, including management of road speed on unsealed roads.
- A fire prevention strategy should be implemented.
- All vehicles should be fitted with fire extinguishers & all personnel trained in their use.

5.0 CONCLUSIONS

The findings of the SRE survey indicate that there are 20 invertebrate species occurring in the Koolanooka / Blue Hills impact area, which represent 4 classes and 6 subclasses (i.e. Mygalomorphae, Pseudoscorpiones, Scorpionida, Myriapoda, Isopoda and Mollusca). Studies show that species in these groups often have high levels of endemicity and short geographical ranges. Although the area to be impacted is relatively small (i.e. less than 50ha), the large diversity of SRE species occurring at Koolanooka / Blue Hills, gives the area significant conservation value. All possible measures, such as the recommendations outlined in this report, should be taken to reduce impacts and ensure that the invertebrate assemblages are maintained in the area.

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