September 2009



HANCOCK PROSPECTING PTY LTD
ROY HILL IRON ORE PROJECT

INTERIM SHORT-RANGE ENDEMIC INVERTEBRATE REPORT

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SHORT-RANGE ENDEMIC
INTERIM INVERTEBRATE SURVEY

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4 September 2009

Document Status						
Rev No.	**Author**	**Reviewer/s**	**Date**	**Approved for Issue**		
				Name	**Distributed To**	**Date**
A	N.Thompson and ES Volschenk	N.Thompson	3/9/09	N Thompson	Ailan Tran	04/09/09

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

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1.0 Executive Summary

Hancock Prospecting Pty Ltd (HPPL) holds Exploration Licence E47/1326 for Roy Hill, which is located approximately 120 km north-east of Newman at the eastern end of the Chichester Range. The Roy Hill Iron Ore Mining Project consists of mining a resource of approximately 1 billion tonnes (Bt) of bedded Marra Mamba iron ore and approximately 1Bt of detrital iron ore to produce 55 million tonnes per annum (55Mt/a) of shippable ore.

During 2009, HPPL commissioned ecologia to undertake a Level 1 survey for short-range endemic fauna and prepare a report for inclusion in the formal environmental assessment process, for a proposed mining development at Roy Hill. Specific items for consideration were the following proposed infrastructure: Marble Bar rd re-alignment (50m either side of centreline); Airstrip and Airport Road; Waste Tailings; Processing Plant; one evaporation pond and two WFSF facilities; construction village, camps and road.

A level one pitfall trapping and foraging survey was undertaken involving 16 survey sites, 15 of which containing 10 wet pitfall traps. Foraging was also undertaken at each site including active searching and litter sifting. Traps were active for approximately 54 days.

Results to date are only partially completed. The final identifications for several taxonomic groups is currently taking place. In the absence of more definitive identifications and short-range endemic determinations, the likelihood of sample areas qualifying as island habitats is explored as a means of trying to gage the likelihood of supporting short-range endemics. We found no obvious evidence for island habitats within the areas proposed for infrastructure.

Two invertebrate groups tentatively identified as Camaenid snail (Camaenidae), and geophilid centipede (Geophilomorpha) were collected. Positive identification is still outstanding on the snail; however, no specialists are available with the contextual (Pilbara) knowledge of geophilid taxonomy. In the absence of contextual taxonomy, we assessed the likelihood of this species being an SRE as low, on the basis of the widespread habitat in which it was collected.

Preliminary examinations of the trapdoor spiders collected indicate that none are likely to be SRE species.

To date none of the species, for which positive identifications have been obtained, represent SRE species.

2.0 INTRODUCTION

2.1 PROJECT BACKGROUND

Hancock Prospecting Pty Ltd (HPPL) holds Exploration Licence E47/1326 for Roy Hill, which is located approximately 120 km north-east of Newman at the eastern end of the Chichester Range. (Figure 2-1). The Roy Hill Iron Ore Mining Project (the Project) consists of mining a resource of approximately 1 billion tonnes (Bt) of bedded Marra Mamba iron ore and approximately 1Bt of detrital iron ore to produce 55 million tonnes per annum (55Mt/a) of shippable ore. Mining will be conducted by conventional drill, blast and hauling operations with possible assistance from continuous strip miners.

During 2006, ecologia Environment (ecologia) conducted a short-range endemic (SRE) survey for HPPL at Roy Hill. The survey revealed very few potential SRE species and a total absence of mygalomorph spiders. This result was queried by representatives of DEC and, consequently, an additional opportunistic SRE survey was conducted in October 2008. This survey confirmed that mygalomorph spiders are rare to non-existent in most parts of the Roy Hill tenement: However, further systematic sampling after the wet season was recommended to complete the survey.

During 2009, HPPL commissioned ecologia to undertake a Level 1 survey for short-range endemic fauna and prepare a report for inclusion in the formal environmental assessment process, for a proposed mining development at Roy Hill. A single phase, short-range endemic invertebrate survey was undertaken that focused on the mine site infrastructure (Figure 2-2):

- realignment of Marble Bar Road (50m either side of centreline);
- airstrip;
- two waste fines storage facilities;
- processing plant;
- one evaporation pond; and
- permanent accommodation village.

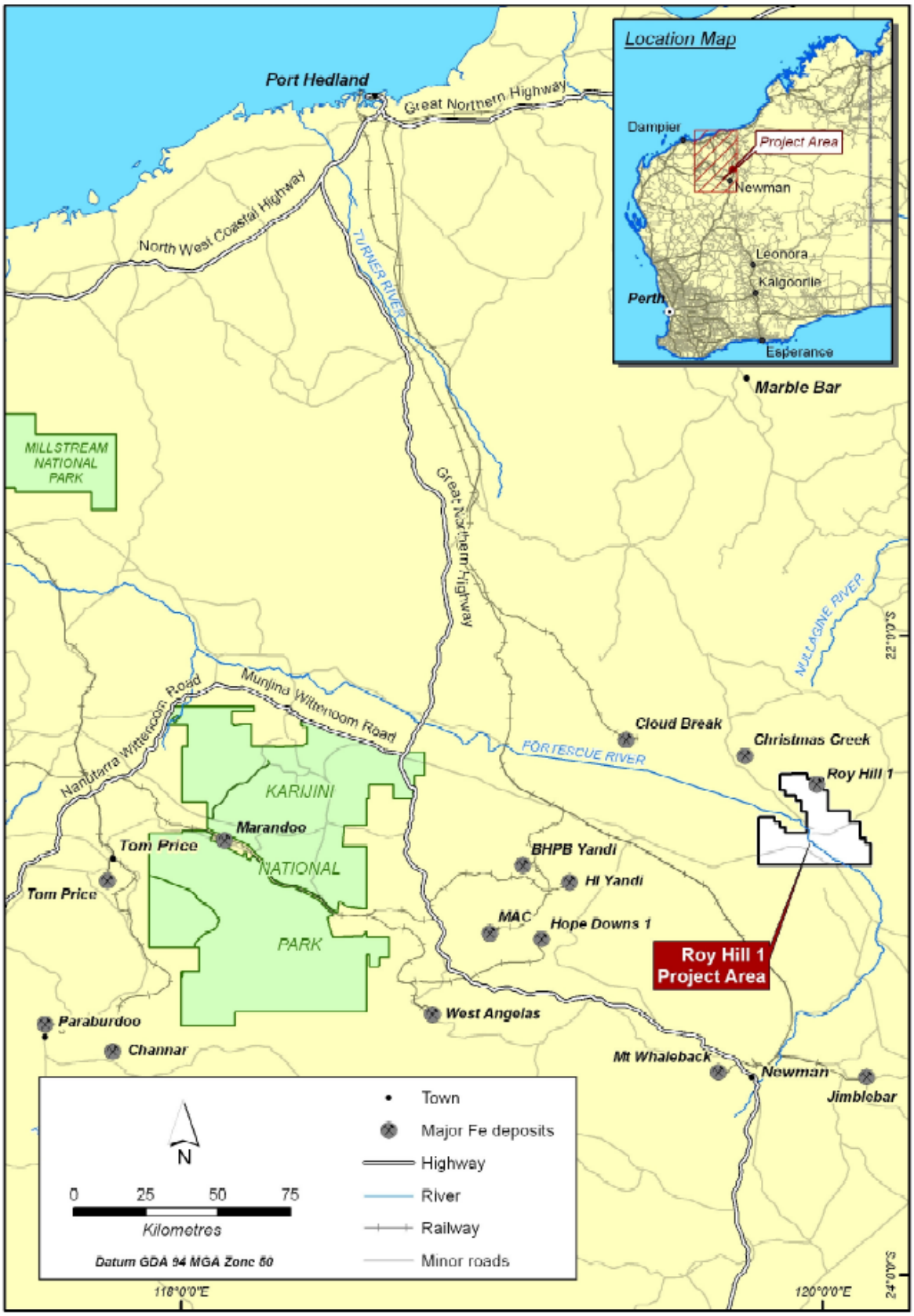

Figure 2-1 Location Map Of Project Area In Relation To The Western Australia.

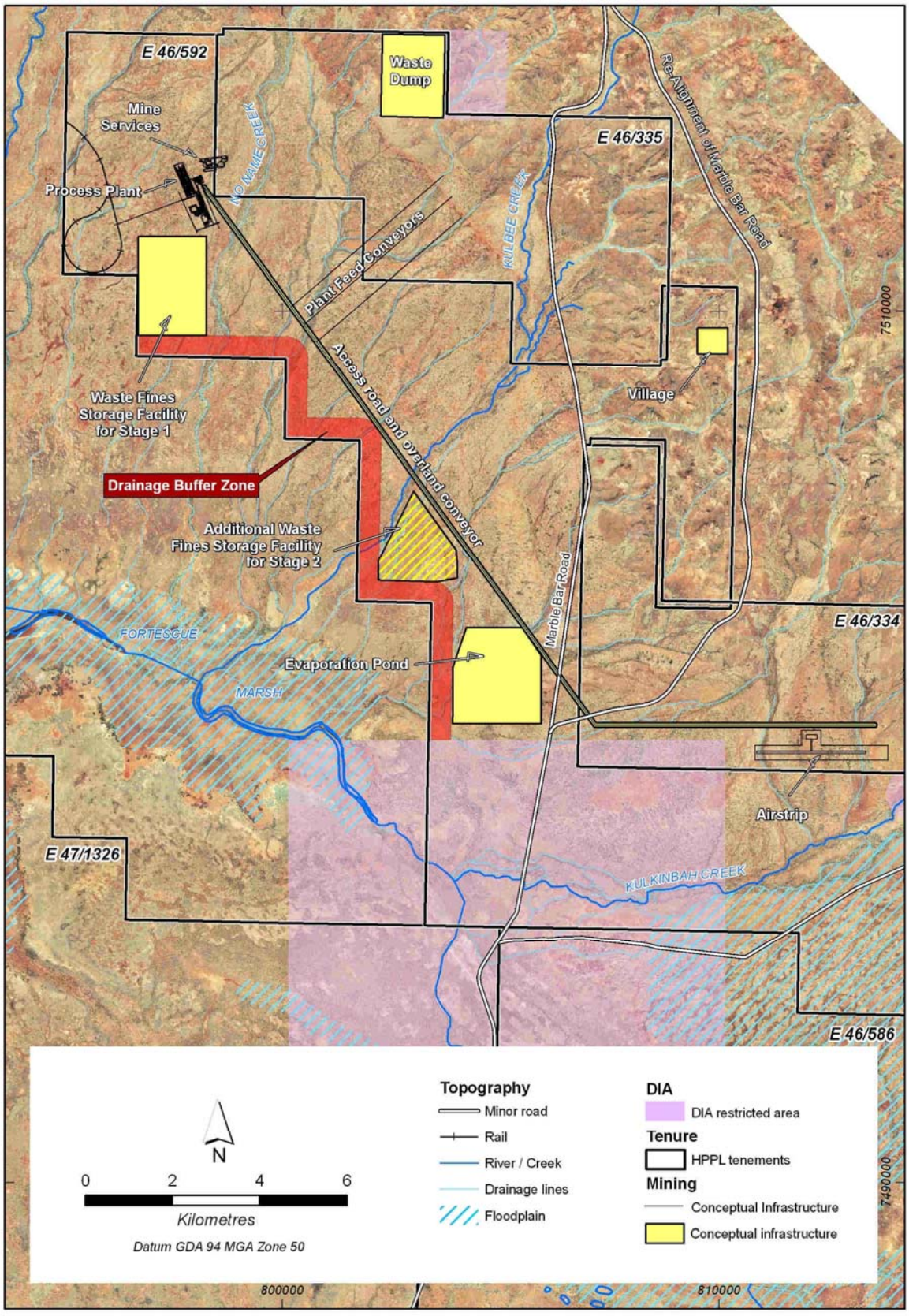

Figure 2-2 Infrastructure of HPPL Roy Hill Mine Site

2.2 SURVEY OBJECTIVES

HPPL commissioned ecologia Environment (ecologia) to undertake a baseline biological survey of the invertebrate fauna of the Roy Hill 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 Short Range Endemic terrestrial invertebrate fauna; and
- protect Specially Protected (Threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

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

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

- A review of background information (including literature and database searches);
- An inventory of Short Range Endemic (short-range endemic) fauna species occurring in the study area, incorporating recent published and unpublished records;
- An inventory of species of biological and conservation significance recorded or likely to occur within the project area and surrounds;
- A review of regional and biogeographical significance, including the conservation status of species recorded in the project area; and
- A risk assessment to determine likely impacts of threatening processes on short-range endemic fauna within the study area.

2.3 OVERVIEW OF SHORT RANGE ENDEMISM IN THE EASTERN PILBARA

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 Australia is currently defined as less than 10,000 km^2 (100 km x 100 km) (Harvey 2002). Such taxa are usually invertebrates, as they are more likely to display poor dispersal abilities and display a more defined or restrictive biology that promotes their isolation and eventual speciation. It is important to note that the potential short-range endemic groups listed in this review are not exhaustive, and that invertebrates are historically understudied and in many cases lack formal descriptions. Reliable taxonomic evaluation of these species has begun only relatively recently and thus the availability of literature relevant to short-range endemics is still scarce. It must be also 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.

2.3.1 Processes promoting short range endemism

Short-range endemism is influenced by numerous processes which generally contribute to the isolation of the 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, influence not only the distribution of a taxon, but also the tendency for differentiation and speciation (Ponder *et al.* 2002).

Isolated populations of both plants and animals tend to differentiate both morphologically and genetically as they are influenced by different selective pressures over time. Additionally, a combination of novel mutations and genetic drift promote the accumulation of genetic differences between isolated populations. Conversely, the maintenance of genetic similarity is promoted by a lack of isolation through migration between the populations, 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 as well as geographical barriers to dispersal. Thus, those taxa that exhibit short-range endemism are generally characterised by poor dispersal, low growth rates, low fecundity and reliance on habitat types that are discontinuous (Harvey 2002).

A number of habitats in Australia contain short-range endemics because they are surrounded by geographic barriers. Islands are a classic example, where terrestrial fauna are 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 in comparison to the surrounding landscape.

The historical connections of habitats are also important in determining species distributions and often explain patterns that are otherwise inexplicable by current conditions. Many short-range endemics are considered to be relictual taxa (remnants of species that went extinct elsewhere) and are confined to certain

habitats, and in some cases, single geographic areas (Main 1996). Relictual taxa include species from as long ago as Gondwanan periods (180-65 million years ago) and have a very restrictive biology (Harvey 2002).

In Western Australia, relictual taxa generally occur in fragmented populations, from lineages reaching back to historically wetter periods. For example, during the Miocene period (from 25 million to 13 million years ago), the aridification of Australia resulted in the contraction of many areas of moist habitat and the fragmentation of populations of fauna occurring in these areas (Hill 1994). With the onset of progressively dryer and more seasonal climatic conditions since this time, 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, which are further restricted by their low dispersal powers typical for all short-range endemic species.

2.3.2 Current knowledge of the Short Range Endemic species in Roy Hill and the Eastern Pilbara Region of Western Australia

Groups or organisms which display short range endemism include (but are not limited to) molluscs (e.g. Camaenid land snails), onychophorans (velvet worms), millipedes, some arachnids (scorpions, pseudoscorpions and schizomids) and some crustaceans (isopods) (Table 1,Table 2) (Harvey 2002). Generally, however, the current state of knowledge on short-range endemism of particular species in Australia, and the Pilbara region, is relatively poor. The paucity of targeted collections makes assessing the likely occurrence and the distribution of short-range endemic fauna very difficult. In such circumstances a habitat-assessment based approach may be used where habitats are assessed for features indicative of preferred SRE habitat i.e island habitats, south-facing slopes, areas that retain moisture etc.

Two previous surveys for short-range endemics have been undertaken at Roy Hill by ecologia (2006, 2008). Potential short-range endemic species were identified from the surveys (Table 1). Ecologia also conducted an intensive foraging survey to determine if suitable habitat was present that could support trapdoor spiders (Mygalomorphae). The survey detected a single sub-adult specimen of *Conothele*: however, this could not be identified to species level as this requires adult specimens.

Table 1 Species Of Conservation Significance Previously Recorded At Roy Hill

Order	Family	Species
SCORPIONES	Urodacidae	*Uradacus* sp.
	Buthidae	*Lychas* sp.
ISOPODA	Philoscidae	*Laevophiloscia* sp.
GEOPHILOMORPHA	unknown	Unknown
SCOLOPENDROMORPHA	Cryptopidae	*Cryptops* 'spinipes'
MYGALOMORPHAE	Ctenizidae	*Conothele* sp.

Table 2 Western Australian Museum Database Search For Primary Arachnids, Myriapods And Mollusc Orders Containing Short-Range Endemics.*

TAXON	FAMILY	Identification
Mygalomorphae (Trapdoor Spiders)	Barychelidae	*Synothele* sp.
		Synothele 'cloudbreak'
		Synothele karara Raven
		Synothele sp 3
		Aurecocrypta 'chichester'
		Aurecocrypta 'chittering'
		Aurecocrypta katersi Raven
	Ctenizidae	*Conothele* sp.
	Dipluridae	*Cethegus* 'cloudbreak'
	Idiopidae	*Anidiops* sp.
		Aganippe sp.
		Aganippe 'cloudbreak'
		Aganippe ?occidentalis Hogg
	Nemesiidae	Gen. sp. undetermined
		?*Aname* sp.
		Aname 'biota'
		Aname sp.
		Teyl sp.
Pseudoscorpiones (Pseudoscorpions)	Atemnidae	*Paratemnoides* sp.
		Oratemnus sp.
	Chernetidae	*Haplochernes* sp.
		Haplochernes sp.1
		Haplochernes sp.2
		cf *Cordylochernes dingo* Harvey
	Chthoniidae	*Tyrannochthonius aridus* Edward & Harvey
		Lagynochthonius 'packsaddle'
		Austrochthonius sp.
	Garypidae	*Synsphyronus heptatrichus* Harvey
		Synsphyronus gracilis Harvey
		Synsphyronus sp.8/1
		Synsphyronus sp.8/2
		Synsphyronus sp.
	Olpiidae	*Austrohorus* sp.
		Beierolpium sp.1
		Beierolpium sp.8/3
		Beierolpium sp.8/4 small
		Beierolpium sp.
		Indolpium sp.
		Euryolpium sp.
		Xenolpium sp.1
		Xenolpium sp.2
	Sternophoridae	*Afrosternophorus* sp.
		Afrosternophorus sp.1
Scorpiones (Scorpions)	Buthidae	*Lychas* 'gracilimanus'
		Lychas 'prendinii'
		Lychas 'marandoo'
	Urodacidae	*Urodacus* sp.4
		Urodacus 'cloudbreak'
		cf Urodacus armatus Pocock
Polydesmida (Polydesmid Millipedes)	Paradoxosomatidae	*?Antichiropus* sp.
		Antichiropus sp.
		Antichiropus 'area C'
		Antichiropus 'chichester'
Mollusca: Pulmonata (Land Snails)	Bulimulidae	*Bothriembryon spp.*
	Camaenidae	*Quistrachia* sp.
		Rhagada richardsoni
		Rhagada sp.

* not all species listed here are short-range endemics

2.4 CLIMATE

Roy Hill is situated in the Pilbara region of Western Australia and experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Annual evaporation exceeds rainfall by as much as 500 mm per year. Seasonally low but unreliable rainfall, together with high temperatures and high diurnal temperature variations are also characteristic climatic features of the region. This region has experienced no rainfall in any month of the year in the past, which is typical of a desert climate (Beard 1975). Within the Pilbara, the temperature range is large and maxima are high. Summer temperatures may reach as high as 46°C at Newman, with a mean maximum of 39.3 (Table 3). Light frosts occasionally occur during July and August. The climate experienced throughout the year is usually very dry since high temperature and humidity seldom occur simultaneously.

The Newman Aero Bureau of Meteorology Weather station is nearest to Roy Hill, located ca.87km SSW of Roy Hill (23°21'29.07"S, 119°44'6.08"E). Weather data are presented for the Newman area and while these will not be identical to those at Roy Hill, it is proximal enough to Roy Hill for general patters applicable to Roy Hill.

Table 3 Summary Of Climatic Data For Newman Aero Weather Station. Records Obtained From The Australian Bureau Of Meteorology,. Rainfall In mm And Temperature In °C.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Monthly Records 1996-2009												
Rainfall	58.5	81.2	39.5	18.4	18.5	15.0	15.7	8.2	3.6	5.0	8.9	39.5
Temp. Max.	39.3	36.6	34.8	31.4	27.3	22.9	23.0	25.6	30.5	34.9	37.5	38.8
Temp. Min.	24.8	23.7	21.3	17.1	11.6	6.3	5.7	7.3	11.9	17.1	20.6	23.5
Records for 2009												
Total Rainfall	39.0	42.2	122.8	8.2	0.0	39.2						
Average daily Temp. Max.	41.5	38.9	35.7	31.7	26.2	23.0						
Average daily Temp. Min.	26.8	26.5	20.7	17.8	11.1	8.7						

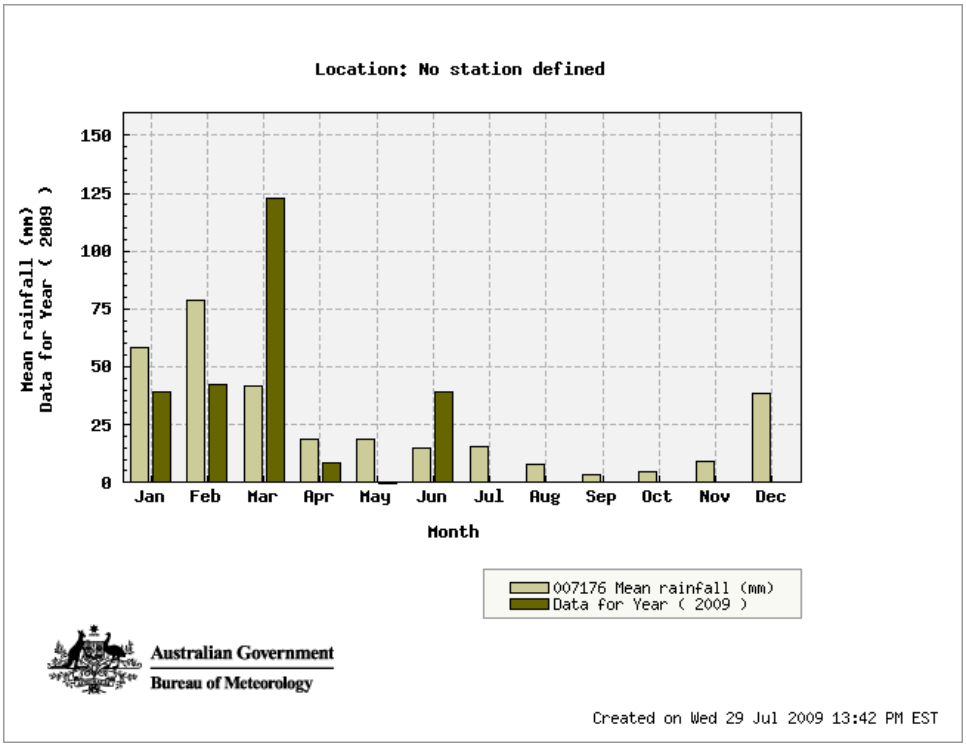

Figure 2-3 Newman Aero Weather Summary: Average Monthly Maximum And Minimum Rainfall Plotted With The Sampling Month Totals For 2009. Data From Australian Bureau Of Meteorology: http://www.bom.gov.au/climate/averages.

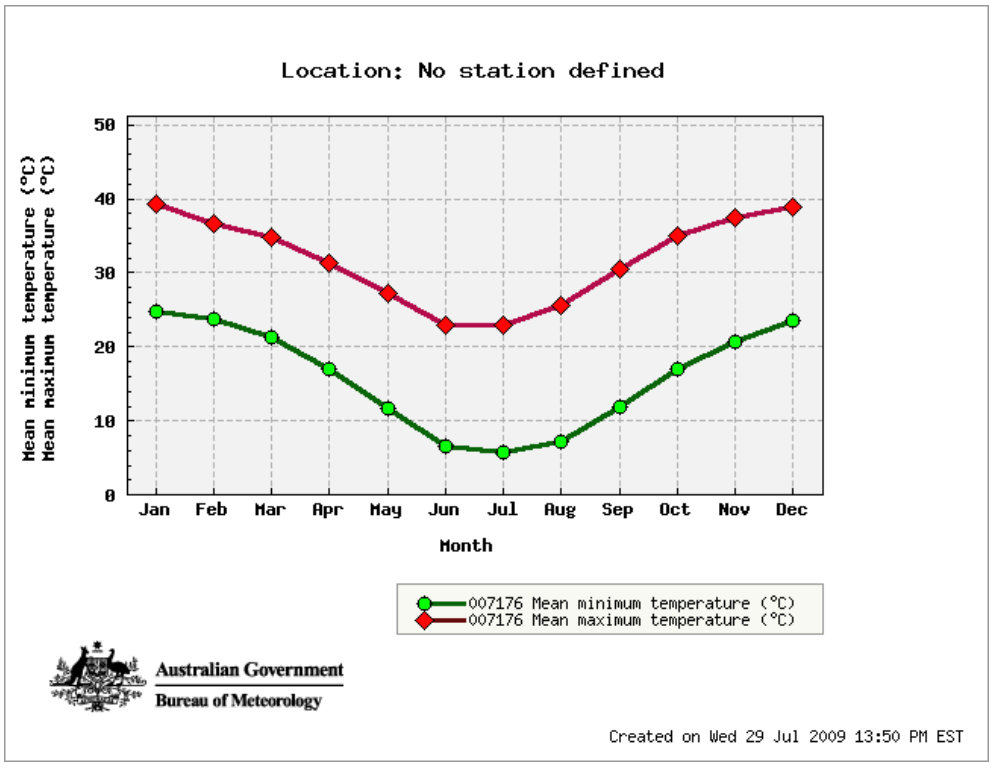

Figure 2-4 Newman Aero Weather Summary: Average Monthly Maximum And Minimum Temperatures. Data From Australian Bureau of Meteorology: http://www.bom.gov.au/climate/averages

2.5 BIOGEOGRAPHY

A biogeographic regionalisation of Australia, the Interim Biogeographic Regionalisation for Australia (IBRA), has been collaboratively developed by all Australian nature conservation agencies and continues to be refined as more detailed information becomes available. (DEWHA 2008). IBRA represents a landscape-based approach to classifying the land surface of Australia, in which bioregions (broad scale regionalisation) are formally recognised and mapped. Biogeographic regions are defined on the basis of climate, geology, landforms, vegetation and fauna. IBRA delineates 85 biogeographic regions, with 403 subregions, each reflecting a unifying set of major environmental influences which shape the occurrence of flora and fauna and their interaction with the physical environment across Australia (Thackway *et al.* 1995a; DEWHA 2008). Subregions are more localised and homogeneous geomorphological units within each bioregion. Western Australia encompasses 26 IBRA bioregions and 53 subregions, each affected by a range of different threatening processes and with varying levels of sensitivity to impact (DEC 2002). The Environmental Protection Authority (EPA) utilises IBRA regions and subregions as the largest unit for EIA decision-making in relation to the conservation of biodiversity (EPA 2002).

The project is based in the Pilbara (PIL) biogeographic region (Figure 2-5) of the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway *et al.* 1995b). There are four major geological components of the Pilbara bioregion: The Hamersley Range is a mountainous area of Proterozoic (545-2500 million years ago) sedimentary ranges and plateaux; the Fortescue Plains consists of alluvial plains and river frontages; the Chichester range comprises Archaean (2500+ million years ago) granite and basalt plains; and the Roebourne consists of Quaternary (less than 10 million years ago) alluvial plains.

The Roy Hill project area falls within the Fortescue subregion at the foot-slope of the Chichester Range (Chichester subregion)(Figure 2-5). Both sub regions contain small areas of national parks. The Chichester subregion contains the Millstream-Chichester National Park and Mungaroona nature reserve. The total reserved area of the Chichester is 6.56%. The Fortescue subregion contains portions of the Millstream-Chichester and Karijini national parks. The total reserved area of Fortescue Plains is 0.79%. The areas of national parks are located on the western sections of both sub regions, not directly involved with the Roy Hill project area. The Fortescue Marsh itself is recognized as a wetland of national significance (DIWA listings). A threatening process of the system is identified by its changed hydrology and therefore, the Roy Hill project work up flow of the marsh may have possible implications upon the hydrology.

The Chichester subregion area is 9,044,560 ha. It is the northern section of the Pilbrara Craton. It features Archaean granite and basalt plains including significant basaltic ranges. The plains support a shrub steppe characterised by *Acacia inaequillatera* over *Triadia wiseana* hummocks grasslands. *Eucalyptus leucaphloia* tree steppes occur on the ranges.

The Fortescue subregion is 2,041,914 ha. It consists of alluvial plains characterised by salt marsh, mulga-bunch grass and short grass communities. Drainage lines are fringed by Rivergum woodlands. Permanent water springs in the central Fortescue are fed by an extensive calcrete aquifer supporting large permanent wetlands.

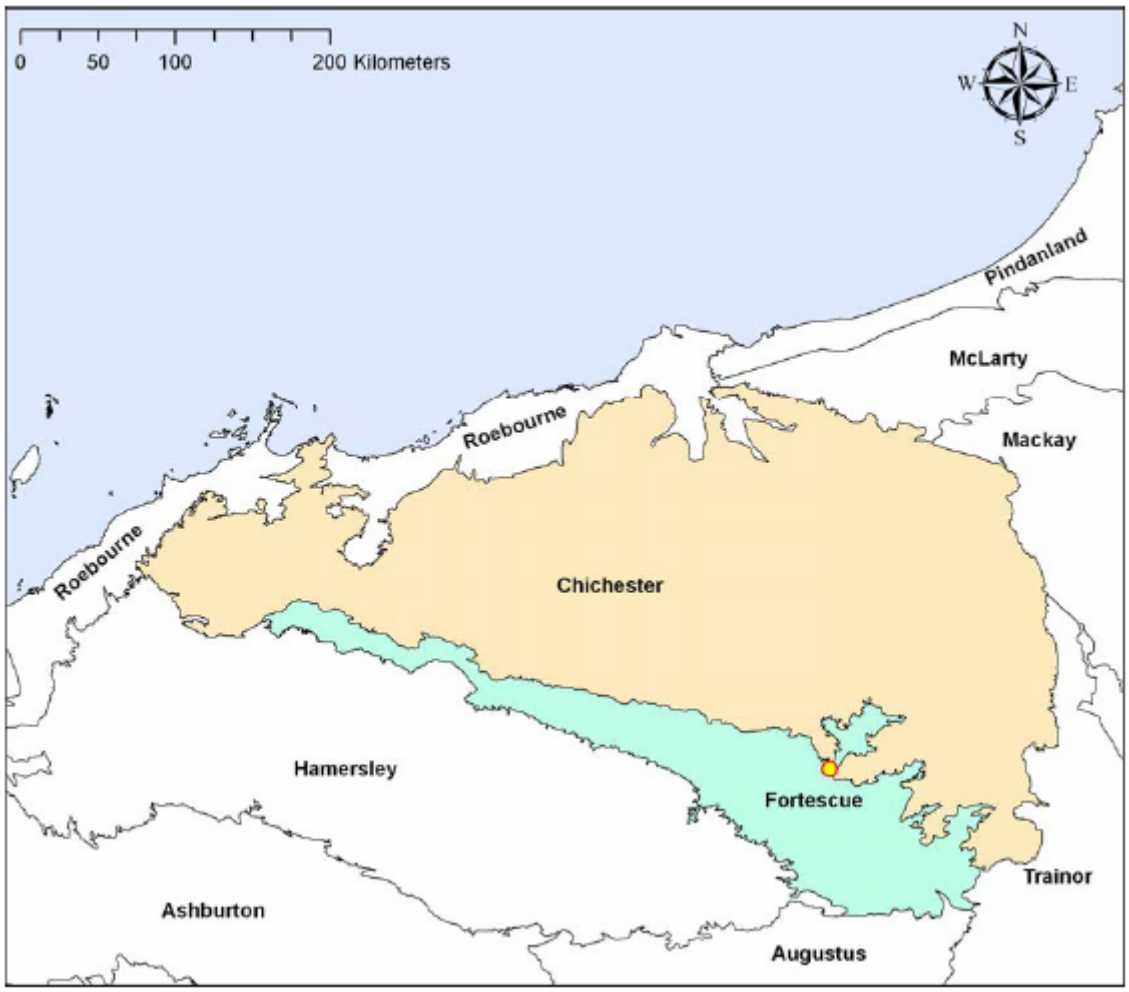

Figure 2-5 Map Of The Pilbara Region Of Western Australia: Indicating The Pilbara IBRA Subregions; The Location Of Roy Hill Indicated With A Circle And Its Position Relative To The Fortescue And Chichester Subregions (shaded).

3.0 METHODS

The survey methods adopted here have been developed in consultation with senior WAM and DEC staff and other local experts. Prior to the completion of the field work for this survey, the Environmental Protection Authority's Guidance Statement No. 56 (EPA 2004) and Position Statement 3 (EPA 2002), provide the only direction for undertaking of short-range endemic surveys, and neither provide specific instructions on the expected design of short-range endemic surveys. Thus the temporal and spatial replication attained with the effort achieved through foraging activities, is at the discretion of the environmental consultant conducting the short-range endemic survey. Subsequent to the completion of field and laboratory work for this survey, the EPA published *Guidence Statement No. 20* for the survey of short range endemic invertebrates (EPA 2009b).

3.1 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

Prior to the development of survey methods, a review of factors likely to influence survey design was undertaken.

3.2 TIMING

The survey was conducted after the wet season between May 2009 and July 2009. Pitfall traps were set up 22-28th May and were collected 15–20th July. They were left out for a total of 54 days.

3.3 SITE SELECTION

Short-range endemic invertebrate taxa are generally found in microhabitats and thus such habitats are the focus of the survey effort while broad scale habitats are largely ignored (discussed in detail at Section 1.3.1). Microhabitats may be any areas that act to maintain the level of moisture in the environment, such as 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.

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

3.4 SAMPLING METHODS

The survey was undertaken using a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data methodically 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 4.

Table 4 Summary Of Survey Effort

SITE	PERSON HOURS FORAGING	NUMBER OF PITFALL TRAPS
1106-01	1.0	10
1106-02	1.0	10
1106-03	1.0	10
1106-04	1.0	10
1106-05	1.0	10
1106-06*	3.0	10
1106-07*	3.0	10
1106-08*	3.0	10
1106-09*	3.0	10
1106-10a	1.0	5
1106-10b*	3.0	5
1106-11	2.0	-
1106-12*	3.0	10
1106-13	1.0	10
1106-14	1.0	10
1106-15*	3.0	10
1106-16*	3.0	10
TOTAL	**33 person hours**	**160 pitfall traps**

* Foraging conducted during Phase one (1 person) and during Phase Two (2 persons)

3.4.1 Wet pitfall trapping

Pitfall traps (containing 30% Ethylene Glycol and 5% Formaldehyde) were set for two successive months; May-July. Traps consisted of a PVC tube (25cm long) dug into the ground so that the surface was flush with the ground level. A receptacle (containing 700 ml of pitfall trapping solution) and funnel (fitting flush to the inside of the pitfall trap) were deployed into each tube and a cover was fitted 3 cm above the tube with steel fittings to exclude medium sized vertebrates and rain, and to deter larger vertebrates. Traps were cleared after 54 days. Each trap was active for 54 days.

3.4.2 Foraging

These searches were undertaken during trap servicing trips. Foraging consisted entirely of sifting with the aid of nested Geo-sieves of graded sieves: ¼"; 1/8"; 1/16"; 1/32". Leaf litter accumulating at the base of large Mulga and Eucalypt trees was sifted. Sand was also sifted from underneath shady trees as well as spinifex clumps with the aim of detecting buried snails and/or millipedes.

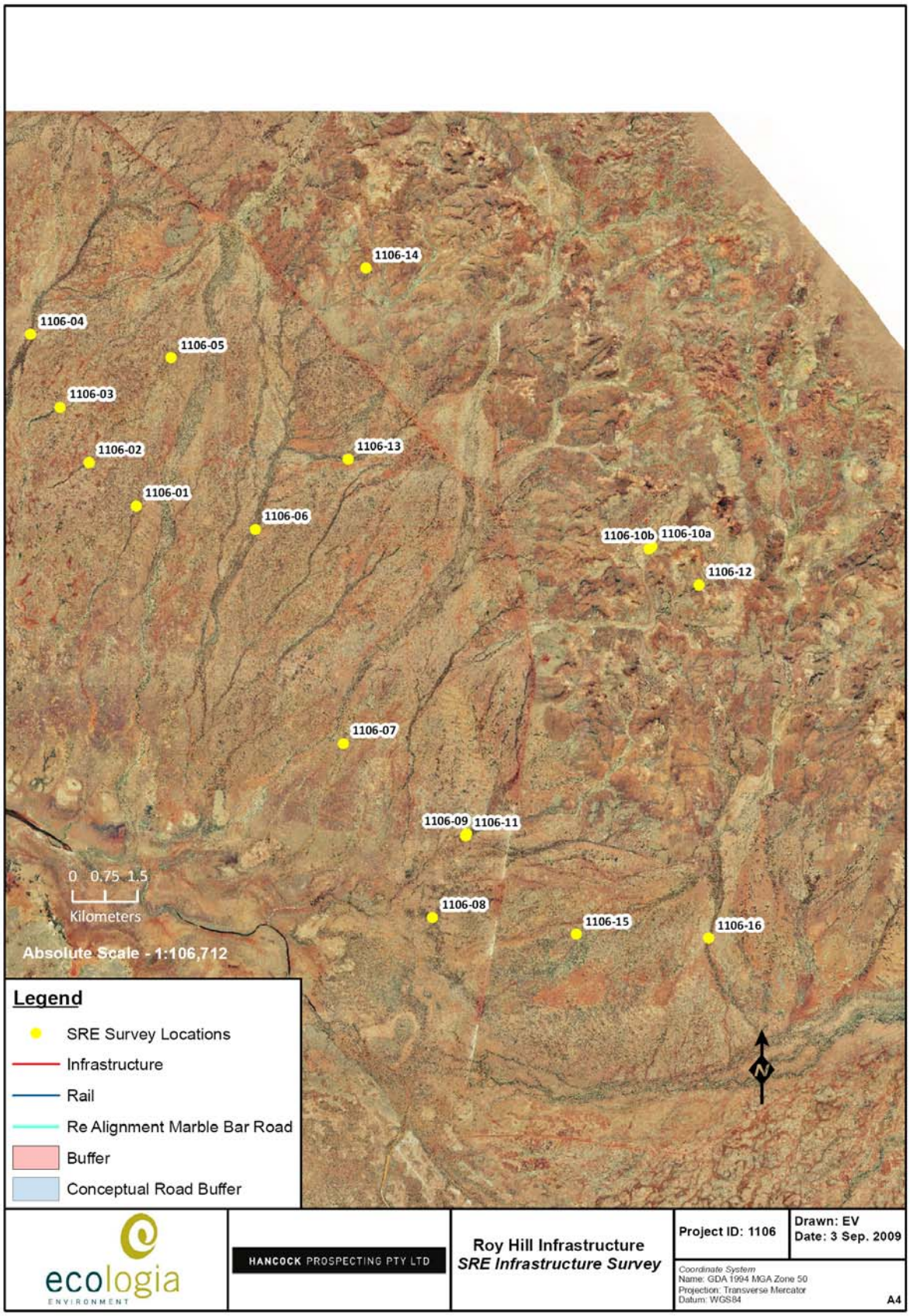

Figure 3-1 Map Of Tenement Area Indicating Survey Sites (yellow circles).

3.5 TAXONOMY AND NOMENCLATURE

Table 5 Taxonomic Experts Used For Invertebrate Identification And SRE Status

Group	Person	Institution
Pseudoscorpions and Araneomorphs	Dr Mark S Harvey & Volker Framenau	WA Museum
Millipedes (Diplopoda)	Dr Mark S Harvey	WA Museum
Land Snails (Mollusca)	Dr Shirley Slack-Smith, Corey Whisson	WA Museum
Isopods (slaters)	Dr Simon Judd	Edith Cowan University
Scorpions (Scorpiones)	Dr Erich S Volschenk	ecologia Environment

3.6 SURVEY TEAM

The *ecologia* staff involved in planning, coordination and execution of this survey are listed in Table 6.

Table 6 Ecologia Staff Involved With Survey Effort

Name	Qualifications	Position
Erich Volschenk	PhD	Senior Invertebrate Zoologist
Lazaro Roque-Albelo	PhD	Senior Invertebrate Zoologist
Sean White	BSc. Environmental Biology	Invertebrate Zoologist
Catherine Taylor	BSc. Hons (Biology)	Invertebrate Zoologist
Marieke Weerheim	BSc.Hons (Biology)	Vertebrate Zoologist (casual)

4.0 RESULTS

Findings of this survey are summarised in Table 7. Many of the taxa are currently being identified and SRE status determined by their relevant specialists (Table 6).

Table 7 Results Of The Roy Hill Short-range Endemic Invertebrate Survey.

Grey text indicates incomplete identifications and dashes represent undetermined identifications.

Taxa					Sites - Pitfall Traps and Foraging															
Taxon	**Family**	**Genus**	**Species**	**SRE Status**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10a**	**10b**	**11**	**12**	**13**	**14**	**15**	**16**
Araneae (Mygalomorphae)	-	-	-	Unlikely				1			1		2					1		1	1
	Barychelidae	-	-	Unlikely					1				1	1							
Pseudoscorpiones	-	-	-	-		1		1	1	6	2		1	1	1	1	4	6	6	2	2
	Olpiidae	-	-	-	1	9	2	2		4			3	2			5				
Scorpiones	Urodacidae	*Urodacus*	sp.	Unlikely																	1
	Buthidae	*Lychas*	'harveyi'	Not				1		1			1								
		Lychas	'bituberculatus'	Not																	1
Chilopoda (Scolopendrida)	Scolopendridae	-	-	Not		1			1	1			1			1	2		1		
Geophilomorpha	-	-	-	Unlikely												1					
Diplopoda (Polyxenida)	Polyxenidae	-	-	Not									1				5				
Gastropoda (Pulmonata)	Pupilidae (and others?)	-	-	Not	23	10				94						1	4	33	9	22	7
	Camaenidae?	-	-	Unlikely												1					
Isopoda	Armadillidae?	-	-	Unlikely	3	19		2	2	2	5	16	16	3			1	1			2

4.1 ARACHNIDS (PHYLUM: ATHROPODA; SUB CLASS ARACHNIDA)

4.1.1 Spiders (Order Araneae)

4.1.1.1 Trap-door Spiders: Infraorder Mygalomorphae

Identifications of the Trapdoor spiders has commenced and initial reports suggest that there are no SRE species amongst the samples (pers. com. V.W. Framenau, WAM)

4.1.2 **Pseudoscorpions**: Order **Pseudoscorpiones**

***Beierolpium* 'sp. 8/2' and 'sp 8/4 small' (family Olpiidae)**

In previous SRE surveys within the Fortescue Plain, ecologia (unpublished data) has encountered three families of pseudoscorpion, Atemnidae, Olpiidae and Chernetidae. Of these species, only two members of the family Olpiide have been flagged as having SRE potential. Both are undescribed species belonging to the genus *Beierolpium*. The systematic status of members of this genus in the Pilbara has not been fully assessed. At present it is not possible to firmly establish the identity of the species until a complete systematic revision of the Western Australian members of *Beierolpium* is undertaken. A full taxonomic revision of the genus *Beierolpium* is needed in the Pilbara and other regions of WA to confirm their status (pers. com. V.W. Framenau and M.S. Harvey, WAM).

4.1.3 **Scorpions:** Order **Scorpiones C.L. Koch**

***Urodacus* sp (family Urodacidae)**

A single juvenile specimen of burrowing scorpion was collected from site 16. The immature state of the specimen makes identification impossible, adult males are needed for identification. This species is unlikely to be restricted given that site 16 does not stand out as an island habitat.

***Lychas* L Koch 1845 (family Buthidae)**

Two different species of the genus *Lychas* were encountered during this survey: *Lychas* 'harveyi' from sites 4, 6 and 9; and *Lychas* 'bituberculatus' from site16. Both species are commonly collected in Pilbara surveys and are not considered to be SRE's (Volschenk, unpublished data).

4.2 CRUSTACEANS (PHYLUM ATHROPODA, SUBCLASS CRUSTACEA)

4.2.1 **Slaters:** Order **Isopoda**

***Buddelundia* spp. (family Armadillidae) and *Laevophiloscia* sp. (Phyloscidae)**

The most commonly recorded isopods which ecologia has encountered within the Pilbara are two undescribed species in the genus *Buddelundia* (sp1 and sp2). In a previous study at Roy Hill a species of *Laevophiloscia* was also recorded.

Buddelundia sp1 is a common species found throughout arid Western Australia and is not considered a short-range endemic species. *Buddelundia* sp2 is only known from the Pilbara where it has been widely recorded, and is not considered to represent a short range endemic species (pers. com. Simon Judd).

4.3 CENTIPEDES AND MILLIPEDES (PHYLUM ARTHROPODA, SUBCLASS MYRIAPODA)

4.3.1 Centipedes: Class Chilopoda

Scolopendrida (family Scolopendridae)

Numerous centipedes were collected during this survey (Table 7); however, most species belong to the family Scolopendridae, which is not known to contain short-range endemic species in the Pilbara. (pers. com. V.W. Framenau and M.S. Harvey, WAM).

Geophilomorpha (family Geophilomorphae)

A single specimen was collected from site 11 (Table 7). The centipede order Geophilomorpha is known to be the most diverse of the centipede orders and is likely to contain SRE species. The taxonomy and systematics of the Australian Geophilomorpha is very poorly known (V.W. Framenau and M.S. Harvey, WAM,) therefore determination of SRE likelihood is based on the nature of the habitat in which it was collected. None of the sites surveyed represents obvious SRE habitat.

4.3.2 Millipedes: Class Diplopoda

This survey found no representatives of the class considered to be SRE species. The only Diplopods collected on this survey were representatives of the class Polyxenida (family Polyxenidae), commonly referred to as pincushion millipedes (Harvey et al. 1989; Brusca et al. 2003). These tiny millipedes are not considered to represent SRE's species.

4.4 MOLLUSCS (PHYLUM: MOLLUSCA)

4.4.1 Order Pulmonata (Land Snails)

Pupillidae and Subulinidae

In the Pilbara, *ecologia* (unpublished data) routinely encounters two different types of snails in our surveys. Both families Pupillidae and Subulinidae, are comprised of small sized snails living in soil and leaf litter. These will almost certainly have been captured in the present survey (Table 7), however none of the species are thought to represent SRE's (S. Slack-Smith and C. Whisson, WAM, pers. com.).

Camaenidae

One specimen from site 11 (Table 7) was tentatively identified to the family Camaenidae and it may represent a SRE species. Little more can be extrapolated from this information until species identification and SRE assessment is made by the WAM. Tentative determination of SRE likelihood is based on the nature of the habitat in which it was collected. None of the sites surveyed represents obvious SRE habitat; therefore, its SRE status seems unlikely.

4.5 REPORT LIMITATIONS

This report is submitted as an interim report to provide the EPA Service Unit (EPA SU) with additional data for their assessment of the Roy Hill project. There are some taxanomic identifications that are currently being completed. A final report will be produced on the receipt of the remaining identifications.

The 2009 SRE survey was undertaken with the aim of documenting the presence and diversity of species in the region of the Roy Hill project area. All major survey aspects including: timing, numbers of foraging sites and foraging methods used, were developed in consultation with the DEC.

Although the Guidance Statement No. 20 (EPA 2009a) was released subsequent to the completion of this survey work, this survey complies with methodologies and practices outlined within the document.

5.0 DISCUSSION

Interpretation of these survey results are based on the identifications and SRE determinations available to date (Table 7) and an assessment of the habitat potential within the project area. Many of the survey sites have been very heavily impacted on by cattle and introduced weeds. Habitat assessment of the areas proposed for impact suggests no indication of island habitats, and these sites represent vegetation types that are well represented throughout Fortescue Plain. For this reason the likelihood of this project impacting on SRE's appears very low.

6.0 IMPACT ASSESSMENT

6.1 THREATENING PROCESSES

The proposed infrastructure is unlikely to have a direct impact on SRE's as the areas selected for this development do not appear conducive to supporting SRE's. Activities and infrastructure associated with the proposed development may have indirect threatening processes to the habitat:

- Dust, resulting from nearby (within 100 meters) infrastructure construction and/or operations, particularly unsealed roads.
- Desiccation/flooding: resulting from construction altering flow of rainwater.
- Fire, increased frequency of bush-fire resulting from human activities. Indirectly the incidence of fire can increase as a result of altered vegetation structure and/or community following the effects of dust and/or introduction of weeds.

7.0 MANAGEMENT RECOMMENDATIONS

In the absence of a complete set of identifications, the risk assessment of SREs potential within the project area becomes habitat focussed. None of the habitats in which infrastructure is proposed shows obvious signs of being Island habitats, nor are they placed near obvious Island Habitats. For this reason, the infrastructure locations are not likely to support SRE's.

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Appendix 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 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 August 5th 2008.

Appendix 2

Survey Locations and Descriptions

Site Code:- 1106-01
Co-ordinates: -23.0025N, 119.1321E

Habitat: Floodplain
Vegetation: Moderate tree abundance, Mulga dominant.
Litter: Leaf-litter concentrated in drifts, 1-5cm deep.
Soil: Red, brown clay.

Site Code:- 1106-02
Co-ordinates: -22.4811N, 119.8844E

Habitat: Floodplain
Vegetation: widespread, Acacia dominant (not Mulga).
Litter: Leaf-litter sparse, congregated under trees, approx.1-5cm deep.
Soil: Red-brown Clay. Slight cracking; Surface crust; Fine gravel; Corse Gravel

Site Code:- 1106-03
Co-ordinates: -22.4698N, 119.8778E

Habitat: Floodplain
Vegetation: Moderately abundant trees, Casuarina dominant. Sparse shrubs but abundant herbs.
Litter: Leaf-litter sparse, approx.1cm deep.
Soil: Red-brown Clay, deeply cracked; corse gravel; rocks and boulders.

Site Code:- 1106-04
Co-ordinates: -22.4548N, 119.8709E

Habitat: Creek bank on Plain.
Vegetation: moderate distribution, Mulga dominant. Sparse shrubs and herbs.
Litter: Leaf-litter concentrated in drifts. Approx.1-5cm deep.
Soil: Red- brown clay. Slight cracking; Surface crust; Corse Gravel

Site Code:- 1106-05
Co-ordinates: -22.4591N 119.9023E

Habitat: Plain
Vegetation: moderate distribution, Mulga dominant. Spinifex dominant, Sparse shrubs, abundant herbs.
Litter: Leaf-litter widespread. Concentratedin drifts, approx.1cm deep.
Soil: Red-brown clay with corse gravel.

Site Code:- 1038-06
Co-ordinates: -22.4943N 119.9217E

Habitat: Minor channel on a Plain.
Vegetation: moderate tree distribution, Mulga dominant. Sparse shrubs and herbs.
Litter: Leaf-litter concentrated under shrubs, 1-5cm deep.
Soil: Red-brown clay with corse gravel.

Site Code:- 1106-07
Co-ordinates: -22.5383N, 119.9424E

Habitat: Minor Channel on a Plain.
Vegetation: sparse distribution,Mulga dominant. Sparse shrubs and herbs.
Litter: not recorded.
Soil: Red-brown clay, slight cracking; surface crust; corse Gravel.

Site Code:- 1106-08
Co-ordinates: -22.574N, 119.9631E

Habitat: Minor channel on a plain.
Vegetation: abundant distribution, Mulga dominant. Sparse herbs and shrubs.
Litter: Leaf litter sparse, concentrated under shrubs, <1 cm deep.
Soil: Red-brown loam, Deeply cracked; Slight cracking; Surface crust; Corse Gravel.

Site Code:- 1106-09
Co-ordinates: -22.5566N, 119.9703E

Habitat: Creek bank on a plain.
Vegetation: moderate distribution, Mulga dominant. Sparse herbs and shrubs.
Litter: Leaf litter sparse, concentrated under shrubs. Approx 1 - 5cm deep
Soil: Red-brown sandy clay, surface crust, fine gravel.

Site Code:- 1038-10a
Co-ordinates: -22.4962N, 120.0104E

Habitat: Open Plain
Vegetation: Sparse distribution, Eucalypt dominant. Abundant shrubs and sparse herbs. Spinifex abundant.
Litter: Leaf litter negligible, <1cm deep
Soil: Red-brown clay, Surface crust, fine gravel, corse gravel and loose soil

Site Code:- 1038-10b
Co-ordinates: -22.4967N, 120.0096E

Habitat: Open Plain
Vegetation: Sparse distribution, Eucalypt dominant. Moderately abundant shrubs and sparse herbs.
Litter: Leaf litter negligible, <1cm deep.
Soil: Red-brown clay, fine gravel and corse gravel.

Site Code:- 1106-11
Co-ordinates: -22.5569N, 119.9700E

Habitat: Creek bank on a footslope.
Vegetation: Moderate distribution, Eucalypt dominant. Sparse shrubs and herbs.
Litter: not recorded.
Soil: Red-brown clay, deeply cracked, slight cracking, surface crust, fine gravel, corse gravel.

Site Code:- 1106-12
Co-ordinates: -22.504N, 120.0210E

Habitat: Minor channel on a plain.
Vegetation: Moderate distribution, Mulga dominant. Sparse shrubs and abundant herbs.
Litter: Leaf litter concentrated under shrubs and trees, <1cm deep.
Soil: Brown clay and loose soil.

Site Code:- 1038-13
Co-ordinates: -22.4794N, 119.9421E

Habitat: Creek bank on a plain.
Vegetation: Moderate, Mulga dominant. Moderately abundant shrubs and sparse herbs.
Litter: Leaf litter negligible, approx 1cm deep
Soil: Red-brown clay, surface crust, corse gravel.

Site Code:- 1106-14
Co-ordinates: -22.4396N, 119.9453E

Habitat: Gully base on a gentle, S facing slope.
Vegetation: Sparse distrubution, Hakea dominant. Moderately abundant shrubs and sparse herbs.
Litter: Leaf litter concentrated under trees/shrubs, approx. 1-5cm deep.
Soil: Red-brown clay, corse Gravel and Stones/Bolders (continuous rock/boulder cover)

Site Code:- 1106-15
Co-ordinates: -22.5769N, 119.9952E

Habitat: Creek bank on a plain
Vegetation: Moderate distribution, Mulga dominant. Sparse shrubs and herbs.
Litter: Leaf litter sparse, approx >1cm deep.
Soil: Red brown clay, deeply cracked, slight cracking, surface crust, fine gravel, corse gravel.

Site Code:- 1106-16
Co-ordinates: -22.7361N, 119.1852E

Habitat: Creek bank on a steep, SW facing slope
Vegetation: Moderate distribution, Eucalypt dominant. Moderately abundant shrubs and sparse herbs.
Litter: Leaf litter concentrated under shrubs/trees, approx. 1-5cm deep.
Soil: Red-brown loam, loose soil and boulders.