MAY 2013

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RIO TINTO PTY LTD
GREATER WEST ANGELAS
SUBTERRANEAN FAUNA ASSESSMENT

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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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ACRONYMS

AIR	Ashburton Regional Inventory
BIF	Banded Ironstone Formations
DEC	Department of Environment and Conservation
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communit**ies**
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IBRA	Interim Biogeographic Regionalisation for Australia
PIR	Pilbara regional Inventory
RT	Rio Tinto Iron Ore
SCA	Species Accumulation Curve
SRE	Short Range Endemic
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

Rio Tinto (RT) is currently conducting preliminary feasibility studies for the development of ore deposits C, D, D extension, F, G, H and Mt Ella, collectively termed the Greater West Angelas Study Area (the Study Area) located approximately 105 km north west of Newman,, covering a total of 175.65 km^2. The Study Area is situated on RT exploration / mining leases and encompasses the Turee Creek Borefield supplying water to West Angelas Mine.

As part of these investigations, *ecologia* was commissioned to conduct a single-phase subterranean fauna (troglofauna and stygofauna) survey of the Study Area. The baseline data may be supplemented with additional studies in the future. The subterranean survey was conducted in July–October 2012, following a drier than average dry season. The previous wet season (November 2011 – March 2012) however, recorded higher than average rainfall.

A total of 91 RC drill holes were sampled for troglofauna using custom designed leaf litter traps baited with banana. Only twenty two bores (24%) had access to ground water, with the remaining holes above the water table. Traps were positioned approximately 2 meters above water or blockage and left in the ground for ninety one days to ensure troglofauna colonisation. All samples were extracted and sorted in the *ecologia* Perth laboratory. The level of survey adequacy was estimated using species accumulation curves (SACs) as computed by Mao Tau.

A large proportion of the species collected were insects (orders Thysanura, Psocoptera, Hemiptera, Embioptera, Blattodea and Coleoptera), which have not been collected in the West Angelas area or the surrounding region before. The remainder of species recorded comprised of spiders, isopods and scolopendrid centipedes. Six (*Nocticola* sp. indet., *Prethopalpus* sp. indet., *Pseudodiploexochus* sp. nov., *Cormocephalus* CH1003, *Atelurinae* sp., indet., Anillini sp.indet.) of the recorded species are likely to have restricted distribution ranges and four (*Hydrobiomorpha* sp. indet., *Embioptera* sp. indet., Meenoplidae sp. indet., Trogiidae sp. indet.) are potentially restricted. Only spiders of the genus *Prethopalpus* and centipedes from the genus *Cormocephalus* have been recorded previously in the area, with the remaining eight genera/families representing new records. In addition, the spider *Prethopalpus* 'sp indet.' and the isopod *Pseudodiploexochus* 'sp. nov.' (the first ever to be recorded in the Pilbara region) represent new species. The centipede *Cormocephalus* 'HCI003' is the first eyeless scolopendrid specimen recorded to date.

There was little commonality of troglofauna species across different geological units, suggesting potential barriers in habitat connectivity and implying isolated species assemblages. However, this could be an artefact of a small sample size, given the low survey efficiency indicated by species accumulation curves (24%). Drilling and bulldozing occurred in D and D extension deposits during the troglofauna survey, causing vibration and air pressure in subterranean voids, hence possibly affecting capture of troglofauna. Further sampling may assist with a more accurate assessment.

It is recommended that all troglofauna specimens (those already collected as well as any future collections) undergo DNA assessment to ascertain correct species identification and thus their true distribution in the Study Area and its surrounds for future impact assessment. Given that the mafic volcanics and dolerite and gabbros geological units found in the Study Area are completely surrounded by sedimentary rocks, it is likely that species inhabiting them are only found within these island-like, isolated units, especially if further evidence suggests that each geology harbours a different troglofauna assemblage.

Stygofauna sampling consisted of sampling bore holes with modified haul nets to identify potential stygofauna assemblage of the Study Area and measurements of groundwater physico-chemistry to aid defining the aquifer conditions and their suitability for stygofauna.

The survey was limited to four accessible bores in Deposit F, which yielded no stygofauna specimens. Consequently, the stygofauna sampling cannot be considered adequate due to its small sample size and limited spatial coverage. Further sampling is recommended, particularly in deposits C, D, D extension G, and H.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Rio Tinto (RT) requires a series of biological surveys to be undertaken, in order to support assessment of the Greater West Angelas Project (the Project). The Project includes a series of iron ore deposits in the Pilbara region of Western Australia.

RT is currently considering development of ore deposits C, D, D extension, F, G, H and Mt Ella, collectively termed the Greater West Angelas Study Area (the Study Area) located approximately 105 km north west of Newman (Figure 1.1). The Study Area comprises three areas covering a total of 175.65 km^2. The Study Area is situated on RT exploration/mining leases and encompasses the Turee Creek Borefield supplying water to West Angelas Mine. No pastoral leases intersect the Survey Area.

As part of these investigations, *ecologia* Environment (*ecologia*) was commissioned to conduct a single-phase subterranean fauna (troglofauna and stygofauna) survey of the Study Area. This survey will provide baseline data which may be supplemented with additional studies in the future.

1.2 LEGISLATIVE FRAMEWORK

Federal and State legislation applicable to the conservation of native fauna include, but are not limited to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Wildlife Conservation Act 1950* (WC Act) and the *Environmental Protection Act 1986* (EP Act). Section 4a of the EP Act requires that developments take into account the following principles applicable to native fauna:

- The Precautionary Principle

Where there are threats of serious or irreversible damage, a 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.

This document includes background information on the Project and a literature review of the subterranean fauna in reference to the habitats and environments of the Study Area. The conservation significance of the fauna in Western Australia is also outlined.

The document was prepared in order to satisfy the requirements of:

- The EPA Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003); and
- The EPA Guidance Statement No. 54a (Technical Appendix to Guidance Statement no. 54): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007).

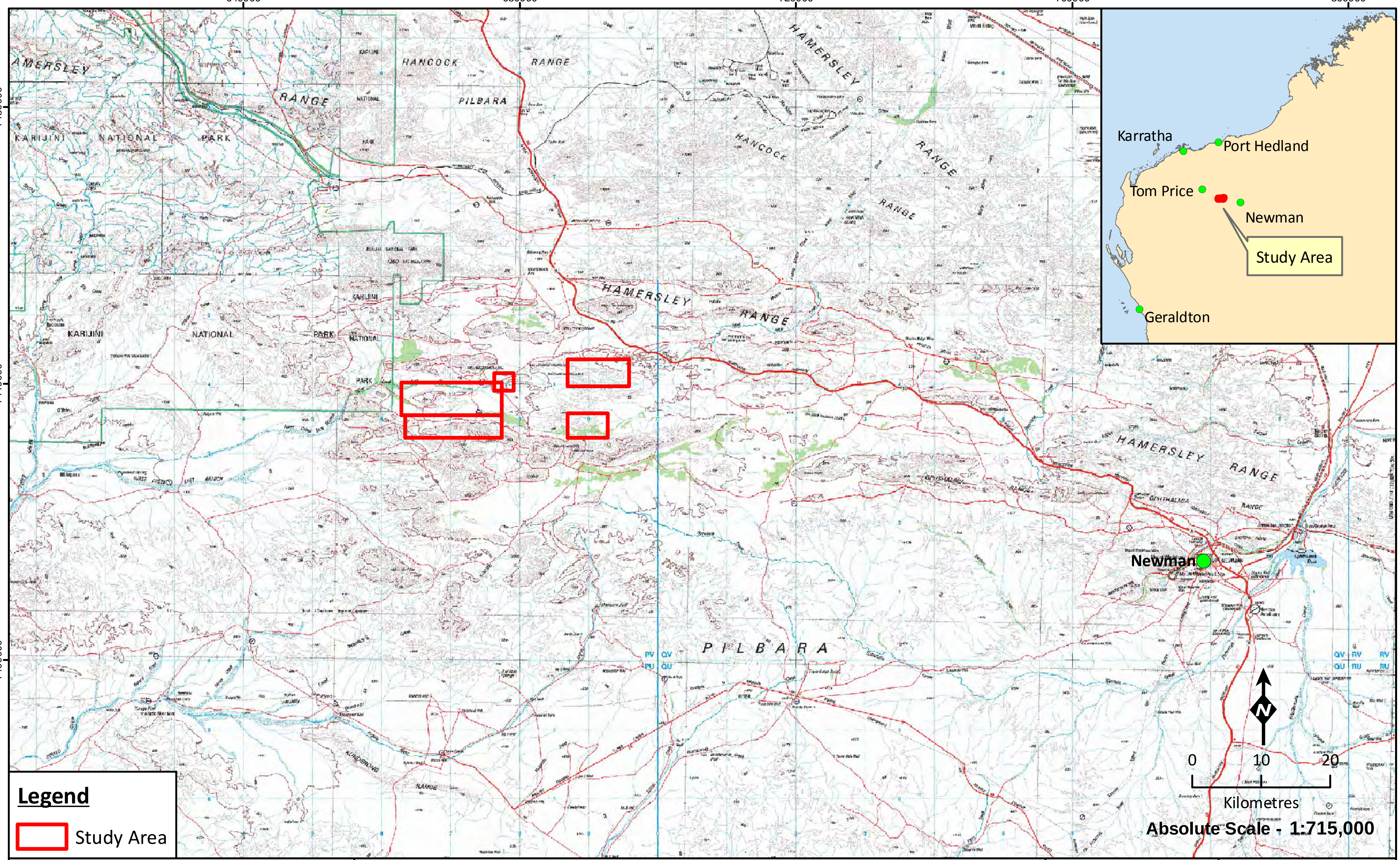
1.3 SURVEY OBJECTIVES

The primary objective of this study was to provide sufficient information to assess the impact of the Project on subterranean fauna in the area in the context of the following EPA objectives:

- Maintain the abundance, species diversity and geographical distribution of subterranean invertebrate fauna; and
- Avoid impacts to Specially Protected (Threatened) fauna, consistent with the provisions of the WC Act.

Specifically, this survey was carried out to satisfy the requirements of the EPA's Guidance Statements 54 and 54a, thus providing:

- A review of background information (including literature and database searches);
- An inventory of subterranean species occurring in the Study Area, incorporating recent published and unpublished records;
- An inventory of conservation significant subterranean fauna recorded or likely to occur within the Study Area and surrounds;
- An assessment of likely habitats that may potentially support subterranean fauna based on geological mapping data as well as bioregion and land system information; and
- An assessment to determine likely impacts of threatening processes on subterranean habitat within the Study Area.



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Location of Study Area

Figure: 1.1
Project ID: 1459

Drawn:BG
Date: 13/02/2013

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

Unique Map ID: BG277

A4

1.4 SUBTERRANEAN FAUNA OVERVIEW

Invertebrate groups dominate the subterranean fauna of Western Australia (WA). Crustacean groups including subterranean representatives are remipedes, ostracods, isopods, copepods, syncarids, amphipods and decapods. Hexapod groups include Blattodea (cockroaches), Orthoptera (crickets), Coleoptera (beetles), Hemiptera (bugs), Thysanura (thrips), Diplura and Collembola (springtails). Subterranean arachnid groups include Aranae (spiders), pseudoscorpions, schizomids, Trombidiformes (mites), Opiliones (harvestmen), and scorpions. Myriapod groups are also represented – diplopods (millipedes) and chiloipods (centipedes). Oligochaete, polychaete and aphanoneuran worms are represented. Two main gastropod groups are known to include subterranean fauna - Neotaeniglossa (family Hydrobiidae) and Basommatophora (family Planorbidae). Stygofauna communities are often dominated by crustaceans whereas troglofauna can include a wide range of taxonomic groups which have adapted to underground life.

Subterranean communities share the following characteristics (from Gilbert and Deharveng 2002):

1. High endemism but low local diversity relative to regional diversity;
2. A relatively small number of genetic lineages resulting in species dissimilar in appearance to related groups;
3. Many relicts from previous climatic conditions; and
4. Truncated food webs.

Traditionally, arid and semi-arid areas were considered poor potential habitat for subterranean fauna as these organisms are moisture-dependent (Harvey *et al.* 2008). However, recent descriptions of subterranean fauna in the arid and semi-arid zone of WA have indicated the presence of a diverse fauna, with an estimate of 4,140 subterranean taxa found in the western half of Australia (Guzik *et al.* 2010).

A total of 403 species have been described to date and additional 367 are known but undescribed (EPA 2012). Based on this estimate, over 80% of the fauna likely to be present have not yet been documented (Guzik *et al*. 2010). Whilst the potential scale for unique diversity of Australian subterranean fauna is not known, a summary of counts (adapted from EPA 2012) and estimates of diversity taken from a series of publications indicate that the Australian (and particularly WA) subterranean fauna is uniquely diverse (Table 1.1).

Table 1.1 – Australian counts and estimates of subterranean fauna diveristy

Country/State/Region	Number of taxa	Count/Estimate	Authors
Australia (whole)	~750	Count	(Humphreys 2008)
Australia – western half	4,140 770	Estimate Count	(Guzik *et al.* 2010)
Australia - NSW	422 (only 84 obligated subterranean)	Count	(Thurgate *et al.* 2001)
Pilbara Region (WA)	78 350 (after Pilbara Biological Survey) 500-550 (ground water species).	Count Count Count	(Eberhard *et al.* 2005a) (DEC 2009) (Eberhard *et al.* 2009)
Carnarvon Basin (WA)	~35	Count	(Humphreys 2008)
Christmas Island	18	Count	(Humphreys and Eberhard 2001)

Subterranean fauna commonly have restricted distributions and are classified as short range endemics (SREs), more so then their surface counterparts. Up to 70% of stygofauna recorded from the Pilbara are regarded as SREs (Eberhard *et al.* 2009). It is thought that the majority of troglofauna are also SRE's, even more so than stygofauna (Lamoreux 2004).

1.5 TROGLOFAUNA OVERVIEW

Troglofauna are communities of terrestrial subterranean animals that inhabit air chambers in underground caves or small, humid voids. They are divided into three ecological categories:

- Troglobites: obligate underground species that are unable to survive outside of the subterranean environment;
- Troglophiles: facultative species that live and reproduce underground but that are also found in similar dark, humid microhabitats on the surface; and,
- Trogloxenes: species that regularly inhabit underground caves and cavities for refuge but normally return to the surface environment to feed.

A fourth group; accidentals, wander into cave systems but cannot survive there (Howarth 1983).

A species is considered truly troglobitic if it displays morphological characteristics that appear to restrict it to subterranean habitats (Howarth 1983). These include a significant reduction or a complete loss of eyes, pigmentation andwings, as well as development of elongated appendages, slender body form and, in some species, a lower metabolism. Behavioural adaptations such as lack of a circadian rhythm (24-hour biological cycle) are also characteristic of true troglobites.

Troglobitic faunal assemblages are dominated by arthropods such as schizomids, pseudoscorpions, spiders, harvestmen, centipedes, millipedes, diplurans and mites. Many species are relict rainforest litter fauna from previous tropical climate eras (Humphreys 1993a) and therefore depend on subterranean habitats that are constantly humid.

The food resources for subterranean ecosystems are largely allochthonous (not formed in the region where found) and carried into caves and cavities by plant roots, water and animals (Howarth 1983).

True troglobites are incapable of dispersing on the surface and thus are subject to dispersal barriers due to geological structure of their habitat. Such dispersal limitations result in extremely small, fragmented species ranges and thus high levels of endemism (EPA 2003), which is characteristic of subterranean fauna worldwide (Strayer 1994). Examples include the millipede *Stygiochiropus peculiaris*, which is restricted to a single cave system at Cape Range (Humphreys and Shear 1993). Genetic analyses of some troglobitic mites from the Pilbara provide evidence that exceptions exist and that these microscopic organisms have wide-range distribution, suggesting that they may use other means of dispersal, possibly on the surface (Biota 2006b).

The presence of troglofauna in Western Australia is still somewhat poorly documented. To date, troglofauna have been recorded from karst limestone systems at Cape Range, Barrow Island and in the Kimberley (Biota 2005; Harvey 1988; Humphreys 2001); pisolitic mesa formations in the Pilbara (Biota 2006a), banded iron formations in the Pilbara and Midwest (Biota 2007; *ecologia* 2009a, b, 2010), Greenfields gold provinces in the Great Victorian Desert (*ecologia* 2009c) and in the cave systems of Yanchep (EPA 2005), Margaret River (Eberhard 2006) and across the Nullarbor (Moore 1995).

1.6 STYGOFAUNA OVERVIEW

Stygofauna are obligate, groundwater dwelling fauna, adapted to a subterranean aquatic environment. This environment is devoid of light, may have restricted available space (i.e. porous or fissured rock) and relatively constant temperature. These species have evolved unique features such as a lack of pigmentation, elongated appendages, filiform body shape (worm like) and reduced or absent eyes. Many species are believed to be relict taxa with affinities with Tethys, Pangea and derived landmasses (Danielopol and Stanford 1994; Humphreys 1993b, 1999, 2001; Knott 1993).

Stygofauna are known to be present in the groundwater associated with a variety of geologies. These include (but are not limited to) calcrete aquifers associated with palaeochannels, haematite sandstone aquifers (e.g. Koolan Island), clay-sandstone aquifers on the Swan and Scott Coastal Plains

(ecologia 1998a, 2006a, b; Humphreys 2001; Rockwater 2006), porous aquifers (e.g. alluvium) (Mamonier *et al.* 1993), fractured-rock aquifers, springs and hyporheic habitats (Eberhard *et al.* 2005b). However, distribution patterns of stygofauna are determined by hydrogeological aquifer types rather than by affiliation of aquifers to a given geological unit. Two main types of aquifer relevant for stygofauna have been defined by Hahn and Fuchs (2009):

1. Compact aquifers (aquitard)

Compact aquifers comprise materials such as clay, loess, and very fine sands, as well as compact rocks, which have reduced pore spaces and thus a low hydraulic conductivity (kf < 10^{-6} m sec-1). Exchange with surface water for food and oxygen supply is reduced and living space is minimal in this type of aquifer, which is why these aquifers are either devoid of fauna or have depleted taxonomic richness and abundance.

2. Open aquifers

Open aquifers comprise porous, fractured and karstic groundwater circulation systems with at least moderate hydraulic conductivity (kf > 10^{-6} m sec-1). There is continuous exchange with surface water for food and oxygen supply and more abundant living space, which is why stygofauna communities are often found in this aquifer type (Hahn and Fuchs 2009). In addition, communities of porous and karstic aquifers have been found to be more similar to each other than the communities of compact and fractured aquifers (Hahn and Fuchs 2009).

Stygofauna are found in oxygenated groundwater, usually ranging from fresh to hyposaline, but they can occur in salinities up to seawater (EC = 54 mS/cm) (Humphreys 1999). Recent experience west of Lake Way near Wiluna has shown that palaeochannel aquifers with an EC of 60,000µS/cm can harbour diverse and abundant stygal assemblages (*ecologia* 2006a).

The presence of stygofauna in Western Australia has been well documented, especially from regions such as the Pilbara and Kimberley, and less so in the Midwest and South West regions of WA (Cho *et al.* 2005; De Laurentiis *et al.* 2001; Eberhard 2004; Humphreys 2001; Karanovic 2004; Wilson and Keable 2002). Australian stygofauna is dominated by crustaceans including Amphipoda (Bradbury and Williams 1997), Isopoda (Wilson 2001), Ostracoda (Karanovic 2005; Karanovic and Marmonier 2002, 2003; Martens and Rossetti 2002) and Speleogriphacea (Poore and Humphreys 2003; Poore and Humphreys 1998).

2 BIOPHYSICAL CLIMATE

2.1 CLIMATE AND WEATHER

The Pilbara experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Temperatures are generally high, with summer temperatures frequently exceeding 40°C. Light frosts occasionally occur inland during July and August.

Rainfall is generally localised and unpredictable (some years have recorded zero rainfall), and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year. The majority of the Pilbara has a bimodal rainfall distribution; from December to March rains result from tropical storms producing sporadic thunderstorms. Tropical cyclones moving south also bring heavy rains. From May to June, extensive cold fronts move eastwards across the state and occasionally reach the Pilbara. These fronts usually produce only light rains. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses generally flow intermittently due to the short wet season (Beard 1975).

The nearest Bureau of Meteorology (BOM) station for which both rainfall and temperature data is available is Paraburdoo Aero (Site No. 007185), 85 km west from the western boundary of the Study Area. The location has a typical Pilbara climate of hot summers with sporadic summer storms and warm dry winters (BoM 2013). Figure 2.1 displays monthly rainfall and temperature averages with temperatures obtained from Paraburdoo Aero (Site No. 007185), rainfall obtained from Turee Creek Station (Site No 007083).

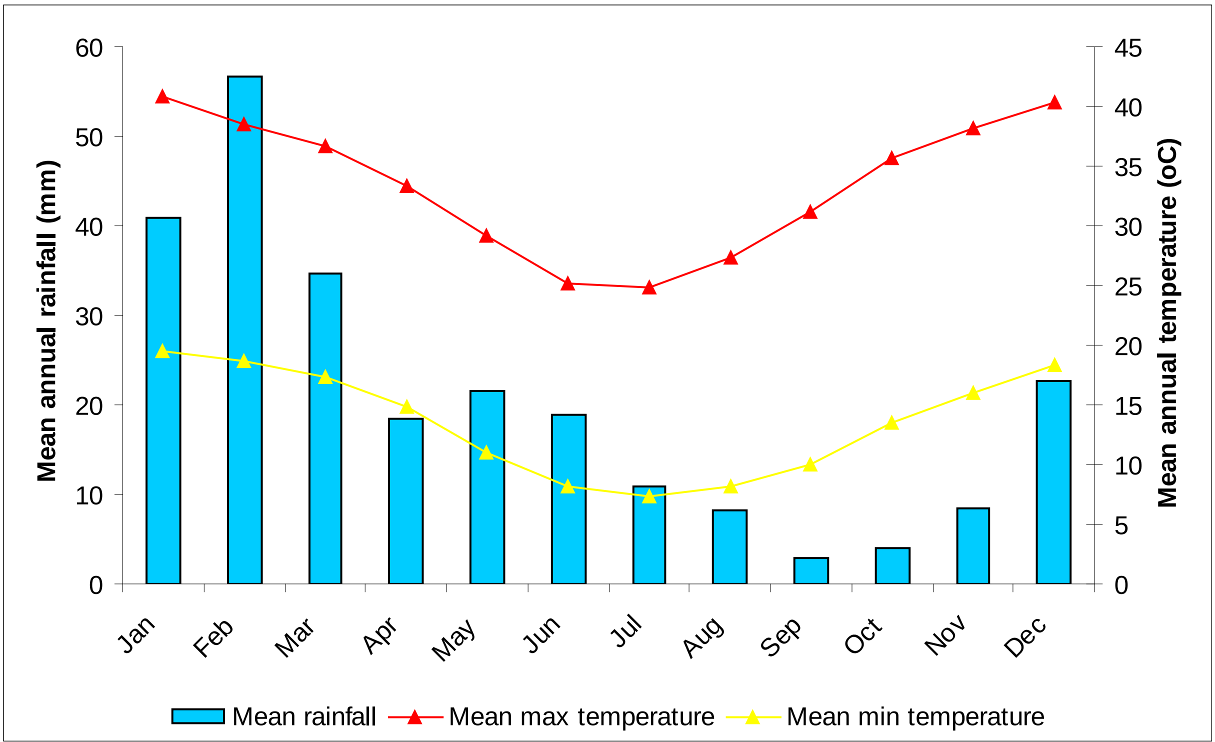
Rainfall data is available from Turee Creek Station (Site No. 007083) located 45.5 km south of the southern boundary of the Study Area. During the 2011 – 2012 wet season (November 2011 to March 2012) considerably higher rainfall fell compared to the long-term average (Table 2.1). The rainfall received in the six months preceding the trap retrieval for troglofauna were all below the long term monthly averages. Such statistics are not unusual as this period typically falls within the dry season in the Pilbara region, with higher than average rainfall occurring at the end of October and December 2012, after the retrieval of traps. Given the proximity to West Angelas, it is probable that rainfall recorded at Turee Creek is a more accurate reflection of the rainfall received by the Study Area.

Table 2.1 – Rainfall at Turee Creek and Paraburdoo meteorological stations

Total rainfall (mm)	Turee Creek Station		Paraburdoo Aero	
	Monthly total	Monthly average (1920-2012)	Monthly total	Monthly average (1974-2012)
August 2011	2	8.3	0	11.6
September 2011	0	2.9	0	3.6
October 2011	2.6	4	0	3.6
November 2011	30.2	8.5	8	8.3
December 2011	27.7	22.6	5	28.5
January 2012	126.3	41	205.2	52
February 2012	42	56.7	73.6	78.3
March 2012	72.5	34.7	77	46.4
April 2012	1.8	18.5	17.4	26.8
May 2012	0	21.6	0	16.4
June 2012	8.6	18.8	10.4	22.2
July 2012	1	10.9	1	14.6
August 2012	0	8.2	0	11.6

Total rainfall (mm)	Turee Creek Station		Paraburdoo Aero	
	Monthly total	Monthly average (1920-2012)	Monthly total	Monthly average (1974-2012)
September 2012	0	2.9	0.4	3.5
October 2012	21.8	4.2	32.8	4.4
November 2012	1.6	8.5	1.6	8.1
December 2012	144.8	22.6	33.6	28.5

Source: BOM (2013)



Source: BOM (2013)

Figure 2.1 – Mean monthly climate data

2.2 GEOLOGY, LAND SYSTEMS AND SOILS

2.2.1 Geology

The Study Area and local geology is presented in Figure 2.2, while Figure 2.3 shows regional geology. Definitions of the geological unit codes are provided in Table 2.2 (Hickman and Kranendonk 2008). Geology of the Study Area comprises 12.4% mafic volcanics, 66.4% sedimentary rock and 21.1% dolerites and gabbros geological units (Hickman and Kranendonk 2008).

Table 2.2 – Geology of the Study Area

Geological Code	Lith Association	Area within Study Area (km^2)	Definition of code
A4 - -Pp	Mafic volcanics	21.7	Archaean period
A3b	Sedimentary rocks	116.9	Archaean – palaeoproterozoic period
A2d	Dolerites and gabbros	37.0	Archaean period

2.2.2 Soils

The most extensive soils in the Pilbara are shallow, stony soils on hills and ranges and sands on sandplains. In the south, the soils are predominantly red earths overlying hardpan on level to gently inclined plains. Lower flood plains have cracking and non-cracking clay soils. Duplex (texture-contrast) soils occur in localised areas on saline alluvial plains and elsewhere. These soils support the most preferentially grazed vegetation and are highly susceptible to erosion (Van Vreeswyk *et al.* 2004).

Within the Study Area, three soil units as classified by Bettenay *et al.* occur. These units are described below:

Fa13: Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some soils on the steeper slopes (Uc5.11). Associated are soils on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains;

Fa14: Steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. (Dr2.33 and Dr2.32) soils whish occur on the pediments are more extensive than unit Fa13, while (Um5.52) and (Uf6.71) soils occur on the valley plains; and

Fb3: High-level valley plains set in extensive areas of unit Fa13. There are extensive areas of pisolitic limonite deposits: principal soils are deep earthy loams (Um5.52) along with small areas of Gn2.12) soils.

2.2.3 Land systems

The Study Area crosses the northern boundary of the area surveyed by Payne *et al* (1982) in the Regional Inventory of the Ashburton Rangelands and into the area surveyed by Van Vreeswyk *et al*. (2004) in the Regional Inventory of the Pilbara Rangelands. Both surveys documented the land systems present and their condition. Because the Survey Area intersects the two regional surveys, they are discussed collectively for the purpose of the report.

Seven land systems mapped by Payne *et al* (1982) within the Ashburton regional Inventory (AIR) and by Van Vreeswyk *et al*. (2004) in the Pilbara regional Inventory (PRI) are present within the Study Area, each of which has been further classified by landform, soil, vegetation and drainage patterns. The seven land systems within the Study Area include Boolgeeda, Egerton, Elimunna, Newman, Platform, Rocklea and Wannamunna, with the Newman (71.4 km^2) and Boolgeeda (56.2 km^2) land systems being the most extensive. Summary descriptions of the characteristics of each land system are provided in Table 2.3, with land systems of the Study Area mapped in Figure 2.5.

Table 2.3 – Summary of Land Systems present within the Study Area

Land System (% of Study Area)	Area (% of PIR and AIR combined)	Area within Study Area (% of Land System)	Description	Vegetation Condition Assessment	Landform (and % of Land System)	Vegetation Community
Boolgeeda (32.01%)	10337 km^2 (3.8%)	56.2 km^2 (0.54%)	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	Very good 82%, good 13%, fair 4%, poor 1%. Hard spinifex grasslands not preferred by livestock.	Low hill and rises (4%)	Hummock grasslands of *T. wiseana* and other *Triodia* spp. with very scattered *Acacia* spp. shrubs.
					Stony slope and upper plain (20%)	Hummock grasslands of *T. lanigera*, *T. wiseana* or scattered tall shrublands of *A. aneura*, *A. ancistrocarpa*, *A. atkinsiana* and other *Acacia* spp., with occasional *Eucalyptus* trees.
					Stony lower plain (65%)	Hummock grasslands of *T. wiseana*, *T. lanigera* or *T. pungens*. Also scattered to moderately close tall shrublands of *A. aneura* and other *Acacia* spp. with hard and soft *Triodia* spp. ground layer.
					Grove (small drainage foci) (1%)	Moderately closed woodlands or tall shrublands of *A. aneura* with sparse low shrubs and tussock or hummock grasses.
					Narrow drainage floor and channel (10%)	Scattered to closed tall shrublands or woodlands of *A. aneura*, *A. atkinsiana* and *C. hamersleyana* with sparse low shrubs and hummock and tussock grasses. Occasionally hummock grasslands of *T. pungens*.
Egerton (2.52%)	3868 km^2 (1.40%)	4.4 km^2 (0.11%)	Dissected hardpan plains supporting mulga shrublands and hard spinifex hummock grasslands.	Very good 89%, good 11%. Vegetation not preferred by livestock.	Hardpan plains (10%)	Very scattered to scattered tall shrublands of *Acacia aneura* and other *Acacia* spp. with prominent ground layer of *Triodia* spp.
					Dissected slopes (75%)	Hummock grasslands of *Triodia brizoides*, *T. wiseana* with isolated *Acacia* shrubs and *Eucalypts*.
					Calcrete drainage margins (6%)	Hummock grasslands of *T. wiseana* with sparse *Eucalyptus socialis* trees or mallees and isolated low shrubs.
					Drainage floors and channels (9%)	Moderately close woodlands/tall shrublands of *A. aneura* with other shrubs including *Senna* spp., *Ptilotus obovatus* and *Eremophila forrestii* with *Triodia* spp. ground layer.
Elimunna (1.15%)	656.6 km^2 (0.24%)	2.0 km2 (0.30%)			Hills and low rises (10%)	Hummock grasslands of *Triodia wiseana* (hard spinifex) or very scattered shrublands of *Acacia* and *Senna* spp.

Land System (% of Study Area)	**Area (% of PIR and AIR combined)**	**Area within Study Area (% of Land System)**	**Description**	**Vegetation Condition Assessment**	**Landform (and % of Land System)**	**Vegetation Community**
			Stony plains on basalts upporting sparse *Acacia* and cassia shrublands and patchy tussock grasslands.	Very good 14%, good 25%, fair 35%, poor 21%., very poor, 5% Vegetation attractive to grazing animals and prone to degradation if grazing pressure is excessive.	Stony plains (45%)	Very scattered to scattered mixed height shrublands with *Acacia aneura* (mulga) other *Acacia*s, *Senna* spp. (cassias) and *Eremophila* spp. occasionally with patchy *Triodia* spp. (hard spinifex) understorey.
					Gilgai plains (26%)	Patchy tussock grasslands with *Eragrostis xerophila* (Roebourne Plains grass), *E. setifolia* (neverfail), *Astrebla pectinata* (barley Mitchell grass) with isolated shrubs mainly *Eremophila* and *Senna* spp.
					Hardpan plains (6%)	Very scattered tall shrublands of *A. aneura* and other *Acacia*s.
					Groves (1%)	Moderately close to close tall shrublands of *A. aneura* with numerous other shrubs and patchy perennial grasses.
					Drainage floors (12%)	Tussock grasslands with *Astrebla* and *Eragrostis* spp. or very scattered to moderately close tall shrublands of *Acacia* spp. with various low shrubs and patchy tussock and/or hummock grasses.
Newman (40.66%)	21109 km^2 (7.7%)	71.4 km^2 (0.34%)	Rugged jaspilite plateaux, ridges and mountains supporting hard.	Very good 91%, good 7%, fair 1%, poor 1%. Inaccessible or poorly accessible and is unsuitable for pastoral purposes.	Plateaux, ridges, mountains and hills (70%)	Hummock grasslands of *Triodia wiseana*, *T. brizoides*, *T. plurinervata* with very scattered to scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii*, *Eucalyptus leucophloia* and other eucalypts. Occasionally hummock grass is *Triodia biflora*.
					Lower slopes (20%)	Similar to the vegetation community above.
					Stony plains (5%)	Hummock grasslands of *Triodia wiseana*, *T.* spp. (hard spinifex) with isolated to very scattered shrubs of *Acacia* and *Senna* spp. and occasional eucalypt trees. Occasionally hummock grasslands of *Triodia pungens* (soft spinifex).
					Narrow drainage floors with channels (5%)	Smaller floors support hummock grassland of *Triodia pungens* with very scattered shrubs. Larger floors and channel support tall shrublands/woodlands of *Acacia* spp. and *Eucalyptus victrix* with tussock grass or hummock grass understoreys.

Land System (% of Study Area)	Area (% of PIR and AIR combined)	Area within Study Area (% of Land System)	Description	Vegetation Condition Assessment	Landform (and % of Land System)	Vegetation Community
Platform (9.75%)	2552 km^2 (0.9%)	17.1 km^2 (0.67%)	Dissected slopes and raised plains supporting hard spinifex grasslands.	Very good 97%, good 3%. Vegetation on this system is not preferred by livestock and is of very little use for pastoralism. The system is not susceptible to erosion.	Stony upper plains (25%)	Hummock grasslands of *Triodia wiseana* and other *Triodia* spp. (hard Spinifex) with isolated to very scattered *Acacia* spp. shrubs
					Dissected slopes (60%)	Hummock grasslands of *Triodia wiseana*, *T. plurinervata* (hard Spinifex) with isolated to very scattered *Acacia* spp. shrubs or *Eucalyptus leucophloia* (snappy gum)
					Drainage floors (15%)	Scattered to close tall shrublands/woodlands with *Acacia citrinoviridis* (black mulga), *A. tumida* (pindan wattle) and other *Acacia*s, occasional eucalypt trees, numerous low shrubs including *Senna* spp. (cassias), *Ptilotus obovatus* (cotton bush), *Corchorus walcottii* (grey Corchorus) and *Triodia pungens* (soft spinifex)
Rocklea (13.89%)	31089 km^2 (11.3%)	24.4 km^2 (0.08%)	Basalt hills, plateaux, lowers slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	Very good 89%, good 7%, fair 2%, poor 2% Spinifex grasslands inaccessible and not preferred by livestock.	Hills, ridges, plateaux and upper slopes (65%)	Hummock grasslands of *T. wiseana*, *Triodia* spp. or less frequently, of *T. pungens* with isolated to very scattered shrubs such as *A.* in*aequilatera* and *Senna* spp.
					Lower slopes (15%)	Hummock grasslands of *T. wiseana*, *Triodia* spp. or less frequently, of *T. pungens* with isolated to very scattered shrubs such as *A.* in*aequilatera* and *Senna* spp.
					Stony plains and interfluves (10%)	Hummock grasslands of *T. wiseana* or less frequently *T. pungens* with isolated to very scattered shrubs such as *A.* in*aequilatera*. Occasionally grassy shrublands with *Acacia*, *Senna* and *Eremophila* spp.
					Gilgai plains (1%)	Tussock grasslands with *Astrebla pectinata*, *E. xerophila* and other perennial grasses.
					Upper drainage lines (4%)	Hummock grasslands of *T. wiseana* or *T. pungens* with very scattered to scattered *Acacia* shrubs and occasional *C. hamersleyana* trees.
					Drainage floors and channels (5%)	Scattered to moderately close tall shrublands or woodlands of *Acacia* and *Eucalyptus* spp. with numerous undershrubs and hummock grass understoreys or tussock grass understoreys.

Wannamunna (0.03%)	630.1 km^2 (0.22%)	0.04 km^2 (0.006%)	Hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands).	Very good 19%, good 25%, fair 19%, poor 21%., very poor, 16% The system supports low shrubs and tussock grasses which are highly preferred by grazing animals and are prone to degradation if grazing pressure is excessive.	Stony plains (8%	Very scattered to scattered tall shrublands of *Acacia aneura* (mulga) with sparse low shrubs and *Triodia* sp. (hard spinifex) understorey
					Hardpan plains (56%)	Very scattered tall or low shrublands of *Acacia aneura*, *Eremophila* spp., *Ptilotus obovatus* (cotton bush), *Maireana villosa*.
					Calcrete platforms (1%)	Scattered shrublands with *Acacia aneura* and other *Acacia*s, *Senna* spp. and *Triodia wiseana* (hard spinifex)
					Groves (15%)	Moderately close to closed woodlands of *Acacia aneura* with numerous undershrubs and tussock grasses such as *Chrysopogon fallax* (ribbon grass) and *Themeda triandra* (kangaroo grass).
					Internal drainage plains (20%)	Moderately close to closed woodlands of *Acacia aneura* and *Eucalyptus victrix* (coolibah) with sparse undershrubs such as *Muehlenbeckia florulenta* (lignum) and *Chenopodium auricomum* (swamp bluebush) and patchy tussock grasses. Also grasslands of *Eriachne* sp. with isolated *Eucalyptus victrix* trees and shrubs such as *M. florulenta* or grassy scattered woodlands of *E. victrix*

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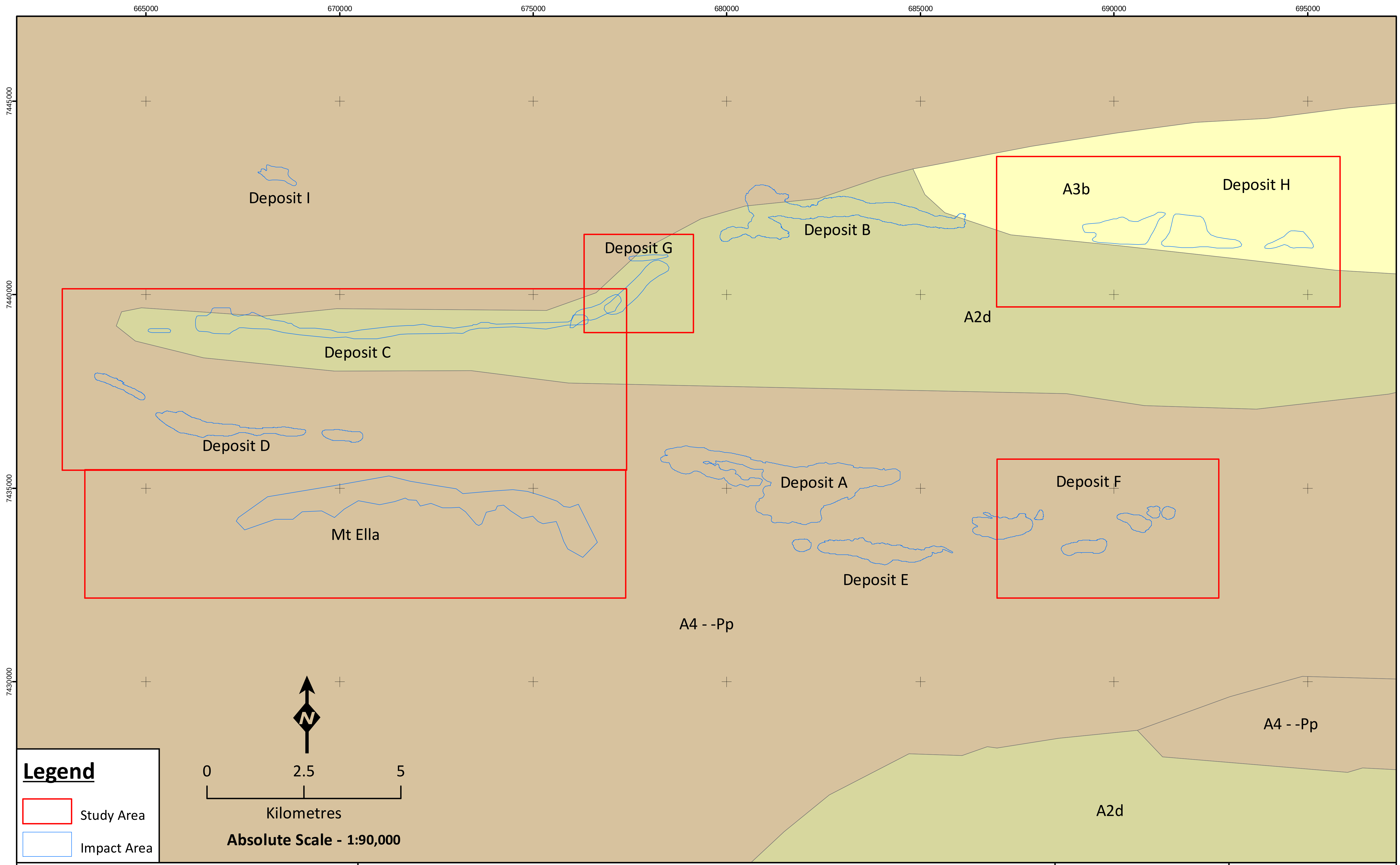

Geology of the Study Area

Figure: 2.H
Project ID: 1459

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Date: 12/2/2013

Coordinate System
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Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: BG280

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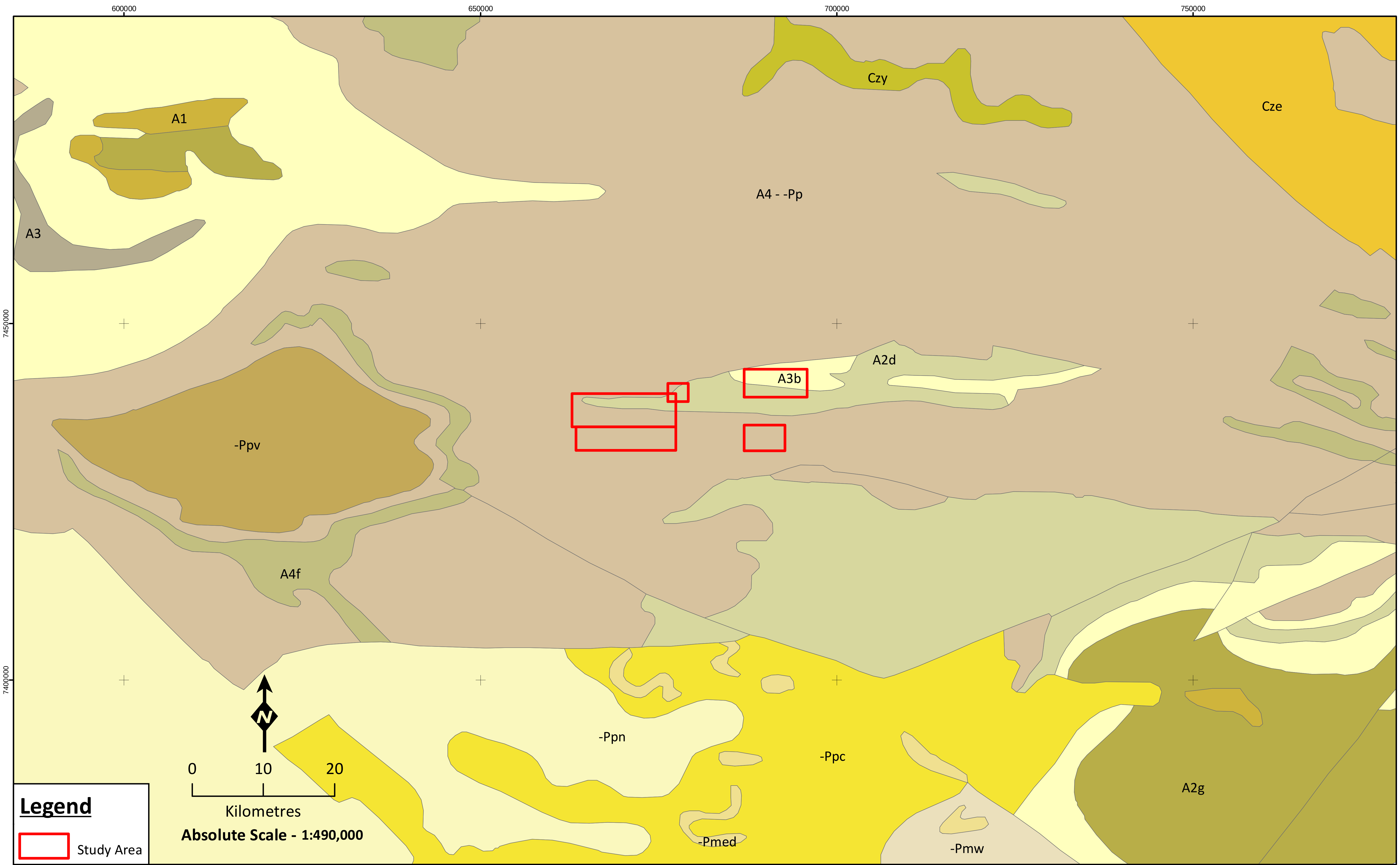

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Regional geology of the Study Area

Figure: 2.0
Project ID: 1459

Drawn: BG
Date: 12/2/2013

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

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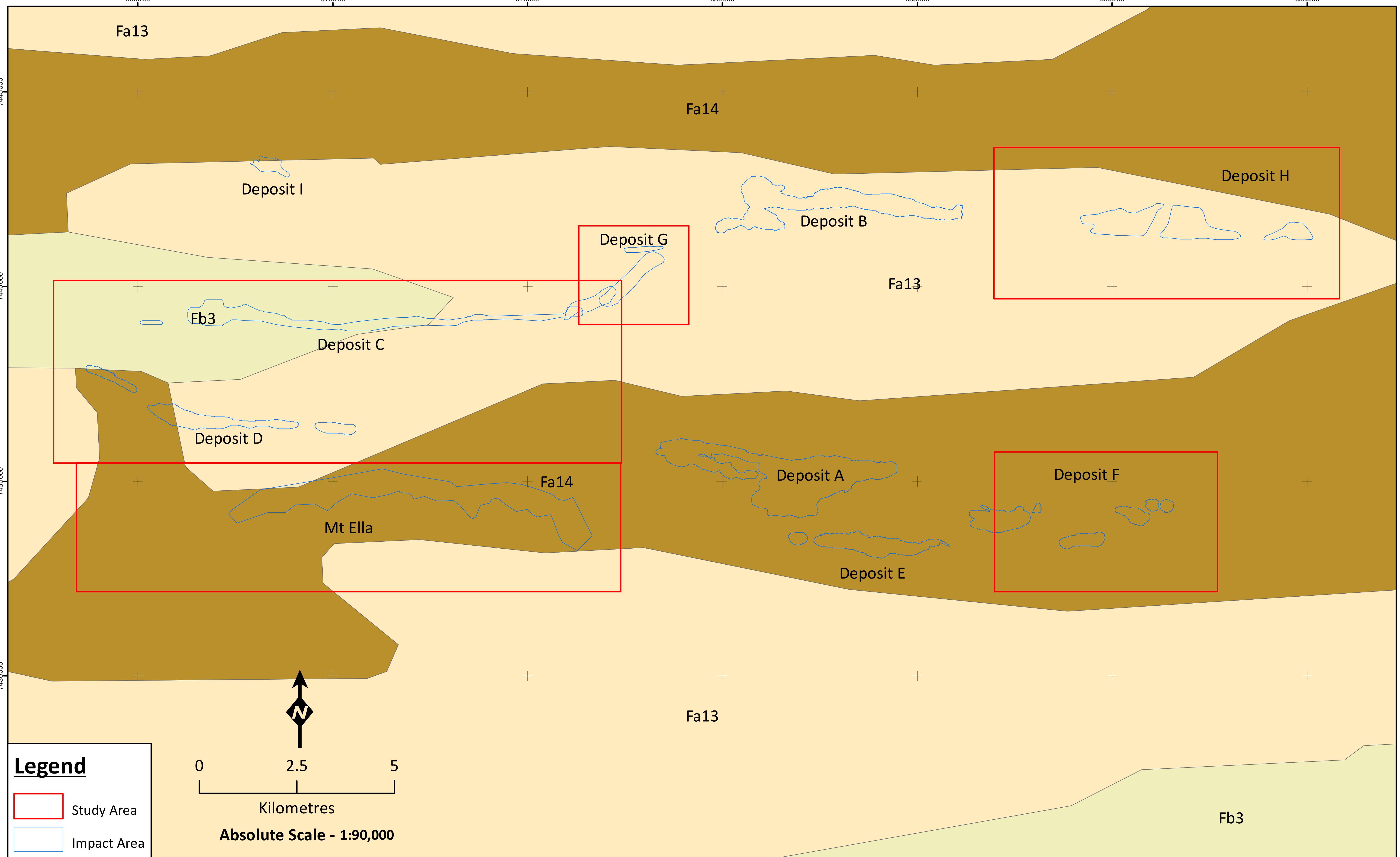

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Soils of the Study Area

Figure: 2.n
Project ID: 1459

Drawn: BG
Date: 12/2/2013

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

Unique Map ID: BG278

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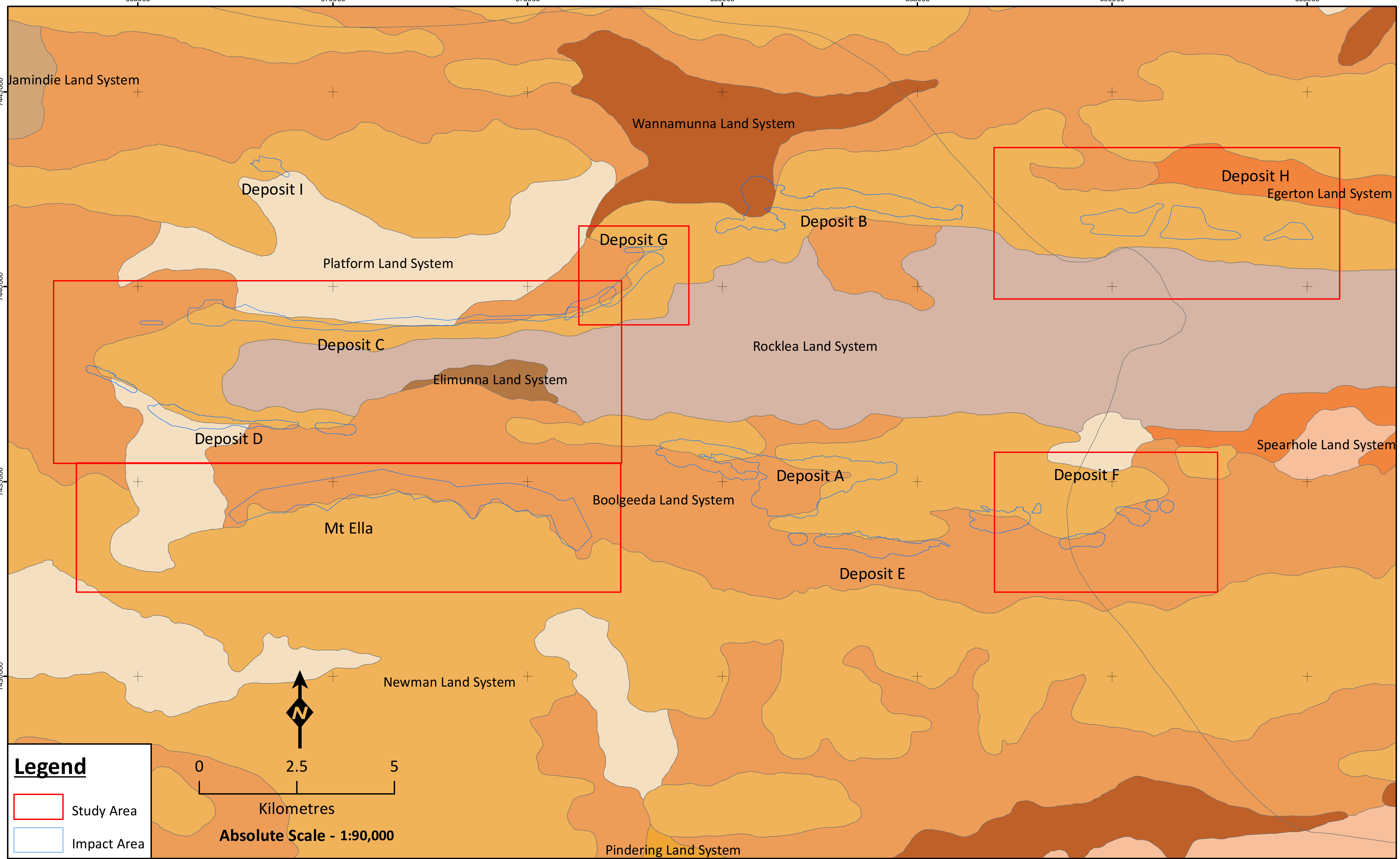

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Landsystems of the Study Area

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Date: 12/2/2013

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

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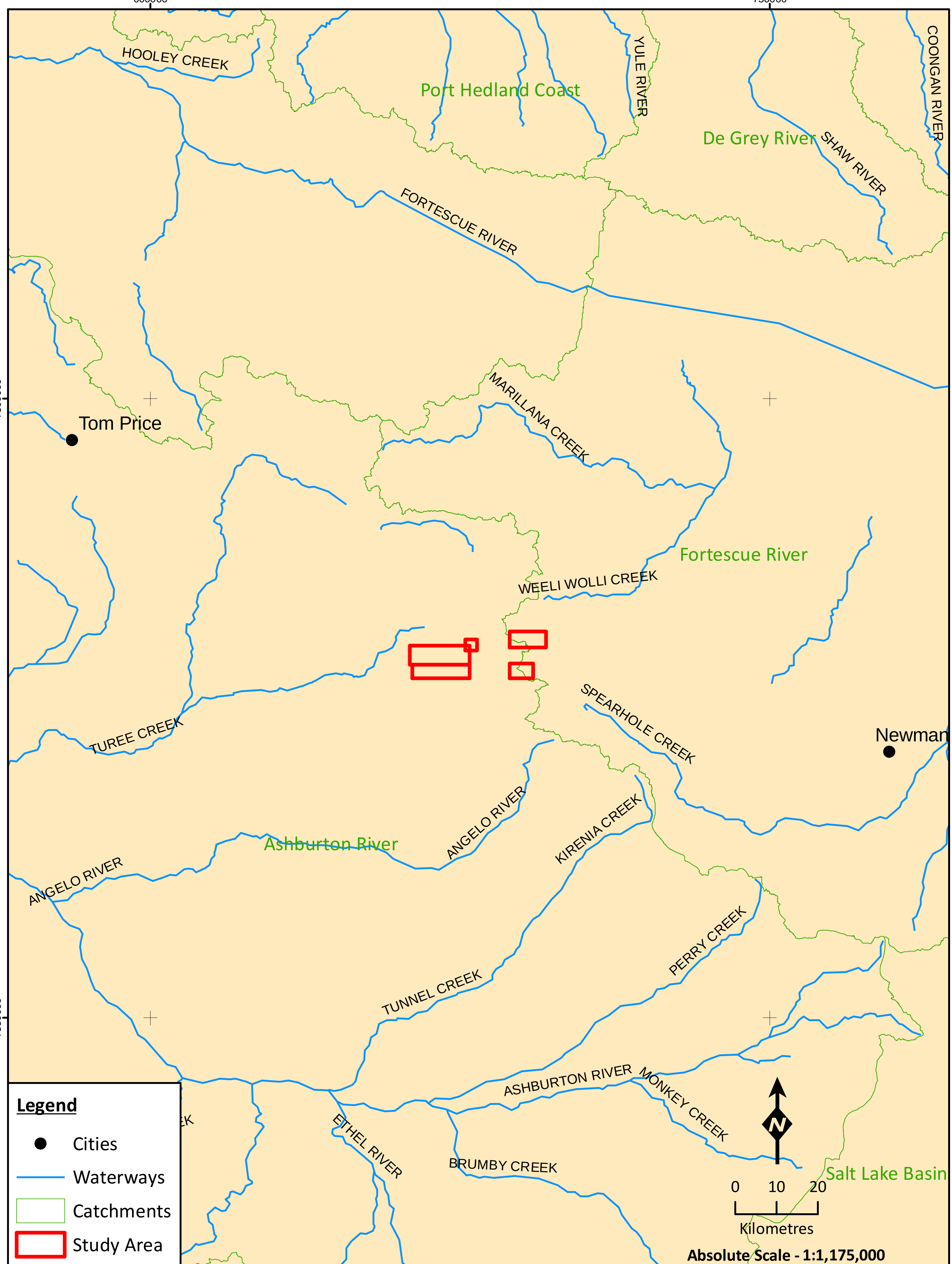
2.3 HYDROLOGY

The Study Area is located in the Hamersley Range, and is a part of both the Ashburton and the Fortescue Catchments (Figure 2.6). The closest creek to the Study Area is Turee Creek, a sub-tributary of the Ashburton River. Turee Creek flows west along a 4 km wide valley before turning sharply to exit the Hamersley Range (Johnson and Wright 2001). The West Angelas mine and Study Area are situated in the Turee Creek East sub-catchment, where drainage is fed by a number of smaller creeks (Johnson and Wright 2001). The creek system is ephemeral and does not support any permanent surface-water features (Johnson and Wright 2001).

2.4 HYDROGEOLOGY

Central Pilbara groundwater occurs in the Archaean/Proterozoic basement rocks and the Cainozoic deposits. It originates from direct rainfall recharge into basement rock outcrops and indirect recharge through runoff (Johnson and Wright 2001). The main aquifer in the area is the vuggy pisolite (Robe Pisolite) which overlies fractured basement rocks of the Woongarra volcanics and Boolgeeda Iron Formations (Johnson and Wright 2001). This aquifer lies within Tertiary paleochannels and the aquifer zone varies between 50 and 80 m in thickness and has an estimated permeability of 40-80 m per day (Johnson and Wright 2001).

Permeability and groundwater storage within the Jeenah formation is generally low except where there is local fracture systems associated with regional lineaments. Groundwater declines steeply from 10-20 m below ground level (m.b.l.) to up to 140 m.b.l. Steep water level gradients are indicative of low permeability or lack of hydraulic connection. Aquifers associated with mineralisation are deep, porous, permeable, confined aquifers, hydraulically isolated by low permeability surrounding rock.



Regional Hydrology of the Study Area

Figure: 2.6
Project ID: 1459

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Date: 13/02/2013

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

Unique Map ID: BG283

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2.5 PREVIOUS SURVEYS

The following databases and publications were consulted in the preparation of potential subterranean (and conservation significant) fauna lists (Appendix C):

- NatureMap Database;
- WA Museum Crustaceans database;
- WA Museum Molluscs database;
- WA Museum Arachnids/Myriapods;
- *ecologia* internal database;
- *ecologia* (1998b);
- Biota (2003); and,
- Biota (2008).

At least 24 subterranean species have been identified as occurring within 100 km radius of the Study Area. Many specimens lack detailed identification, with identification to order level only.

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3 METHODS

The methodology used was based on the principles outlined in the EPA Guidance statement 54A (EPA 2007). The methodology developed for the survey was compliant with these requirements and in accordance with the guidance received from the Department of Environment and Conservation (DEC) before the survey commenced.

3.1 DETERMINATION OF SURVEY DESIGN AND INTENSITY

Prior to the development of field survey methods, a review was undertaken of factors likely to influence survey design and intensity (Table 3.1). Based on this review, and in consideration of the level of disturbance and the results of a desktop study, a subterranean survey methodology was developed.

Table 3.1 – Factors influencing survey design and intensity

Factor	Relevance
Bioregion-level of existing survey knowledge of the region and associated ability to predict accurately	Regional knowledge of subterranean fauna is well established
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region	The Study Area covers seven land systems: the Boolgeeda, Egerton, Elimunna, Newman, Platform, Rocklea and Wannamunna. None of the land systems are exclusive to the Study Area.
Life forms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present	Troglobitic populations are likely to increase in size during and immediately after wet season, following an influx of nutrients into the underground systems (EPA 2007). Sampling in the current survey was conducted from 9 July 2012 to 5 October 2012, following a drier than average dry season. The previous wet season (November 2011 – March 2012) however recorded higher than average rainfall.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves)	Previous sampling in the Greater West Angelas area identified subterranean fauna (troglobitic spiders, millipedes and centipedes, stygobitic amphipods, copepods, ostracods and bathynelaceae).
Number of different habitats or degree of similarity between habitats within a survey area	Three geological units exist within the Study area – Sedimentary rocks, Mafic volcanics and Dolerites and Gabbros.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods)	No climatic constraints influenced the survey.
Technical constraints (e.g. condition and/or number of bore holes)	Ninety one troglofauna trapping sites were sampled successfully. Drilling and bulldozing occurred in D and D extension deposits during the troglofauna survey, causing vibration and air pressure in subterranean voids, hence possibly affecting capture of troglofauna. Stygofauna sampling was limited to four bores in Deposit F as all other boreholes were rehabilitated, did not reach groundwater or were blocked.
Scale and impact of the Project	The final sample size was determined by the overall Study Area and deposit areas.

3.2 SURVEY ADEQUACY

There are three general methods of estimating species richness from sample data: extrapolating species-accumulation curves (SAC), fitting parametric models of relative abundance, and using non-parametric estimators (Bunge and Fitzpatrick 1993; Colwell and Coddington 1994; Gaston 1996). In this report, the level of survey adequacy was estimated using species accumulation curves (SACs) as computed by Mao Tao. A SAC is a plot of the accumulated number of species found with respect to the number of units of effort. The curve, as a function of effort, monotonically increases and typically approaches an asymptote, which is the total number of species. In addition, a Michaelis-Menten enzyme kinetic curve was calculated and used to apply a stopping rule. To eliminate features caused by random or periodic temporal variation, the sample order was randomised 100,000 times. All estimators applied to the data set were performed using EstimateS (version 8, Colwell 2009).

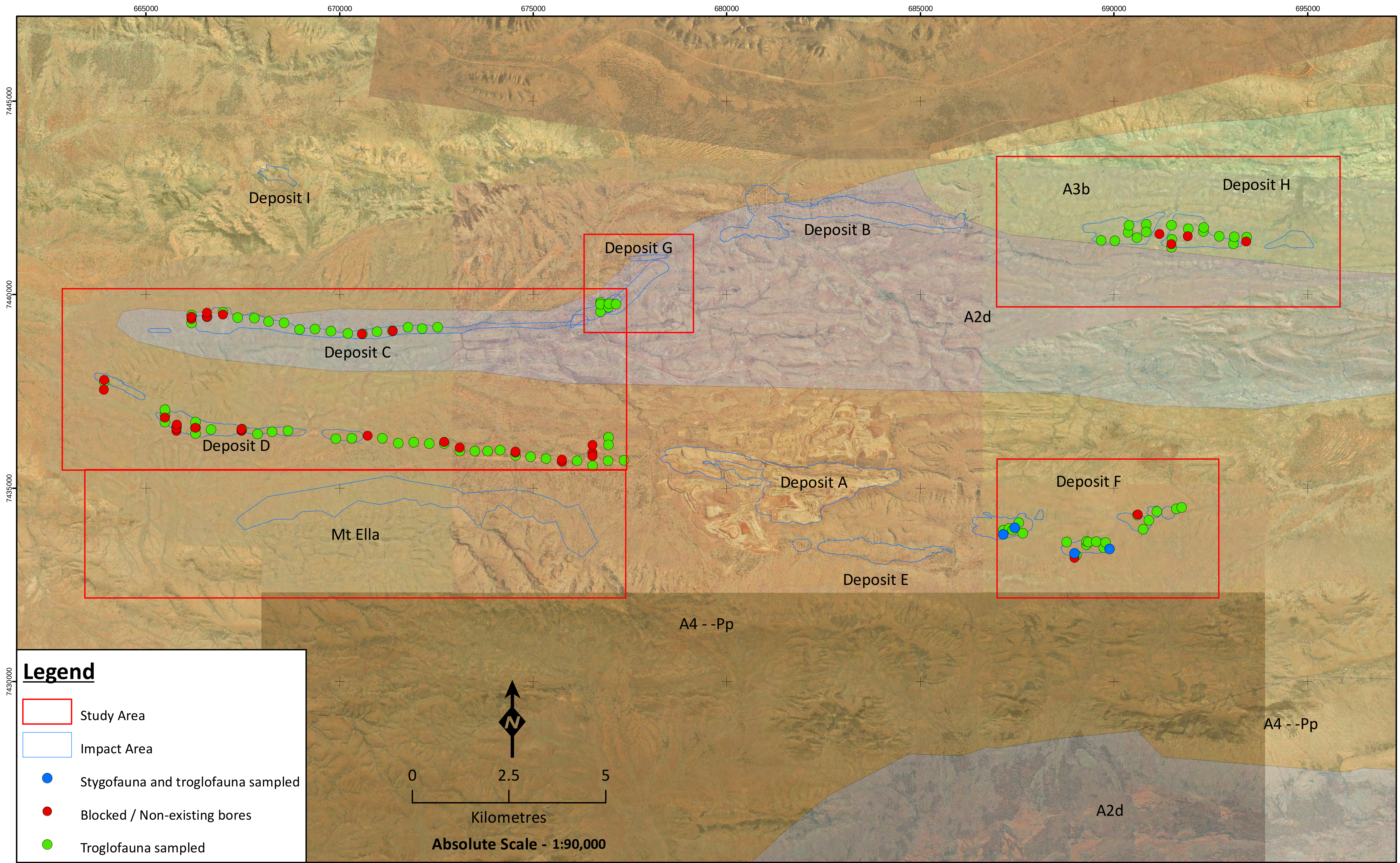
3.3 SURVEY TIMING

The EPA's Guidance Statement 54a recommends that the sampling is conducted in two phases, of which at least one occurs during wet season. If two phases of sampling are impractical, a single phase sampling event should be conducted during the wet season.

The survey was undertaken between 9 July and 5 October 2012 at the end of the dry season. Unusually high rain events occurred during the summer season prior to the survey, however the dry season was also drier than the long-term average.

3.4 SITE SELECTION

Sites were selected based on the best possible spread in each deposit with the information provided by RT. Once in the field, however, many of the bore holes could not be sampled. This was due to their rehabilitation over 20 years ago, and they either could not be located, were blocked or did not reach the water table. A total of 91 troglofauna traps were deployed with the recovery of 88 traps (two traps were lost in the retrieval process and one trap was accidentally bulldozed). A total of four bores were sampled for stygofauna, all within the Deposit F. Sampled bore holes and notes are shown in Appendix A (stygofauna samples highlighted in bold), with sample sites mapped in Figure 3.1.



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Sample sites of the Study Area

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Project ID: 1459

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Date: 12/2/2013

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

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3.5 SAMPLING METHODS

The subterranean fauna survey conformed to requirements of a pilot study outlined in EPA Guidance Statement No. 54 - *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (2003), and EPA Technical Appendix to Guidance Statement No. 54: *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (2007).

3.5.1 Troglofauna Trapping

Only drill holes which were sealed and unobstructed were used for sampling. Drill holes were sampled using custom-designed traps (DEC and EPA approved) filled with leaf litter and baited with banana. Leaf litter was soaked over several days and sterilised by microwaving at a high setting for three minutes (to destroy any terrestrial predators present in the leaf litter that could inhibit, predate or impact on troglofauna colonising the traps once in the ground). The leaf litter was then stored in an air-tight container to further develop over eight weeks before deployment.

The water level of each drill hole was measured (where possible) using a standing water level meter prior to traps being deployed. This information aids positioning of troglofauna traps above the water table. Traps were placed approximately two meters above the water table (or above the blockage if drill holes were blocked but still reached a reasonable depth for sampling) and positioned so that the trap rested against the wall of the hole. The drill holes were re-sealed after the insertion of traps to maintain humidity levels and to reduce contamination from surface fauna. Each site was demarcated with flagging tape and a sign "DO NOT DISTURB- TROGLOFAUNA TRAPPING IN PROGRESS". Site management were informed of the areas where trapping was occurring to minimise accidental disturbance and tampering.

Traps were left in the ground for 91 days to ensure troglofauna colonisation. After this period, the traps were recovered and the leaf litter from each trap was placed into plastic bags, which were immediately sealed to avoid contamination. Samples were returned to the *ecologia* Perth laboratory for fauna extraction and sorting prior to being sent to relevant taxonomic experts for identification.

3.5.2 Stygofauna Sampling

A standing water level dipper was used to determine the standing water level in each drill hole. This information assisted with information on the local aquifers for stygofauna. Water parameters such as conductivity (salinity), turbidity, temperature, Dissolved Oxygen and Redox potential were collected *in situ* using a portable water quality meter to assess habitat related to water quality.

Sampling was conducted using haul nets of appropriate diameter (depending on water bore diameter), lowered slowly into bores using rope to prevent the net from free falling to the bottom of the bore. A minimum of three hauls were performed with a 150 µm mesh net and a further three hauls were performed with a 50 µm mesh net. All samples were washed in a 50µm sieve and preserved in a vial with 100 % ethanol in case DNA assessment was required at a later date. All vials were labelled with the date, bore name and replicate number. Samples were stored in cool, dark conditions returned to the *ecologia* Perth laboratory for sorting prior to being sent to relevant taxonomic experts for identification.

3.5.3 Laboratory Sorting and Specimen Identification

Tullgren funnels were used to extract troglofauna from the collected leaf litter samples. The general principle of Tullgren funnels is that a sample of leaf litter is suspended above a vessel containing ethanol. Animals inhabiting the sample are forced downwards by the progressive drying of the sample and ultimately fall into the collecting vessel containing 100 % ethanol (in case for the need of

DNA assessment at a later date). Typically, drying is enhanced by placing an incandescent lamp or heat source above the sample.

After the leaf litter samples were processed on the Tullgren funnels, each sample was examined for dead animals that were not collected during the Tullgren funnel extraction. Each sample was emptied into a tray and examined using a fluorescent light magnifier. Any dead animals were collected and immediately placed into 100 % ethanol.

Extracted troglofauna samples and stygofauna samples were sorted under a Lecia S6 stereo microscope. All specimens were identified to the lowest taxonomic resolution by *ecologia* scientists. Specimens are then sent to Western Australian Museum (WAM) taxonomic specialist for further identification. A list of taxonomic specialists used for identification is shown in Table 3.2.

Table 3.2 – Taxonomic experts used to identify potential SRE subterranean taxa

Taxonomic Expert	Institution	Specialist Group
Dr Mark Harvey Mieke Burger Amber Beavis Julianne Waldock	Western Australian Museum	Arachnids Myriapods
Dr Volker Framenau Dr Erich Volschenk	Phoenix Environmental	Troglofauna
Dr Simon Judd	Private consultant	Isopods

3.5.4 Short Range Endemic Status

The likelihood of the invertebrate species to be considered a SRE was determined by expert taxonomists (Table 3.2) based on the current knowledge of the distribution and biology of each species, as follows:

- No – Not considered a SRE.
- Confirmed - Current knowledge confirms that this species is a SRE.
- Likely – Current knowledge suggests this species is probably a SRE. However, further research is required to confirm status.
- Potential – Current knowledge of this species or group is very limited however, there is the potential for this species to represent a SRE. Further research is required to confirm status.
- Unknown – No comment can be made regarding SRE status, usually due to uncertainty over species level due to life stage/sex, and/or lack of taxonomic knowledge.

All likely, potential and unknown SREs should be treated as confirmed SREs under the precautionary principle (Section 4a of the EP Act).

4 RESULTS

4.1 SURVEY ADEQUACY

4.1.1 Species Accumulation Curve (SAC)

Both the empirically observed SAC and the estimated Mao and Tau rarefaction curve suggest that a low proportion of the diversity of troglofauna of the region was sampled (Figure 4.1).

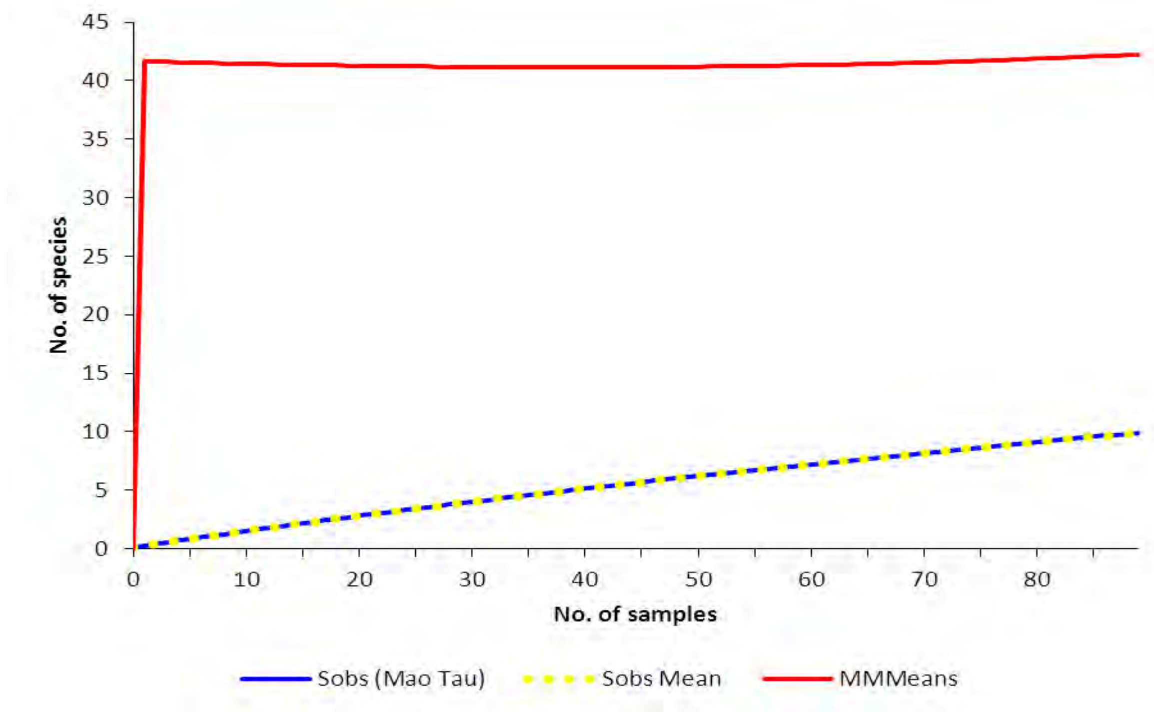

Figure 4.1 – SAC of the troglofauna data

The observed SAC (based on 100,000 randomisations) showed a gradual inclination upwards of species richness, however there was a large gap between the actual and predicted species richness curves. The Chao-1 estimator of total species richness predicted that the troglofauna assemblage in the Study Area consisted of approximately eleven species, with 95% confidence interval between ten and twenty species. Most of the other richness estimators resulted in estimate values between 11 and 42 (Table 4.1).

The Michaelis-Menten (MMS) estimator (used as a stopping rule) predicted that a total of 42 species potentially occur in the Study Area. This number indicates that approximately 24 % of the predicted troglobitic species were collected during this survey (i.e. 10 of the predicted 42).

Table 4.1 - Mean estimates of total species richness of troglofauna assemblage

Richness Estimators	Richness Estimate
ACE	14
ICE	33
Chao-1	11
Jack-1	18
Jack-2	25
Bootstrap	13
Michaelis-Menten	42

4.2 FIELD RESULTS

The survey yielded one hundred and nine invertebrate specimens representing eleven orders. Of these, ten species were identified as troglobitic. These species belong to the orders; Thysanura (silverfish), Psocoptera (booklice), Hemiptera (true bugs), Embioptera (webspinners), Blattodea (cockroaches), Coleoptera (beetles), Araneae (spiders), Isopoda (slaters) and Chilopoda (centipedes). Non-troglobitic specimens included Collembola (springtails), Blattodea, Coleoptera, Araneae and Diplopoda (millipedes).

Appendix B presents the full list of invertebrate species collected in the Study Area, with troglobitic species highlighted in bold. Troglobitic specimens collected are summarised in Table 4.2. The presence of troglobitic species in different geologies has been assessed (Figure 4.2). The x axis shows all 10 troglobitic species collected and the y axis shows the three geological units present in the Study Area: 1 – sedimentary rocks (A3b), 2 – dolerites and gabbros (A2d), 3 – mafic volcanics (A4 - -Pp).

Troglobitic specimens collected are mapped in Figure 4.3. Figure 4.3 also displays the geology of the Study Area (mapped by Hickman and Kranendonk 2008, Figure 2.2,), which gives an indication as to the geological associations and preferences of recorded troglobitic species.

The majority of troglobitic species recorded were collected as singletons and doubletons, with only the Blattodea specimens (*Nocticola* sp. indet.) and Coleoptera specimens (*Anillini* sp. indet.) collected in higher numbers 13 and 26, respectively).

Table 4.2 – Troglobitic specimens recorded

Order	Genus/Species	Easting	Northing	Bore ID	No. individuals
Thysanura	*Atelurinae* 'sp. indet.'	667471	7436527	WAD358	1
Psocoptera	*Trogiidae* 'sp. indet.'	691917	7441689	DHRC006	1
Hemiptera	*Meenoplidae* 'sp. indet.'	677142	7439755	WAG307	1
Hemiptera	*Meenoplidae* 'sp. indet.'	690832	7441805	WAH189	1
Embioptera	*Embioptera* 'sp. indet.'	676945	7436109	DExt13	1
Blattodea	*Nocticola* 'sp. indet.'	691491	7441209	DHRC010	2
Blattodea	*Nocticola* 'sp. indet.'	690832	7441805	WAH189	3
Blattodea	*Nocticola* 'sp. indet.'	693430	7441478	WAH048	8
Coleoptera	*Anillini* 'sp. indet'.	672131	7439118	WACRC332	26
Coleoptera	*Hydrobiomorpha*'sp. indet.'	665491	7437029	WAD329	2
Araneae	*Prethopalpus* 'sp indet.'	693112	7441491	WAH017	2
Isopoda	*Pseudodiploexochus* 'sp. nov.'	693112	7441491	WAH017	2
Chilopoda	*Cormocephalus* 'CHI003'	690369	7441601	WAH192	1

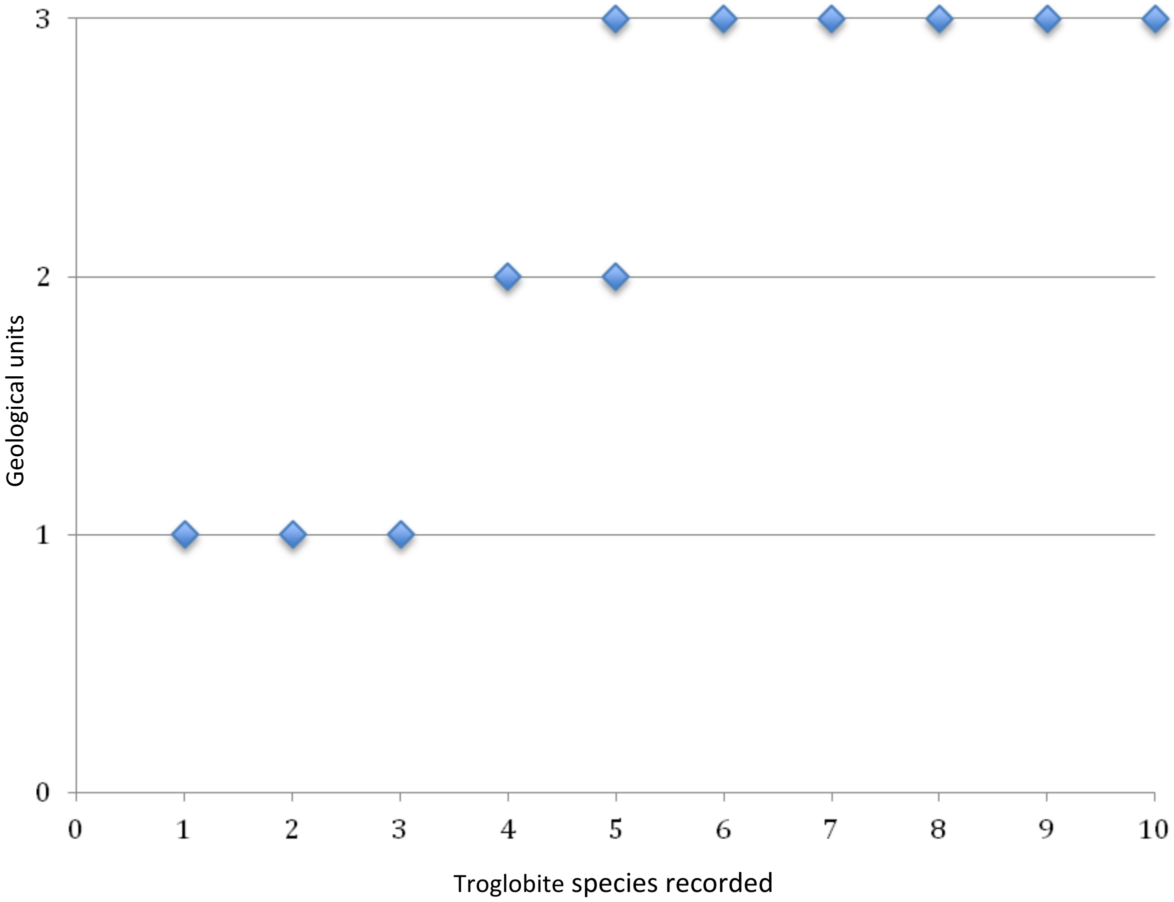

Figure 4.2 – Presence of troglobitic species in different geological units

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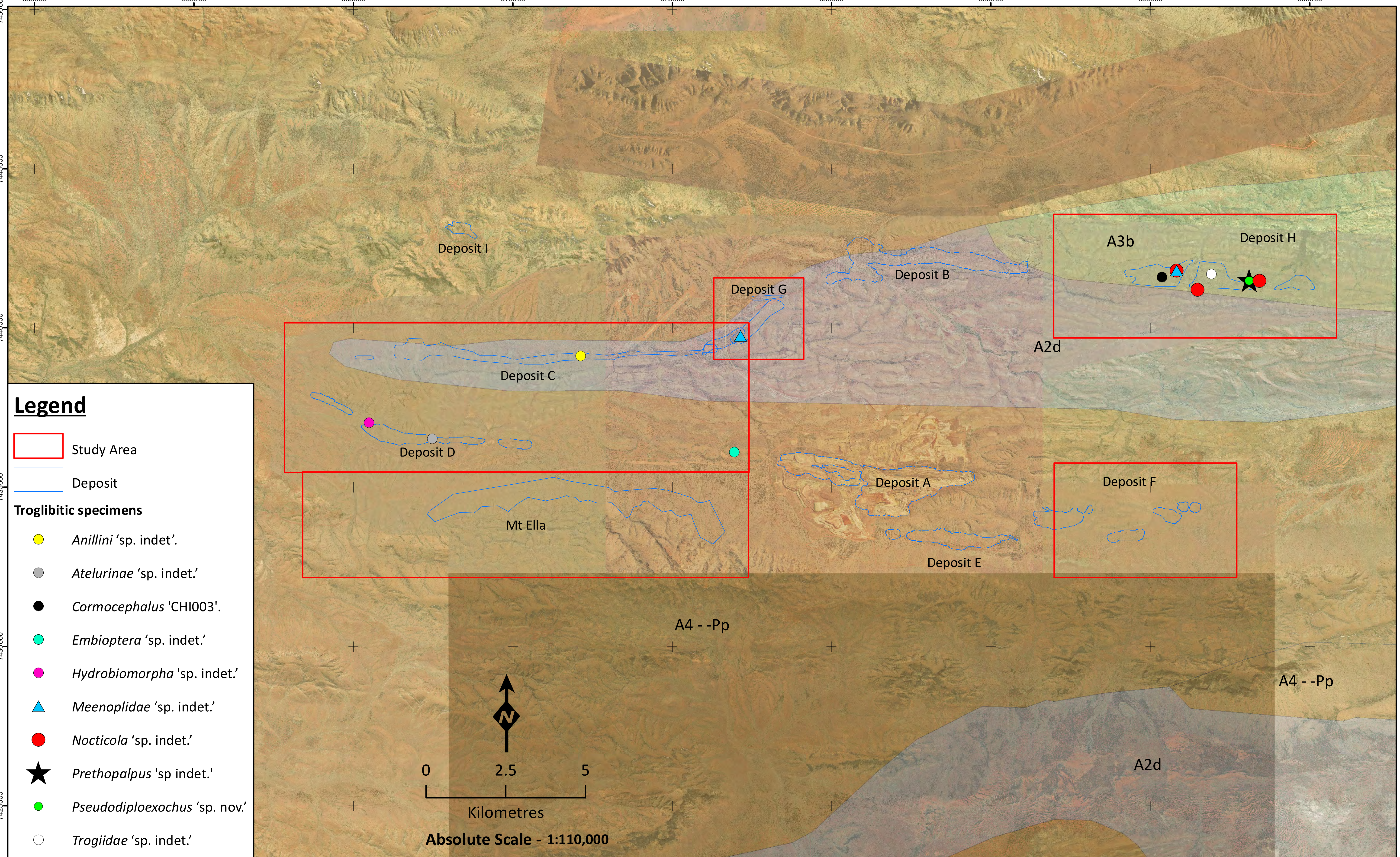

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Troglobitic specimens recorded

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Date: 12/2/2013

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

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4.3 SUMMARY OF TROGLOFAUNA GROUPS RECORDED

4.3.1 Thysanura

FAMILY NICOLETIIDAE

***Atelurinae* 'sp. Indet.'**

A single specimen was collected from Deposit D in bore WAD 358. Pilbara thysanurans are poorly known and the taxonomy of Nicoletiidae is based on their DNA sequences rather than published species descriptions. Subterranean *Atelurinae* are well known throughout the Pilbara; however, nearly all of the species recognised to date appear to be range restricted. This specimen appears to be characteristic of the Pilbara nicoletiids. This species is a **likely SRE.**

4.3.2 Psocoptera

FAMILY TROGIIDAE

***Trogiidae* 'sp. indet.'**

A single specimen was collected from Deposit D in bore DDRC 006. Only identification to family level was possible. This family of Psocoptera posses vestigial or no wings and are commonly found in soils, leaf litter and subterranean systems (Phoenix 2013). This unidentified species is likely to be a troglobite and is a **potential SRE.**

4.3.3 Hemiptera

FAMILY MEENOPLIDAE

***Meenoplidae* 'sp. indet.'**

Two specimens were collected from two bore holes within Deposits G and H, WAG 307 and WAH 189, respectively. The two specimens could not be identified to species level due to lack of taxonomic information. However, this family is considered moderately diverse in Western Australia and contains both SRE and troglobitic species. The species is considered a **potential SRE**.

4.3.4 Embioptera

FAMILY EMBIOPTERA FAM. INDET

***Embioptera* 'sp. indet.'**

A single juvenile specimen was collected from Deposit D Extension in bore DExt 13. Classification to family level was not possible because only adult males can be taxonomically identified. Little is known about troglobitic Embioptera. Generally they have limited distribution due to the flightless nature of the females, and morphologically distinct groups appear to be geographically restricted (Phoenix 2013). This species is thus considered to represent a **potential SRE**.

4.3.5 Blattodea

FAMILY NOCTICOLIDAE

***Nocticola* 'sp. indet.'**

Thirteen specimens were collected from Deposit H in bores WAH048 (8 specimens), WAH189 (3 specimens) and DHRC010 (2 specimens). The family Nocticolidae is represented by a single genus, *Nocticola.* This genus is distinguished by its small size (< 10 mm), males with membranous wings and relatively unspecialised abdominal sclerites, and wingless females. Species level identification is only possible from adult males, which are often absent in subterranean survey samples. For this reason, genomic analyses are essential in identification of *Nocticola* species (Phoenix 2013). This species is considered a **likely SRE**.

4.3.6 Coleoptera

Beetles inhabit a wide range of habitats and are the only insect order known to have both stygobitic and troglobitic representatives. A total of 28 specimens, representing two families were recorded from within the Study Area.

FAMILY CARABIDAE

***Anillini* 'sp. indet.'**

A total of 26 specimens were collected from Deposit C in bore WACRC 332. This tiny troglobitic beetle occurs in soils and leaf litter, as well as in subterranean microcaverns and voids. Very little is known about *Anillini* and hence this species is considered a **likely SRE**.

FAMILY HYDROPHILIDAE

***Hydrobiomorpha* 'sp. indet.'**

Two specimens were collected from Deposit D in bore WAD 329. This family is made up largely of aquatic species, however there are several terrestrial species that inhabit moist environments of high humidity. This *Hydrobiomorpha* specimen has no eyes and is pale in appearance, features that identify it as a possible subterranean inhabitant. As subterranean Hydrophilidae appear to be unknown from the Pilbara, despite extensive surveying of these habitats, this species is considered a **potential SRE**.

4.3.7 Araneae

FAMILY OONOPIDAE

***Prethopalpus* 'sp.indet.'**

Two specimens (male and female, Figure 4.4) were collected from Deposit H in bore WAH 017. They could not be identified to species level, as they did not key out to any species in the latest key (Baehr *et al.* 2012), which may indicate a new species. This genus is considered an obligate troglobite (WAM 2012) and a **likely SRE**.

(Photo © Western Australian Museum 2012).

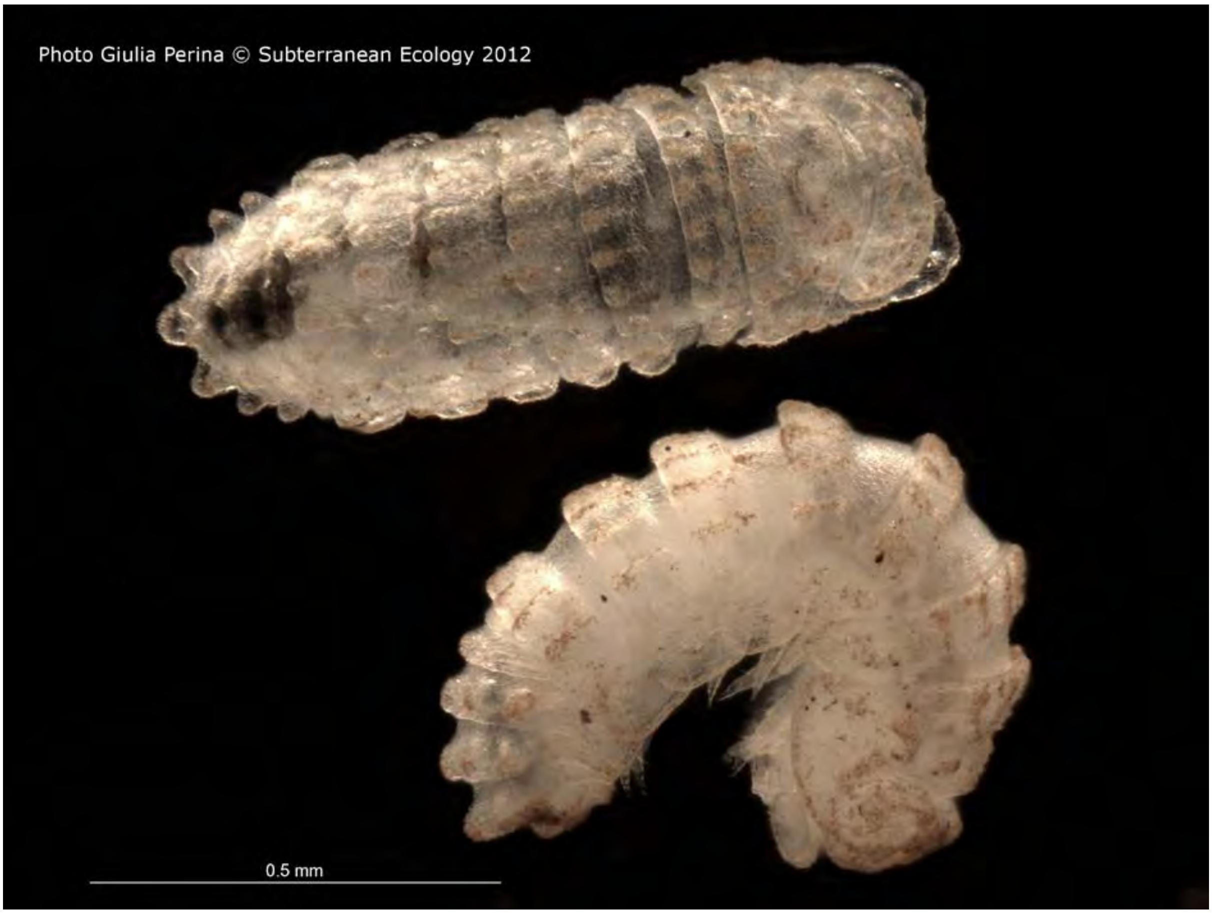
Figure 4.4 – Image of the two *Prethopalpus* 'sp. indent.' collected

4.3.8 Isopods

FAMILY ARMADILLIDAE

***Pseudodiploexochus* 'sp. nov.'**

Two specimens (one male and one female) representing a single species were recorded from Deposit H Both specimens show troglobitic characteristics such as non-pigmented bodies and extended appendages (Figure 4.5). The specimens represent a new, blind species, and the first troglobitic *Pseudodiploexochus* recorded from the region. Historically , this genus has been found more commonly in the high rainfall areas of the south-west and a number are known SRE species (Judd 2013). Other SRE *Pseudodiploexochus* species are known from the Yeelirrie/Yakabindi area and from Tropicana (previously collected by *ecologia*). As no previous records of *Pseudodiploexochus* are known from the Pilbara this species is highly **likely a SRE**.



(Photo © Subterranean Ecology 2012).

Figure 4.5 – Image of the two troglobitic *Pesudodiploexochus* 'sp. nov.' collected

4.3.9 Chilopoda

FAMILY SCOLOPENDRIDAE

***Cormocephalus* 'CHI003'**

A single specimen was collected from Deposit H in bore WAH 192. Scolopendrids are not generally considered SREs, however this specimen showed distinguishable troglobitic morphology with pale pigmentation and no eyes (Figure 4.4). This specimen is, therefore, likely to have a more restricted distribution than most scolopendrids (WAM 2012). This is the first eyeless scolopendrid specimen to be submitted to the WAM, and is considered a **likely SRE**.

(Photo © Western Australian Museum 2012).

Figure 4.6 – Image of head of troglobitic *Cormocephalus* 'CHI003' collected

4.4 SUMMARY OF STYGOFAUNA SAMPLING

Only four bores were sampled successfully for stygofauna due to poor bore conditions and lack of information on existing bores. All four bores (WAF1152, WAF 2081, WAFRC 1089 and WAFRC 1992) occur in Deposit F, the only deposit where the water table was accessible. No stygofauna were detected in any of the four bores.

4.5 GROUNDWATER PHYSICO-CHEMISTRY

Groundwater quality is measured by extracting water using sterile bailers. However, out of the four bores sampled, only one water quality reading was obtained (bore WAFCR 1152, Table 4.2), due to inability to collect water in the bailer.

Table 4.3 – Groundwater physico-chemistry data at Deposit F

Bore ID	Easting	Northing	Temperature (°C)	Conductivity (mS/cm)	Ph	D.O. (mg/L)	D.O. (% sat.)	Redox (mV)
WAFRC 1152	687438	7433973	27.8	0.003	6.43	5.59	65	201

Bore WAFRC 1152 recorded a temperature (27.8 °C) which probably reflected the atmospheric conditions at the time of day when sampling occurred. Water salinity/conductivity for the bore (0.003 mS/cm) and pH (6.43) indicates that the groundwater was fresh and mildly acidic. Dissolved oxygen (5.59mg/L at 65 % saturation) and positive redox potential (201 mV), indicating the presence of aerobic conditions in the bore.

4.6 SURVEY LIMITATIONS

The limitations of the survey are provided below in Table 4.4.

Table 4.4 – Limitations of the Subterranean Survey at the Study Area

Aspect	Limitation	Comment
Survey Adequacy	Yes	The results from the SAC analysis suggest that the survey was not adequate (24% efficiency). Drilling and bulldozing occurred at some of the survey areas, which could affect capture rates.
Method Efficiency	Possible	Survey methods complied with the EPA Guidance Statement 54a (EPA 2007). However, water quality readings were not possible due to the inability to collect water in bailers.
Seasonality	No	The survey occurred during the wet seasons and after an unusually wet period during dry season and therefore was compliant with the EPA Guidance Statement 54a (EPA 2007).
Field Personal Experience	No	Field personnel had adequate experience in subterranean surveys.
Species Identification Resolution	Yes	None of the troglobitic specimens collected could be identified to species level. The taxonomic resolution of species thus remains one of the largest limitations of the survey.
Adverse Weather Conditions	No	Weather conditions did not influence the survey

5 DISCUSSION

5.1 TROGLOFAUNA

Database searches of previous troglofauna records within the West Angelas area revealed that species of isopods, spiders and polyxenid millipedes have previously been collected in the area. Species recorded in the surrounding region also include pseudoscorpions, schizomids, harvestmen and cryptopid centipedes. In the current survey, a large proportion of the species collected were insects (orders Thysanura, Psocoptera, Hemiptera, Embioptera, Blattodea and Coleoptera), which have not been previously collected in the West Angelas area or the surrounding region.

The remainder of species recorded comprised of spiders, isopods and scolopendrid centipedes. Of these, six species are likely to have restricted distribution ranges and four are potentially restricted (Table 5.1). Only *Prethopalpus* and *Cormocephalus* have been recorded previously in the area and the remaining eight genera/families represent new records. In addition, the spider *Prethopalpus* 'sp indet.' and the isopod *Pseudodiploexochus* 'sp. nov.' (first to be recorded in the Pilbara region) represent new species. The centipede *Cormocephalus* 'CHI003' represents the first eyeless scolopendrid specimen to be presented to WAM.

Table 5.1 – Summary of troglobitic fauna

Order	Genus/Species	SRE status	Geology*	Deposit
Blattodea	*Nocticola* 'sp. indet.'	Likely	MV	H
Araneae	*Prethopalpus* 'sp indet.'	Likely	MV	H
Isopoda	*Pseudodiploexochus* 'sp. nov.'	Likely	MV	H
Chilopoda	*Cormocephalus* 'CHI003'.	Likely	MV	H
Thysanura	*Atelurinae* 'sp. indet.'	Likely	S	D
Coleoptera	*Anillini* 'sp. indet'.	Likely	DG	C
Coleoptera	*Hydrobiomorpha*'sp. indet.'	Potential	S	D
Embioptera	*Embioptera* 'sp. indet.'	Potential	S	D ext
Hemiptera	*Meenoplidae* 'sp. indet.'	Potential	DG, MV	G,H
Psocoptera	*Trogiidae* 'sp. indet.'	Potential	MV	H

*S – sedimentary, DG – Dolerites and Gabbros, MV – mafic volcanics

Such a diverse sample indicates a rich fauna assemblage. Furthermore, a closer examination of the species distribution within the geological units of the Study Area (i.e. sedimentary, mafic volcanics and dolerites and gabbros, Figure 4.3 shows that, with the exception of Meenoplidae sp. indet., there is no overlap of species between different geological units. In other words, each geological unit seems to harbour a different troglofauna assemblage.

Importantly, such results may be an artefact of a low sample size, because the survey efficiency has been estimated by SACs to be 24%, which suggests that only a quarter of the diversity has been sampled. Influences such as survey effort and seasonality may have impacted on capture rates, although survey timing was consistent with relevant guidelines (Section 1.2). Relatively low survey adequacy (based on SACs) is common in pilot subterranean surveys, such as this.

Further sampling could potentially establish records of most species across all geologies, demonstrating that all species belong to the same troglofauna assemblage. This argument could also be reversed, however, as it is also possible that the SAC's algorithm has been influenced by the concentration of species in certain locations (i.e. geological units), in which case the SAC curve would be an artefact of the pooling together of separate troglofauna assemblages. In this case, further sampling would deepen the species diversification between geological units, demonstrating little or no connectivity between different geologies.

The majority of species were recorded from Deposit H, which is the only deposit of the current Study Area located within mafic volcanic rocks. This type of rock can be very porous, and thus it probably presents the most suitable troglofauna habitat in the Study Area. Geologically, there is some overlap with Deposit B (not part of this survey).

Deposits C and G were found to harbour one species each and are located within dolerites and gabbros. These types of rocks are usually solid with little porosity therefore fractures within the rock probably present the only suitable troglofauna habitat.

Deposit D and D extension are located within sedimentary rocks and collectively recorded three species. The sedimentary rocks can range from solid and compact (e.g. shale) to loose (e.g. breccia) and/or cavernous (e.g. karst limestone), and thus present potentially suitable troglofauna habitat. Geologically, there is overlap with Deposit A (not part of this survey).

In summary, the troglofauna species collected from the Study Area were of conservation significance. Further sampling is recommended to clarify the composition and the extent of the troglobitic assemblage, its potential restriction to the geological units and the impact that the Project may have on the species

As many troglobitic species are understudied or yet to be discovered, it is also recommended that all specimens (those already collected as well as any future collections) undergo DNA assessment to ascertain correct species matching and thus their true distribution in the Study Area and its surrounds. Given that the mafic volcanics and dolerite and gabbros geological units found in the Study Area are completely surrounded by sedimentary rocks (Figure 2.3), it is likely that species inhabiting them are restricted to these island-like, isolated units; especially if further evidence suggests that each geology harbours different troglofauna assemblages.

5.2 STYGOFAUNA

Historically, stygofauna surveys have focused on two borefields adjoining the West Angelas area; Turee Creek B and West Angelas (Biota 2003; *ecologia* 1998b),. While the borefields were located within open aquifers and their sampling has yielded amphipods, cyclopoid copepods and bathynelaceae (*ecologia* 1998b), the sampling within Deposit A returned no stygofauna (Biota 2003, 2008). Biota (2008) assessed the Deposit A as a closed aquifer - i.e. low hydraulic connectivity aquifer, also called an aquitard; (Hahn and Fuchs 2009) and unlikely to contain any stygofauna.

The current survey was limited to four accessible bores in Deposit F. No stygofauna was collected from any of the four bores.

Given that the geology of deposits D and D extension and F are dominated by sedimentary rocks, as is Deposit A (Figure 2.2), it is possible that these deposits will have similarly low hydraulic conductivity and thus be less suitable for stygofauna. The remaining deposits, on the other hand, are composed of intrusive igneous rocks (dolerites and gabbros; deposits C and G) and extrusive igneous rocks (mafic volcanics; Deposit H) and thus may form different types of aquifers, potentially suitable for stygofauna.

In summary, the current stygofauna sampling cannot be considered adequate due to its low sample size and limited spatial coverage. Further sampling is recommended, particularly in deposits C, D, D extension, G and H

6 CONCLUSIONS

The main conclusions of the baseline subterranean survey carried out at the Greater West Angelas Study Area are as follows:

- The survey methods were consistent with the EPA Guidance Statements 54 and 54a;
- No species listed under the EPBC Act, WC Act or by the DEC as critical, endangered or vulnerable were recorded during the survey;
- The troglofauna survey yielded 109 invertebrate specimens representing 11 orders. Of these, 10 species were identified as troglobitic, comprising Thysanura (silverfish), Psocoptera (booklice), Hemiptera (true bugs), Embioptera (webspinners), Blattodea (cockroaches), Coleoptera (beetles), Araneae (spiders), Isopoda (slaters) and Chilopoda (centipedes). Non-troglobitic specimens included Collembola (springtails), Blattodea, Coleoptera, Araneae and Diplopoda (millipedes);
- Only *Prethopalpus* and *Cormocephalus* have been recorded previously in the area, the remaining eight genera/families represent new records. In addition, the spider *Prethopalpus* 'sp indet.' and the isopod *Pseudodiploexochus* 'sp. nov.' (first to be recorded in the Pilbara region) represent new species. The centipede *Cormocephalus* 'CHI003' represents the first eyeless scolopendrid specimen. Most species were collected in low abundance (singletons and doubletons) and they mostly originated from inside deposit areas.
- There was little overlap of species between different geological units, suggesting potential barriers in habitat connectivity and implying isolated species assemblages. However, this could be an artefact of low sample size (i.e. 24 % survey efficiency), which can be resolved with further sampling;
- The species accumulation curve (SAC) indicated that the troglofauna survey was not adequate (24% efficiency), however such result could be skewed in case troglofauna was partitioned into separate, isolated assemblages.
- It is recommended that all troglofauna specimens (those already collected as well as any future collections) undergo DNA assessment to ascertain correct species matching and thus their true distribution in the Study Area and its surrounds for future impact assessment; and
- The stygofauna survey was limited to four accessible bores in Deposit F. No stygofauna was collected from any of the four bores. Thus, the stygofauna sampling cannot be considered adequate. Further sampling is recommended, particularly in deposits C, D, D extension, G and H.

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7 STUDY TEAM

The Rio Tinto Greater West Angelas Subterranean Fauna Survey described in this document was planned, coordinated, and executed by:

ecologia Environment

1025 Wellington Street

WEST PERTH WA 6005

Project Staff:

Lazaro Roque-Albelo,	BSc, MSc, PhD, Principal Zoologist
Kellie Honczar	BSc, Principal Ecologist
Magdalena Davis	BSc, MSc, PhD, Senior Invertebrate Zoologist
MC Leng	BSc (Hon), Invertebrate Zoologist
Bruce Greatwich	BSc, Zoologist
Sean White	Invertebrate Zoologist

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APPENDIX A SUBTERRANEAN SAMPLING SITES AND NOTES

Subterranean sampling sies in the Study Area (bold indicates stygofauna sampling)

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
Deposit C									
DCDD002	23°8`44.755``S	118°38`19.973``E	667790	7439400	50	20	30		
DCDD003	23°8`48.691``S	118°38`47.298``E	668565	7439270	50	20	31		
DCDD006	23°8`54.335``S	118°40`25.892``E	671368	7439065	50	50	77	60.5	
DCRC001	23°8`44.377``S	118°37`37.035``E	666568	7439425	50				could not be located
DCRC001	23°8`40.477``S	118°37`51.61``E	666984	7439541	50	15	20		
DCRC002	23°8`42.111``S	118°37`51.408``E	666978	7439490	50				blocked @ 2m
DCRC004	23°8`55.317``S	118°39`29.699``E	669769	7439053	50	40	48		
DCRC005	23°8`57.293``S	118°39`58.182``E	670579	7438983	50				blocked @ 15m
DCRC007	23°8`49.647``S	118°37`23.148``E	666172	7439268	50	20	25		
DCRC008	23°8`46.082``S	118°37`23.161``E	666173	7439377	50				plug stuck
DCRC009	23°8`44.541``S	118°37`23.289``E	666177	7439425	50				could not be located
DCRC010	23°8`42.847``S	118°37`23.266``E	666177	7439477	50	30	35		
WAC071	23°8`44.063``S	118°37`37.284``E	666576	7439435	50	10	16.6		
WAC077	23°8`40.854``S	118°37`37.258``E	666576	7439534	50				blocked @ 10m
WAC089	23°8`54.175``S	118°39`1.3``E	668962	7439097	50	30	41		
WAC197	23°10`39.036``S	118°42`32.592``E	674934	7435802	50	20	28		
WAC283	23°8`54.463``S	118°40`26.001``E	671371	7439061	50				blocked
WAC301	23°8`44.666``S	118°38`4.93``E	667362	7439408	50	30	35		
WAC306	23°8`47.887``S	118°38`33.141``E	668163	7439299	50	30	36		original depth 146m
WAC313	23°8`53.692``S	118°39`15.423``E	669364	7439107	50	10	14		original depth 144m
WAC318	23°8`57.087``S	118°39`45.195``E	670209	7438993	50	40	50		original depth 52m
WAC321	23°8`57.306``S	118°39`58.231``E	670580	7438982	50	40	52		original depth 100m
WAC324	23°8`55.312``S	118°40`11.572``E	670960	7439039	50	20	26.9		
WAC329	23°8`51.181``S	118°40`39.625``E	671760	7439157	50	40	58	54	

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
WAC335	23°8`50.885``S	118°41`6.814``E	672533	7439157	50	40	60	54	
WACRC332	23°8`52.314``S	118°40`52.694``E	672131	7439118	50	40	46		
Deposit D									
DD002	23°9`46.652``S	118°36`4.26``E	663908	7437539	50				could not be located
DD004	23°10`18.429``S	118°37`10.617``E	665785	7436541	50				could not be located
DD005	23°10`15.343``S	118°37`11.082``E	665799	7436635	50				could not be located
DDDD001	23°9`38.231``S	118°36`4.522``E	663919	7437798	50	40	45		no plug
DDRC003	23°10`20.374``S	118°37`10.573``E	665783	7436481	50				blocked @ 7m
DDRC006	23°10`16.981``S	118°37`10.549``E	665783	7436585	50	10	20		
WAD148	23°10`18.216``S	118°38`9.789``E	667468	7436528	50				blocked @ 2m
WAD152	23°10`19.782``S	118°38`9.712``E	667465	7436480	50				blocked @ 10 m
WAD201	23°10`7.257``S	118°36`59.892``E	665484	7436888	50	10	17		
WAD225	23°9`39.969``S	118°36`4.455``E	663916	7437745	50	20	34		
WAD235	23°10`41.951``S	118°43`14.85``E	676135	7435698	50	40	59		
WAD256	23°10`12.782``S	118°37`27.779``E	666275	7436709	50	10	17		
WAD259	23°10`19.185``S	118°38`9.71``E	667465	7436499	50				blocked at surface
WAD273	23°10`17.802``S	118°37`27.651``E	666269	7436555	50		1		blocked
WAD328	23°10`26.984``S	118°41`13.943``E	672702	7436199	50				plug stuck
WAD329	23°10`2.67``S	118°37`0.115``E	665491	7437029	50	40	44		
WAD331	23°10`9.294``S	118°36`59.96``E	665485	7436825	50				blocked @ 8m
WAD333	23°10`13.212``S	118°37`0.168``E	665489	7436704	50	40	44		original depth 46
WAD334	23°10`18.479``S	118°37`10.565``E	665783	7436539	50				blocked @ 10 m
WAD343	23°10`17.782``S	118°37`27.688``E	666270	7436555	50	40	46		original depth 106
WAD346	23°10`22.641``S	118°37`27.742``E	666270	7436406	50	30	46		
WAD354	23°10`19.018``S	118°37`41.837``E	666672	7436513	50	50	64	61	original depth 112m
WAD358	23°10`18.251``S	118°38`9.905``E	667471	7436527	50	10	15		original depth 46m
WAD361	23°10`22.214``S	118°38`24.102``E	667873	7436401	50	50	68	58	original depth 106m

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
WAD363	23°10`20.386``S	118°38`37.468``E	668254	7436453	50	20	29		original depth 64m
WAD366	23°10`19.528``S	118°38`52.037``E	668669	7436475	50	50	72	60.4	original depth 82m
WAD374	23°10`25.453``S	118°39`35.203``E	669894	7436278	50	20	31		
WAD379	23°10`25.013``S	118°39`49.898``E	670312	7436287	50	50	64	61	
Deposit D and D extension									
WAD379B	23°10`24.959``S	118°40`17.702``E	671103	7436280	50	40	50		
WAD383	23°10`28.511``S	118°41`14``E	672703	7436152	50	30	68		
WAD396	23°10`41.472``S	118°43`42.918``E	676933	7435704	50	50	70		
WAD400	23°10`40.942``S	118°43`57.244``E	677341	7435715	50	40	75		
WAD439	23°10`28.597``S	118°41`0.132``E	672308	7436154	50	30	39		
WAD441	23°10`27.917``S	118°40`46.074``E	671909	7436179	50	40	82	80	
WAD447	23°10`28.869``S	118°40`32.076``E	671510	7436155	50	20	83	76	
WADRC0425	23°10`34.547``S	118°41`53.246``E	673817	7435953	50	60	64		
WADRC0432	23°10`34.684``S	118°41`41.914``E	673494	7435953	50	40	94	86	
WADRC0436	23°10`31.627``S	118°41`28.052``E	673101	7436051	50				plug stuck
WADRC438	23°10`34.848``S	118°41`28.215``E	673105	7435952	50	50	89	78	
DExt01	23°10`33.656``S	118°42`4.581``E	674139	7435977	50	30	35		
DExt02	23°10`34.484``S	118°42`18.786``E	674543	7435947	50				could not be located
DExt03	23°10`35.23``S	118°42`18.599``E	674538	7435924	50				plug blocked
DExt04	23°10`37.788``S	118°42`18.607``E	674537	7435845	50	50	60		
DExt05	23°10`40.086``S	118°42`46.741``E	675336	7435765	50	50	61		
DExt06	23°10`42.577``S	118°43`0.872``E	675737	7435684	50				could not be located
DExt07	23°10`40.895``S	118°43`0.872``E	675738	7435735	50				blocked at surface
DExt08	23°10`28.127``S	118°43`28.733``E	676535	7436119	50				blocked at surface
DExt09	23°10`34.625``S	118°43`28.728``E	676532	7435919	50		2		blocked
DExt10	23°10`37.733``S	118°43`28.837``E	676534	7435823	50				blocked at surface
DExt11	23°10`45.763``S	118°43`28.985``E	676535	7435576	50	60	73		

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
DExt12	23°10`21.704``S	118°43`42.995``E	676943	7436312	50	10	17		
DExt13	23°10`28.278``S	118°43`43.149``E	676945	7436109	50	10	14		
DExt14	23°10`26.977``S	118°41`14.029``E	672704	7436199	50				could not be located
DExt15	23°10`22.727``S	118°40`4.089``E	670717	7436353	50				could not be located
Deposit F									
DFRC001	23°11`44.748``S	118°51`0.044``E	689340	7433604	50	40	62		
F475	23°11`44.593``S	118°51`7.167``E	689543	7433606	50	40	64		
F98	23°11`14.903``S	118°52`24.61``E	691756	7434492	50	30	72		
WAF1098	23°11`45.23``S	118°51`15.499``E	689779	7433584	50		16		original depth 120m
WAF1152	**23°11`33.555``S**	**118°49`53.001``E**	**687438**	**7433973**	**50**		**111**	**96.4**	**6 hauls 90mm nets**
WAF2081	**23°11`50.139``S**	**118°51`19.55``E**	**689892**	**7433431**	**50**		**127**	**117**	**6 hauls 90mm nets**
WAFPLF438	23°11`47.315``S	118°50`58.35``E	689291	7433526	50		104		
WAFRC1076	23°11`34.233``S	118°49`47.883``E	687292	7433954	50	80	118	95	
WAFRC1089	**23°11`54.473``S**	**118°50`47.448``E**	**688978**	**7433310**	**50**	**80**	**160**	**113**	**6 hauls 90mm nets**
WAFRC1141	23°11`35.81``S	118°49`51.144``E	687384	7433904	50	40	87		
WAFRC1159	23°11`29.294``S	118°49`56.619``E	687542	7434102	50	40	64		
WAFRC1164	23°11`38.105``S	118°50`0.216``E	687641	7433830	50	40	58		
WAFRC1267	23°11`44.023``S	118°50`58.42``E	689294	7433627	50		56		
WAFRC1299	23°11`56.185``S	118°50`49.313``E	689030	7433256	50		76		original depth 124m
WAFRC1361	23°11`49.511``S	118°51`14.114``E	689738	7433453	50	80	124.8	116	
WAFRC1464	23°11`21.563``S	118°51`44.4``E	690610	7434301	50	20	35		original depth 52m
WAFRC1510	23°11`33.688``S	118°51`49.612``E	690754	7433926	50	60	106		
WAFRC1558	23°11`26.142``S	118°51`54.978``E	690909	7434157	50	80	88		
WAFRC1590	23°11`18.382``S	118°52`1.745``E	691105	7434393	50	20	30		original depth 52m
WAFRC1640	23°11`16.213``S	118°52`19.395``E	691608	7434453	50	40	80		
WAFRC1902	23°11`45.002``S	118°50`40.37``E	688780	7433604	50	10	12		original depth 40m
WAFRC1991	23°11`35.875``S	118°49`42.502``E	687138	7433905	50	80	130	92	

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
WAFRC1992	**23°11`39.252``S**	**118°49`42.705``E**	**687143**	**7433801**	**50**		**111**	**91**	**original depth 112m, 6 hauls 90mm nets**
WAFRC821	23°11`21.015``S	118°51`44.474``E	690613	7434318	50				could not be located
WFPC1297	23°11`58.026``S	118°50`47.585``E	688980	7433200	50		93		blocked
Deposit G									
WAG068	23°8`32.715``S	118°43`41.73``E	676946	7439665	50	40	52		
WAG070	23°8`29.513``S	118°43`41.872``E	676952	7439763	50	10	15		
WAG304	23°8`36.374``S	118°43`34.502``E	676739	7439554	50	30	40		
WAG307	23°8`29.688``S	118°43`48.58``E	677142	7439755	50	15	19		
WAG319	23°8`29.94``S	118°43`34.522``E	676742	7439752	50	50	110	60	original depth 112m
WAGRC321	23°8`28.349``S	118°43`34.417``E	676740	7439801	50	50	84	68	original depth 113m
Deposit H									
DHRC001	23°7`32.768``S	118°53`8.149``E	693083	7441309	50	50	60	56	
DHRC002	23°7`26.743``S	118°52`55.498``E	692726	7441499	50	40	45		
DHRC003	23°7`19.3``S	118°52`41.218``E	692322	7441733	50	40	64	57	
DHRC004	23°7`22.716``S	118°52`40.879``E	692311	7441628	50	30	41		
DHRC005	23°7`26.58``S	118°52`26.818``E	691910	7441514	50				blocked @ 8m
DHRC006	23°7`20.887``S	118°52`26.996``E	691917	7441689	50	40	72	52	
DHRC008	23°7`30.014``S	118°52`12.496``E	691501	7441414	50	50	68		
DHRC009	23°7`33.397``S	118°52`11.925``E	691483	7441310	50				blocked
DHRC010	23°7`36.683``S	118°52`12.232``E	691491	7441209	50	20	25		
DHRC011	23°7`25.113``S	118°52`1.156``E	691180	7441569	50				blocked
WAH 193	23°7`31.464``S	118°51`8.236``E	689672	7441393	50	50	67		
WAH002	23°7`18.062``S	118°52`12.053``E	691493	7441782	50	50	70		
WAH017	23°7`26.829``S	118°53`9.081``E	693112	7441491	50	30	44	40	
WAH047	23°7`30.333``S	118°53`20.034``E	693422	7441379	50				blocked
WAH048	23°7`27.11``S	118°53`20.279``E	693430	7441478	50	30	35		

Deposit Bore Name	Latitude	Longitude	Easting	Northing	Zone	Trog Trap Depth (m)	Total Bore Depth (m)	Depth to Water (m)	Notes
WAH054	23°7`23.865``S	118°51`49.05``E	690836	7441612	50	60	95	85	
WAH176	23°7`28.737``S	118°51`40.573``E	690593	7441465	50	20	24		
WAH179	23°7`31.662``S	118°51`20.463``E	690020	7441382	50	20	28		
WAH189	23°7`17.599``S	118°51`48.804``E	690832	7441805	50	40	46		
WAH192	23°7`24.416``S	118°51`32.646``E	690369	7441601	50	10	13		
WAH194	23°7`18.269``S	118°51`33.269``E	690389	7441790	50	40	52		

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APPENDIX B TOTAL INVERTEBRATE SPECIMENS COLLECTED

Invertebrate specimens collected from Deposits C, D, D extension, F, G and H, with troglobitic specimens in bold.

		Bore ID Deposit C																		
Order	**Family/Genus/Species**	**DCRC001**	**DCDD003**	**DCDD006**	**DCRC004**	**DCRC007**	**DCRC010**	**WAC071**	**WAC089**	**WAC197**	**WAC301**	**WAC306**	**WAC313**	**WAC318**	**WAC321**	**WAC324**	**WAC329**	**WAC335**	**WACRC332**	**DDRC006**
Symphypleona	Sminthuridae 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Thysanura	**Atelurinae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Psocoptera	**Trogiidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Hemiptera	**Meenoplidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Embioptera	**Embioptera 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blattodea	Blattaria 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattodea	**Nocticola 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	**Anillini 'sp. indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**0**
Coleoptera	Hydrobiomorpha'sp. indet.'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	Gnaphosidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	**Prethopalpus 'sp indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Theridiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	**Pseudodiploexochus 'sp. nov.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chilopoda	**Cormocephalus 'sp.indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diplopoda	Lophoproctidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0

		Bore ID Deposit D																						
Order	**Family/Genus/Species**	**WAD201**	**WAD225**	**WAD235**	**WAD256**	**WAD329**	**WAD333**	**WAD343**	**WAD346**	**WAD354**	**WAD358**	**WAD361**	**WAD363**	**WAD366**	**WAD374**	**WAD379**	**WAD379B**	**WAD383**	**WAD396**	**WAD400**	**WAD439**	**WAD441**	**WAD447**	**WADR0425**
Symphypleona	Sminthuridae 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thysanura	**Atelurinae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Psocoptera	**Trogiidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Hemiptera	**Meenoplidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Embioptera	**Embioptera 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blattodea	Blattaria 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattodea	**Nocticola 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	**Anillini 'sp. indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	Hydrobiomorpha'sp. indet.'	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Gnaphosidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	**Prethopalpus 'sp indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Theridiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	**Pseudodiploexochus 'sp. nov.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chilopoda	**Cormocephalus 'sp.indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diplopoda	Lophoproctidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	3	0

		Bore ID Deposit D continued																							Bore ID Deposit D Extension						
Order	**Family/Genus/Species**	**WAD201**	**WAD225**	**WAD235**	**WAD256**	**WAD329**	**WAD333**	**WAD343**	**WAD346**	**WAD354**	**WAD358**	**WAD361**	**WAD363**	**WAD366**	**WAD374**	**WAD379**	**WAD379B**	**WAD383**	**WAD396**	**WAD400**	**WAD439**	**WAD441**	**WAD447**	**WADR0425**	**WADR0432**	**WADRC438**	**DExt01**	**DExt05**	**DExt11**	**DExt12**	**DExt13**
Symphypleona	Sminthuridae 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thysanura	**Atelurinae ‘sp. indet.’**	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psocoptera	**Trogiidae ‘sp. indet.’**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemiptera	**Meenoplidae ‘sp. indet.’**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Embioptera	**Embioptera ‘sp. indet.’**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Blattodea	Blattaria 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattodea	**Nocticola ‘sp. indet.’**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	**Anillini ‘sp. indet’.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Hydrobiomorpha’sp. indet.’	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	Gnaphosidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	**Prethopalpus 'sp indet.'**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	Theridiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	**Pseudodiploexochus ‘sp. nov.’**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chilopoda	**Cormocephalus 'sp.indet'.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplopoda	Lophoproctidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	3	0	0	0	0	0	1	0	3

		Bore ID Deposit F																			Bore ID Deposit G					
Order	**Family/Genus/Species**	**DFRC001**	**F475**	**F98**	**WAFRC1076**	**WAFRC1089**	**WAFRC1141**	**WAFRC1159**	**WAFRC1164**	**WAFRC1267**	**WAFRC1361**	**WAFRC1464**	**WAFRC1510**	**WAFRC1558**	**WAFRC1590**	**WAFRC1640**	**WAFRC1902**	**WAFRC1991**	**WAFRC1992**	**WFPC1297**	**WAG068**	**WAG070**	**WAG304**	**WAG307**	**WAG319**	**WAGRC321**
Symphypleona	Sminthuridae 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thysanura	**Atelurinae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Psocoptera	**Trogiidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Hemiptera	**Meenoplidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Embioptera	**Embioptera 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blattodea	Blattaria 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattodea	**Nocticola 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	**Anillini 'sp. indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	Hydrobiomorpha'sp. indet.'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Gnaphosidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	**Prethopalpus 'sp indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Theridiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	**Pseudodiploexochus 'sp. nov.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chilopoda	**Cormocephalus 'sp.indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diplopoda	Lophoproctidae	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	0	1	4	0	9	0	0

		Bore ID Deposit H																
Order	**Family/Genus/Species**	**DHRC001**	**DHRC002**	**DHRC003**	**DHRC004**	**DHRC006**	**DHRC008**	**DHRC010**	**WAH002**	**WAH017**	**WAH048**	**WAH054**	**WAH176**	**WAH179**	**WAH189**	**WAH192**	**WAH193**	**WAH194**
Symphypleona	Sminthuridae 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thysanura	**Atelurinae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Psocoptera	**Trogiidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Hemiptera	**Meenoplidae 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
Embioptera	**Embioptera 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blattodea	Blattaria 'sp. epigean'	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Blattodea	**Nocticola 'sp. indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**8**	**0**	**0**	**0**	**3**	**0**	**0**	**0**
Coleoptera	**Anillini 'sp. indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coleoptera	Hydrobiomorpha'sp. indet.'	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Gnaphosidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Araneae	**Prethopalpus 'sp indet.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Araneae	Theridiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Isopoda	**Pseudodiploexochus 'sp. nov.'**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chilopoda	**Cormocephalus 'sp.indet'.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Diplopoda	Lophoproctidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

APPENDIX C PREVIOUS SUBTERRANEAN RESULTS

Class (order)	**Family**	**Taxa**
Arachnida (Prostigmata)		
	Bdellidae	not specified
Arachnida (Oribatida)		
	not specified	not specified
Arachnida (Trombidioidea)		
	not specified	not specified
Arachnida (Palpigradida)		
	not specified	not specified
Arachnida (Schizomida)		
	Hubbardiidae	not specified
Arachnida (Pseudoscorpiones)		
	Olpiidae	Sub-adult
Chilopoda (Scolopendrida)		
	Cryptopidae	*Cryptops* sp.
Diplopoda (Polyxenida)		
	not specified	not specified
	Polyxenidae	not specified
Insecta (Hemiptera)		
	Emesinae	not specified
Insecta (Coleoptera)		
	not specified	not specified
Insecta (Blattodea)		
	Nocticolidae	*Nocticola* sp.
Malacostraca (Bathynellacea)		
	Parabathynellidae	not specified
Malacostraca (Amphipoda)		
	not specified	not specified
Malacostraca (Bathynellacea)		
	Bathynellidae	not specified
	Parabathynellidae	*Billibathynella* new species 3
		Billibathynella n. sp. 2 & 3
Malacostraca (Isopoda)		
	not specified	not specified
	Oniscoid	not specified
Oligochaeta (Haplotaxida)		
	Phreodrilidae	*Insulodrilus angela*
	Phreodrilidae	immature
	Enchytraeidae	spp.
Pauropoda (Pauropodina)		
		Allopauropus n. sp. 2
		Allopauropus n. sp. 1