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Orebody 32 East AWT (Above Water Table) Terrestrial Short-Range Endemic Fauna Environmental Impact Assessment

BHP Billiton Iron Ore Pty Ltd

April 2015

Orebody 32 East AWT (Above Water Table)
Terrestrial Short-Range Endemic Fauna
Environmental Impact Assessment

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EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is preparing referrals to the Environmental Protection Authority (EPA) to develop a new mining operation at the Orebody 32 East Above Water Table (AWT) project. The Orebody 32 East AWT project is located approximately five kilometres (km) northeast of Newman and immediately west of BHP Billiton Iron Ore's existing Orebody 24 mining operations, within Mineral Lease *ML244SA*.

Biologic Environmental Survey Pty Ltd (Biologic) has been commissioned to undertake an environmental impact assessment (EIA) of short-range endemic (SRE) invertebrate fauna within the Development Envelope for the Orebody 32 East AWT project (Figure 1.2). In 2013, Biologic conducted a two-season baseline survey of SRE fauna within the Development Envelope and the surrounding local area (referred to as the OB24-25 SRE Survey), which has provided detailed information on the key SRE values relevant to this assessment.

This report provides:

- a review of relevant literature, previous survey reports, and SRE database records within the Development Envelope and the surrounding local area;
- a description of the methods and results of the OB24-25 SRE Survey;
- identification of key SRE values (comprising SRE species, conservation significant species, and important SRE habitats) within the Development Envelope and the surrounding local area; and
- an assessment of potential impacts to key SRE values (including discussion of potential impact receptors, pathways and magnitude).

Ten sites within the Development Envelope were sampled by active foraging and leaf litter/ soil sifting during the OB24-25 SRE Survey. Six of these sites were sampled twice; *i.e.* sampling was repeated during the wet season and the dry season of 2013. A further 114 sites were sampled in the surrounding local area during the OB24-25 SRE Survey. The sampling effort within the Development Envelope reflected the relatively low diversity and suitability of the habitats present (compared with the more complex and highly suitable habitats nearby at Orebody 24 and Orebody 25).

The habitats of the Development Envelope were categorised into two SRE habitat zones comprising the Low hills zone and the Sandplain zone. The Low hills zone featured small foothills and ridges incised by mainly shallow gullies, whereas the Sandplain zone was dominated by flat, open plains and occasional vegetation groves. Overall, the suitability of these habitat zones for SRE species was regarded as moderate to low due to the lack of highly sheltered, complex microhabitats, and the high level of habitat connectivity with similar adjacent areas outside of the Development Envelope.

A total of 15 species and morphospecies were detected within the Development Envelope, comprising 12 widespread or data-deficient taxa, and three Potential SRE taxa:

- a mygalomorph spider, *Cethegus* `MYG299-DNA` and

- two isopods, *Buddelundia* `16NM`, and *B.* `49`.

Each of the Potential SRE taxa were also recorded beyond the Development Envelope within the surrounding local area, and from regional records further afield. Owing to the fact that none of the Potential SRE species were restricted to the Development Envelope, the proposed development at Orebody 32 East AWT was considered to have a negligible direct impact on SRE species.

Similarly, each of the Potential SRE species were found within a range of habitat zones that have been shown to extend beyond the Development Envelope, therefore the direct impact on SRE habitats is considered low. This finding is also attributed to the relatively small size of the Development Envelope and the moderate to low suitability of the habitat zones within the Development Envelope.

The small size of the Development Envelope is also a major factor in the low likelihood of any indirect impacts to SRE values; such as indirect impacts from habitat fragmentation, changes to surface hydrology, vibration/ noise/ dust, and groundwater hydrology (particularly as the proposed development is above water table). Any indirect impacts from environmental incidents such as introduced flora/ fauna species, fire, and spills/ contamination would be expected to be further mitigated by the extension of current environmental management processes in place at the Orebody 24, Orebody 25 and Orebody 23 mining operations.

1. INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is preparing referrals to the Environmental Protection Authority (EPA) to develop the Orebody 32 East Above Water Table (AWT) project. The Orebody 32 East AWT project is located approximately five kilometres (km) northeast of Newman and immediately west of BHP Billiton Iron Ore's existing Orebody 24 mining operations (Figure 1.1). The project is within Mineral Lease *ML244SA*, which is subject to *the Iron Ore (Mount Newman) Agreement Act 1964 (Newman Agreement Act)*. Orebody 32 has not previously been developed and as such, the Orebody 32 East AWT project is considered a greenfield development.

BHP Billiton Iron Ore has commissioned Biologic Environmental Survey Pty Ltd (Biologic) to conduct an environmental impact assessment (EIA) of short-range endemic (SRE) invertebrate fauna values within the Development Envelope of the Orebody 32 East AWT project (Figure 1.2). Biologic (2014a) has previously conducted a baseline survey of SRE invertebrate fauna within the Development Envelope and the surrounding local area (hereafter referred to as the OB24-25 SRE Survey), and has incorporated the results from all previous surveys within the Development Envelope and surrounds.

This report provides:

- a review of relevant literature, previous survey reports, and SRE database records within the local area surrounding the Development Envelope;
- a description of the methods and results of the targeted SRE survey;
- identification of SRE values (comprising SRE species, conservation significant species, and important SRE habitats) within the Development Envelope and surrounds; and
- an assessment of potential impacts to SRE values (including discussion of potential impact receptors, pathways and magnitude) from the proposed development.

1.1 Project Description

1.1.1 Environmental Approvals

A Native Vegetation Clearing Permit (NVCP) has been granted by the Department of Mines and Petroleum (DMP) (29 September 2014) to construct a trial pit at Orebody 32, and associated haul road and infrastructure within the Development Envelope (Figure 1.2). The NVCP included the clearing of up to 30 hectares (ha) of native vegetation within an application area of 286 ha.

The Orebody 32 East AWT project is planned to be referred to the Environmental Protection Authority (EPA) as a Revised Proposal under the existing Orebody 24/25 Upgrade Project (Ministerial Statement MS834), which was conditionally approved 8 July 2010. The maximum disturbance boundary (or Development Envelope) for MS834 was increased in November 2011, following a successful application to the EPA, under section 45C.

550000 600000 650000 700000 750000 800000 850000 900000 950000 1000000 1050000 1100000 1150000

7750000 7700000 7650000 7600000 7550000 7500000 7450000 7400000

Port Operations
PORT HEDLAND
Nimingarra
SHAY GAP
Yarrie
MARBLE BAR
TOM PRICE
PARABURDOO
Marillana
Yandi (Marillana Creek)
Mining Area C
Jinidi
Mudlark
South Flank
Mt Whaleback
OB 18
OB 31
Jimblebar (Wheelarra Hill)
OB 29/30/35
TELFER

Pindanland
Roebourne
Chichester
Hamersley
Fortescue
Ashburton
Augustus
McLarty
Mackay

OB32 Development Envelope

OB 23/24/25
Mt Whaleback
NEWMAN
OB 29/30/35

Legend

- Pilbara Towns
- Pilbara Rail
- Pilbara Hwy
- OB23-25 Approved disturbance
- OB32 Development Envelope

Mining/ Exploration Locations

- Care & Maintenance
- Exploration
- Operations
- Operations (Third party)

IBRA sub-region

- Ashburton
- Augustus
- Chichester
- Fortescue
- Hamersley
- Mackay
- McLarty
- Pindanland
- Roebourne
- Rudall
- Trainor

1:1,600,000

0 15 30 60 90 km

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Fig. 1.1: Regional Location and IBRA sub-region

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

Created 29/01/2015. Size: A3

780000 781000 782000 783000 784000 785000 786000

7421000

7420000

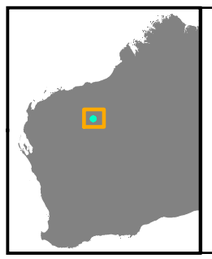
7419000

7418000

Sources: Esri, DeLorme, USGS, NPS

Legend

- OB23-25 Approved disturbance
- OB32 Development Envelope
- OB32 Indicative Pit Area



1:17,000

0 0.15 0.3 0.6 0.9 km

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Fig. 1.2: Indicative proposed project layout

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

Created 29/01/2015. Size: A3

1.1.2 Project summary

The mineralised resource at Orebody 32 East AWT has been estimated at approximately 40 million tonnes (Mt). The open pit mine will be developed using conventional drill and blast techniques, with ore sent to the existing Orebody 24 or Orebody 25 crusher facilities via heavy vehicle haul road.

Based on initial studies (subject to final drilling results), the Orebody 32 East AWT project will comprise the following:

- a single open pit (above water table);
- an access road linking Orebody 32 to existing Orebody 24/25 infrastructure; and
- topsoil and vegetation stockpiles.

Mine planning and design is currently in early stages and will progress in parallel to the environmental approvals. As such, the final locations of infrastructure have not been determined, but will not extend beyond the Development Envelope (Figure 1.2). The major project components are expected to require the following areas:

- Development Envelope: 414 ha
- Indicative pit area: up to 202 ha; and
- Other infrastructure: up to 150 ha.

1.2 Short-Range Endemic Fauna

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale, the latter being commonly referred to as short-range endemism (Allen *et al.* 2002, Harvey 2002). Short-range endemism is influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions and historical conditions which, not only influence the distribution of a species, but also the tendency for differentiation and speciation (Ponder and Colgan 2002).

In recent years a number of taxonomic groups of invertebrates have been highlighted as comprising a high proportion of species likely to be regarded as short-range endemics (SREs) (*i.e.* Harvey 2002; freshwater snails: Ponder and Colgan 2002; land snails: Johnson *et al.* 2004; mygalomorph spiders: Main *et al.* 2000). This identification of restricted taxonomic groups has led to SRE invertebrate fauna becoming an important component of the environmental impact assessment process, as it has provided a focal point for survey work aimed at protecting species of conservation value.

Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) species at less than 10,000 km^2 (or 100 km x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA 2009). SRE invertebrate species often share similar biological, behavioural and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey 2002). For example, burrowing taxa such as mygalomorph spiders and *Urodacus* scorpions may only leave their burrows (or a narrow home territory around the burrow) as juveniles dispersing from the maternal burrow, or when males search

for a mate. In other cases SRE taxa are dispersal-limited because of their slow pace of movement and cryptic habitats (such as isopods, millipedes and snails), while some specialised taxa can be limited by very specific habitat requirements, such as selenopid spiders within fractured rocky outcrops.

1.2.1 Legislation and Guidance

An increasingly large number of terrestrial invertebrates exhibit short-range endemism in Western Australia; however, very few SRE species and communities are listed within federal and state legislation, largely due to incomplete taxonomic and/or ecological knowledge. During EIA, the EPA's primary objectives for SRE fauna are to:

"ensure the protection of key habitats for SRE species; maintain the distribution, abundance, and productivity of populations of SRE taxa; and ensure that the conservation status of SRE taxa is not adversely changed as a result of development proposals" (EPA 2009).

This assessment of SRE invertebrate fauna was designed to meet the objectives of a Level 2 (baseline) survey for SRE invertebrates, under the following guidelines:

- EPA (2009) Guidance Statement 20 Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia;
- EPA (2004) Guidance Statement 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia; and
- EPA (2002) Position Statement 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection.

Protection for listed (conservation significant) species and/ or Threatened or Priority Ecological Communities is provided under State and Federal legislation, including:

- *Environmental Protection Act 1986* (EP Act 1986) (WA);
- *Wildlife Conservation Act 1950* (WC Act 1950) (WA); and
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) (Commonwealth).

2. EXISTING ENVIRONMENT

2.1 Biogeography

In a regional sense, the Development Envelope lies on the south eastern fringe of the Pilbara bioregion as defined by the Interim Biogeographic Regionalisation of Australia (Thackway and Cresswell 1995). The Pilbara bioregion is further divided into four subregions, and the Development Envelope lies in the Hamersley subregion (Figure 1.1), which forms the southern section of the Pilbara Craton (Kendrick 2001). This subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges. The vegetation of the subregion is dominated by *Eucalyptus leucophloia* over *Triodia* hummock grassland on skeletal soils atop mountains and slopes, while swathes of Mulga woodland occur over hard and soft grasses on fine-textured soils of the plains and valleys (Kendrick 2001). The Development Envelope is in the immediate vicinity of the Fortescue subregion to the north and Augustus subregion of the Gascoyne bioregion to the south. The Gascoyne bioregion comprises low rugged ranges and broad flat valleys with vegetation dominated by Mulga woodlands (McKenzie *et al.* 2009).

2.2 Climate

The Pilbara region has a semi-desert to tropical climate with highly variable, mostly summer rainfall. Two distinct seasons, a hot summer from October to April and a mild winter from May to September, occurs in the region (Australian Natural Resource Atlas 2008). The Pilbara climate is heavily influenced by tropical cyclones that develop over the Indian Ocean in the north of Australia. These sometimes cross the north-west coastline, bringing heavy rainfall to inland regions of the Pilbara. Rainfall events within the Pilbara are often sporadic and can occur within both summer and winter months.

The nearest Bureau of Meteorology (BoM) weather station, located approximately 10 km south at Newman Airport, reports an average annual rainfall of 310 mm (Figure 2.1), although rainfall is known to be very patchy in the region. The local area experiences a wide range of temperatures throughout the year with an average temperature of 31.3°C. During summer maximum temperatures may reach a high of 46.0°C, while in winter minimum temperatures may be as low as -2.0°C (BoM 2013). Figure 2.1 shows the monthly long-term average rainfall and maximum temperatures from Newman Airport (BoM 2013), compared to the conditions experienced during the two parts of the survey in 2013.

Prior to the OB24-25 SRE Survey, the local area had received above average rainfall early in the wet season (December 2012 - January 2013) (Figure 2.1). Following this, the rainfall had reduced considerably by the end of the wet season, resulting in predominantly dry conditions during the survey in April 2013 (S. Callan pers. obs. 2013). During the dry season survey (August 2013), conditions were significantly cooler (averaging maximum 28°C, rather than 34°C), and mostly dry except in very highly sheltered sites. No rainfall was recorded during the survey, but evidence of previous rainfall was abundant, with water levels in several

permanent pools higher than observed during April. It was assumed that the moisture from large winter rainfall events (such as experienced in June 2013) was more persistent within the sheltered habitats and permanent pools, due to the lower temperatures and evaporation rates experienced during the `dry` season (Biologic 2014a).

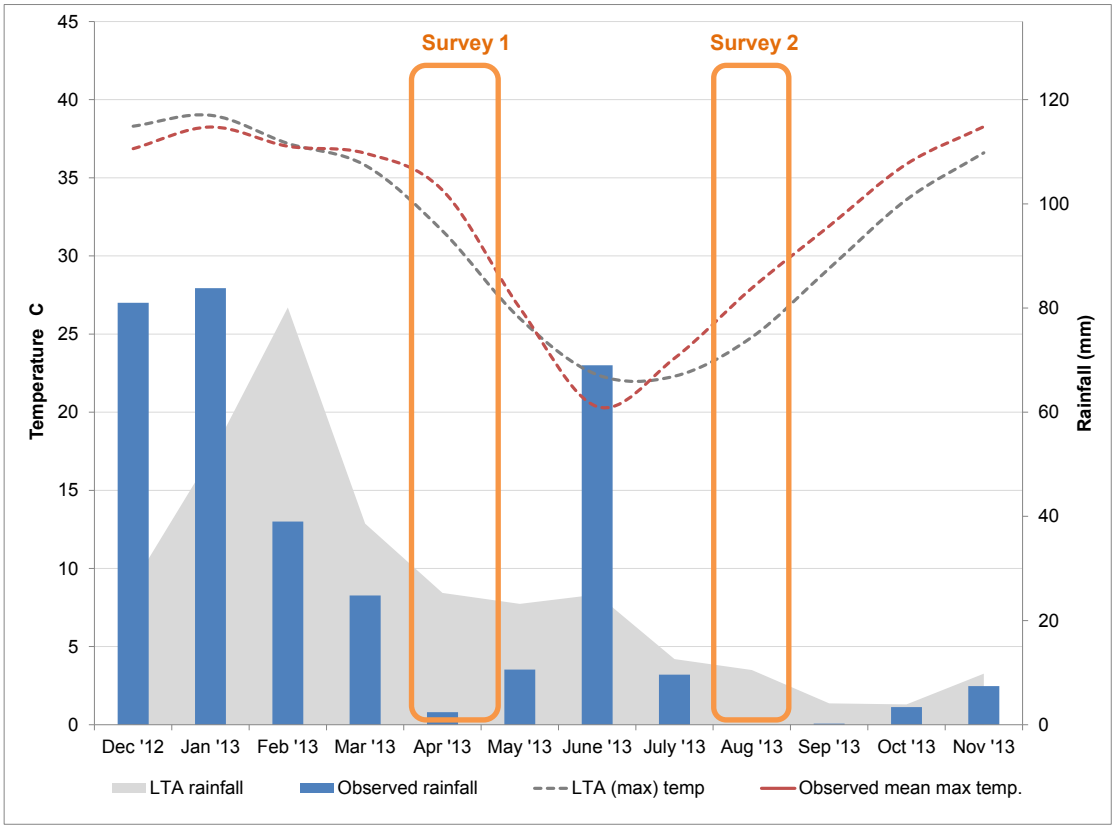

Figure 2.1. Observed mean monthly maximum temperature and rainfall (2013), compared with the Long-Term Averages (LTA) from Newman Airport (BoM 2013). Two orange boxes represent the approximate dates of the OB24-25 SRE Survey in 2013.

2.3 Geology

The Development Envelope and the surrounding local area are underlain by bedrock of Late Archaean to Early Proterozoic age, of the Hamersley and Fortescue Groups. In this area, the younger Hamersley Group comprises mainly Banded Iron Formations (BIF), acid to intermediate volcanics, and minor shale, intruded by dolerite sills. The Fortescue Group consists mainly of mafic volcanics, mudstone, chert and shale, with minor dolerite sills (Thorne and Tyler 1997). The interbedded rock strata mainly strike west-north-west to east-south-east, although faulting and folding is prominent.

Following Tyler *et al.* (1991) (refer Figure 2.2), the major geological formations within the Development Envelope, from north to south include:

1. Wittenoom Formation: metamorphosed dolomite, dolomitic mudstone, chert, and felsic to mafic volcanic sandstone. Occurs in a thin band to the south of the Mount McRae Shale and Mount Sylvia Formation;
2. Marra Mamba Iron Formation: metamorphosed chert, BIF, mudstone, and siltstone. Occurs in two wedge-shaped bands in the south-western part of the Development Envelope, interbedded with other small bands of Brockman Iron Formation and Mount McRae/ Mount Sylvia Formation;
3. Brockman Iron Formation: banded iron-formation, chert, mudstone and siltstone with minor shale. Two major bands stretch from north west to south east throughout the Development Envelope, aligning with the major strike ridges; and
4. Mount McRae Shale and Mount Sylvia Formation: interbedded shale, chert, BIF and dolomite. A thin band follows the southern slopes of the ridges formed in Brockman Iron Formation;

This sequence is mirrored to the immediate north of the Development Envelope before being overlain by a large area of the basaltic flows associated with the Bunjinah Formation. The area immediately south and east of the Development Envelope features a similar sequence, heavily deformed by faulting and folding. The geological units found within the Development Envelope extend further to the west-north-west, beyond the Development Envelope boundaries (Figure 2.2).

2.4 Soils

The Development Envelope features only a single soil type, as defined by the CSIRO Atlas of Australian Soils (Northcote *et al.* 1960-1968) (Figure 2.3), *"Fa13 - Ranges of banded jaspilite (BIF) and chert along with shales. Soils with predominantly physical limitations (shallow-skeletal soils). Low A1 horizon organic content."* However, field observations recorded during the OB24-25 SRE Survey recorded several distinct soil types at localised scales, associated with the major landforms of the area.

The low hill crests and upper slopes featured rocky outcrops with skeletal, gravelly soils, while the lower slopes and washplains were characterised by gravelly sandy loam to clay-loam soils, covered in surface gravels that disappeared as slope decreased to the valley floor. The surrounding plains featured deep clay-loam to clay soils, with generally low gravel. Small alluvial deposits occurred along drainage lines, including a mixture of pebbles, sand, and silt.

775000
780000
785000
790000
7420000
7415000
NEWMAN

Legend

- OB23-25 Approved disturbance
- ML244SA
- OB32 Development Envelope

Geological formation (GSWA 1:500,000)

- Boolgeeda Iron Frm. BIF-mudstone-siltstone-chert
- Brockman Iron Frm. BIF-chert-mudstone-siltstone
- Bunjinah Frm. basaltic flows
- Bunjinah Frm. conglomerate sandstone
- Dolerite intrusive
- Granite to granodiorite
- Jeerinah Frm. basaltic flows
- Jeerinah Frm. mudstone-sandstone
- Marra Mamba Iron Frm. chert-BIF-mudstone
- Mt McRae Shale_Mt Sylvia mudstone-siltstone-chert
- Weeli Wolli Frm. Jaspilitic BIF-mudstone-siltstone
- Wittenoom Frm. dolomite-mudstone-chert
- Woongarra rhyolite-rhyodacite-breccia-BIF

1:50,000

0 0.45 0.9 1.8 2.7 km

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Fig. 2.2: Geology of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

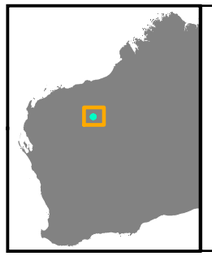
775000
780000
785000
790000
7420000
7415000
Fa13
Mz25
Fa14
BE6
Fa13
NEWMAN
Oc64

Legend

- OB23-25 Approved disturbance
- ML244SA
- OB32 Development Envelope

Soil Unit (CSIRO Atlas of Australian Soils)

- BE6- flat/ gently sloping plains
- Fa13- ranges of jaspilite/ chert/ shales
- Fa14- steep hills/ dissected pediments
- Mz25- plains of Fortescue valley
- Oc64- low stony hills/ dissected pediments



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0 0.45 0.9 1.8 2.7 km

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Fig. 2.3: Soils of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

2.5 Topography and Landforms

The Development Envelope is located in the eastern Hamersley Ranges which dominate the topography of the surrounding local area. The major topographical features of the local area include two deeply dissected strike ridges running north-west to south-east immediately north and south of the Development Envelope (Figure 2.4). The largest (and tallest) of these ridges is the Orebody 24 range, the tallest point of which occurs approximately 1 km north of the Development Envelope. The smaller range to the south of the Development Envelope is associated with Orebody 25 West, and occurs approximately 0.5 km south east of the Development Envelope.

Within the Development Envelope itself, relief is much lower overall, with the majority of the area dominated by gently sloping plains (refer inset in Figure 2.4). There is one main hill/ ridge system in the central western part of the Development Envelope that rises approximately 50 m from the surrounding plain, and is incised by a series of small gullies and one small gorge on its north western face. The eastern part of this low hill/ ridge system declines into a number of fragmented, low hills.

The remaining parts of the Development Envelope (*i.e.* the northern, eastern and southern parts) feature small, flat plains that extend far beyond the Development Envelope to the south west and north west (Figure 2.4).

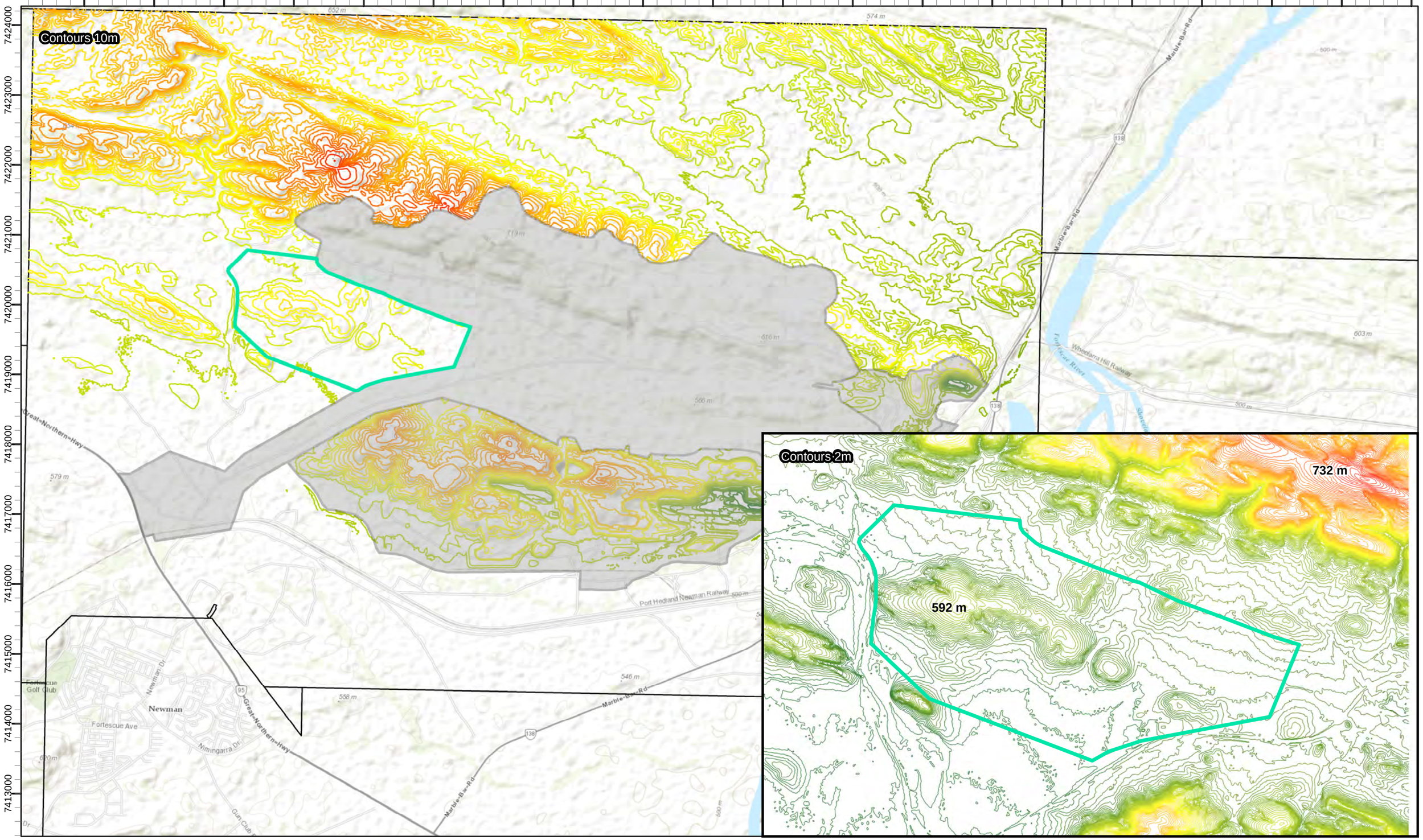
2.6 Surface Hydrology (Drainage)

The Development Envelope is located in the upper portion of the Fortescue River catchment, which drains northward towards Fortescue Marsh (RPS Aquaterra 2012). A major tributary of the Fortescue River, Homestead Creek runs along the short western boundary of the Development Envelope (Figure 2.5). A 50 m buffer has been allowed for between Homestead Creek and the Development Envelope.

Local runoff is directed mainly to the south or west via minor drainage channels towards Homestead Creek, which flows southward after leaving the Development Envelope, before turning to the east towards Ophthalmia Dam (Figure 2.5). Due to climatic conditions, all of the drainage lines are ephemeral, with typically one to three flow events per year (RPS Aquaterra 2012).

The average annual rainfall at Newman is approximately 310 mm, but rainfall occurs mainly as tropical summer storms, and annual totals vary widely. Drainage lines flow only after prolonged heavy rain, as short-duration flooding with rapid peaks and slightly less rapid decline. Along the major tributaries, including Homestead Creek, water from flood events can persist as impermanent pools for several days to weeks.

The Development Envelope is within the Priority 1 area of the Newman Water Reserve. Homestead Borefield is located immediately west of the Development Envelope.

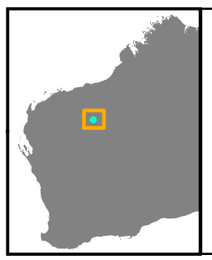


Legend

- ML244SA
- OB23-25 Approved disturbance
- OB32 Development Envelope

Elevation (mAHD)

420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710 720



1:50,000

0 0.45 0.9 1.8 2.7 km

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Fig. 2.4: Topography of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

777000 778000 779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000

7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000 7415000

600 m
654 m
712 m
719 m
616 m
571 m
566 m
657 m
664 m
579 m
541 m
546 m
558 m
Homestead Creek
95
Great Northern Hwy
138
Port Hedland Newman Railway
Marble Bar Rd
Newman Dr
Fortescue Golf Club
Fortescue River

Sources: Esri, DeLorme, USGS, NPS

Legend

- ML244SA
- OB23-25 Approved disturbance
- OB32 Development Envelope
- Minor drainage channels

1:40,000

0 0.375 0.75 1.5 2.25 km

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Fig. 2.5: Drainage of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

2.7 Land Systems

Van Vreeswyk *et al.* (2004) classified and mapped the Land Systems of the Pilbara region according to similarities in landform, soil, vegetation, geology and geomorphology. Three Land Systems comprising Newman, Boolgeeda, and River (a minor proportion) occur within the Development Envelope, as shown in Figure 2.6, and described further in Table 2.1:

Table 2.1. Landforms, soils and vegetation of the Land Systems present within the Development Envelope

Landform	Soil	Vegetation
Newman Land System Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands		
Lower slopes	Stony soils on upper margins with red loams on lower margins	Hummock grasslands *Triodia wiseana, T. brizoides* with very scattered to scattered shrubs and trees including *Acacia* and *Senna* spp., *Grevillea wickhamii*, *Eucalyptus leucophloia* and other eucalypts.
Narrow drainage floors with channels	Red shallow loams, red loamy earths. Channels with river bed soils.	Smaller floors support hummock grassland of *Triodia pungens* with very scattered shrubs. Larger floors and channels support tall shrublands/ woodlands of *Acacia* spp. and *Eucalyptus victrix* with tussock grass or hummock grass understories.
Plateaux, ridges, mountains and hills	Stony soils, red shallow loams and some red shallow sands.	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.
Stony plains	Stony soils, red shallow loams with red loamy earths.	Hummock grasslands of *Triodia wiseana, T.* spp. with isolated to very scattered shrubs of *Acacia* and *Senna* spp. and occasional eucalypt trees. Occasionally hummock grasslands of *Triodia pungens*.
Boolgeeda Land System Stony lower slopes and plains below hill systems with hard/ soft spinifex grasslands and Mulga shrublands		
Low hills and rises	Stony soils and red shallow loams	Hummock grasslands of *Triodia wiseana* and other *Triodia* spp. with very scattered *Acacia* shrubs.
Groves	Red loamy earths	Moderately close woodlands or tall shrublands of *A. aneura* with sparse low shrubs and tussock or hummock grasses.
Narrow drainage floors and channels	Red loamy earths and minor self-mulching cracking clays. Channels with river bed soils	Scattered to close tall shrublands or woodlands of *A. aneura*, *A. atkinsiana*, *Corymbia hamersleyana* with sparse low shrubs and hummock and tussock grasses. Occasionally hummock grasslands of *T. pungens*.
Stony lower plains	Red loamy earths	Hummock grasslands *T. wiseana, T. lanigera* or *T. pungens*. Also scattered to moderately close tall shrublands of *A. aneura* and other *Acacia*s with hard and soft spinifex ground layer.
River Land System Flood plains and rivers supporting grassy *Eucalyptus* woodlands, tussock and soft spinifex grasslands		
Sandy levees and sand sheets	Mostly red deep sands with red sandy earths, red loamy earths and some river bed soils	Hummock grasslands of *Triodia pungens* (soft spinifex) with very scattered to moderately close shrubs such as *Acacia trachycarpa* (miniritchie) and *A. inaequilatera*
Minor and major channels	River bed soils	Channels - no vegetation. Banks - close or closed fringing woodlands with *Eucalyptus camaldulensis* (river red gum), *E. victrix*, *Melaleuca argentea*, *M. glomerata*, *Sesbania formosa* (white dragon tree), *Acacia coriacea* (river jam) with understorey of sedges and grasses including *Cyprus vaginatus*, *Cenchrus ciliaris* and *Triodia pungens*

775000
780000
785000
790000
7420000
7415000
Rocklea
Boolgeeda
Newman
Wannamunna
McKay
Elimunna
Disturbed Land
NEWMAN
River
Washplain
Spearhole

Legend

- OB23-25 Approved disturbance
- ML244SA
- OB32 Development Envelope

Land System

- Boolgeeda
- Disturbed Land
- Elimunna
- McKay
- Newman
- River
- Rocklea
- Spearhole
- Wannamunna
- Washplain

1:50,000

0 0.45 0.9 1.8 2.7 km

N

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BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 2.6: Land Systems of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

2.8 Vegetation

The Development Envelope is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia following Beard (1975) who broadly mapped the area as `ranges and valley plains`. The ranges are described as a tree steppe of the *Eucalyptus-Triodia* association with a change to *Eucalyptus* mallee at the summits (Beard 1975). The valley plains mainly carry Mulga low woodlands to shrubland (formerly *Acacia aneura*) with some areas of open *Triodia* grassland.

Onshore Environmental (2014) mapped the vegetation of the local area surrounding the Development Envelope (Figure 2.7), identifying 23 vegetation associations within 10 broad floristic formations. Figure 2.7 shows that seven of these vegetation associations from three broad floristic formations occur within the Development Envelope, none of which are restricted to the Development Envelope. These seven vegetation associations within the Development Envelope are described in Table 2.2.

Table 2.2: Vegetation associations of the Development Envelope, following Onshore Environmental (2014).

Veg Code	Broad Floristic Formation	Vegetation Association	Veg Condition
HILL CRESTS AND UPPER HILL SLOPES			
HC TwTbrTp ElCh AmaGwAb	*Triodia* Hummock Grassland (E49)	Hummock Grassland of *Triodia wiseana, Triodia brizoides* and *Triodia pungens* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over High Open Shrubland of *Acacia maitlandii, Grevilllea wickhamii* subsp. *hispidula* and *Acacia bivenosa* on red brown sandy loam on hill crests and upper hill slopes	Excellent
HC TpTs El AaAkAsi	*Triodia* Hummock Grassland (E25)	Hummock Grassland of *Triodia pungens* and *Triodia* sp. Shovelanna Hill with Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* over Scattered Tall Shrubs of *Acacia aptaneura, Acacia kempeana* and *Acacia sibirica* on red brown loam on hill crests, hill slopes and breakaway slopes	Excellent
HILL SLOPES AND LOW UNDULATING HILLS			
HS TsTwTp ElCh AhiAad	*Triodia* Hummock Grassland (E47)	Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835), *Triodia wiseana* and *Triodia pungens* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* over Low Open Shrubland of *Acacia hilliana* and *Acacia adoxa* var. *adoxa* on red brown sandy loam on hill slopes	Excellent
HS Tw ElChHc AanAbAa	*Triodia* Hummock Grassland (E35)	Hummock Grassland of *Triodia wiseana* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia, Corymbia hamersleyana* and *Hakea chordophylla* and Open Shrubland of *Acacia ancistrocarpa, Acacia bivenosa* and *Acacia aptaneura* on red sandy loam on hill slopes	Excellent
SAND PLAINS			
SP Tb ChEg SpBeKp	*Triodia* Hummock Grassland (E21)	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Low Open Shrubland of *Scaevola parvifolia, Bonamia erecta* and *Kennedia prorepens* on red loamy sand on sand plains	Very Good
MINOR DRAINAGE LINES			

Veg Code	Broad Floristic Formation	Vegetation Association	Veg Condition
MI AmoAanPl ChEl TtAin	*Acacia* Shrubland (E65)	Shrubland of *Acacia monticola, Acacia ancistrocarpa* and *Petalostylis labicheoides* with Scattered Low Trees of *Corymbia hamerselyana* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Tussock Grassland of *Themeda triandra* and *Aristida inaequilatera* on red loamy sand on minor drainage lines	Excellent to Very Good
MEDIUM DRAINAGE LINES			
ME TtEaEte ApyAtpPl EvCh	*Eucalyptus* Low Woodland (E64)	Tussock Grassland of *Themeda triandra, Eulalia aurea* and *Eriachne tenuiculmis* with High Shrubland of *Acacia pyrifolia* var. *pyrifolia, Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* and Open Woodland of *Eucalyptus victrix* and *Corymbia hamersleyana* on red brown silty loam on medium drainage lines and flood plains	Very Good

777000 778000 779000 780000 781000 782000 783000 784000 785000 786000

7422000 7421000 7420000 7419000 7418000 7417000

Legend

- ML244SA
- OB23-25 Approved disturbance
- OB32 Development Envelope

Vegetation Association (Onshore 2014)

- *Cenchrus Tussock Grassland, E32
- *Cenchrus Tussock Grassland, E63
- Acacia Low Open Forest, E42
- Acacia Low Open Forest, E57
- Acacia Low Open Woodland, E23
- Acacia Low Woodland, E17b
- Acacia Low Woodland, E19
- Acacia Low Woodland, E67
- Acacia Shrubland, E65
- Corymbia Low Open Woodland, E59
- Disturbed, E1
- Eucalyptus Low Woodland, E64
- Eucalyptus Woodland, E60
- Eucalyptus Woodland, E61
- Themeda Tussock Grassland, E70
- Themeda Tussock Grassland, E86
- Triodia Hummock Grassland, E17
- Triodia Hummock Grassland, E21
- Triodia Hummock Grassland, E35
- Triodia Hummock Grassland, E36
- Triodia Hummock Grassland, E39
- Triodia Hummock Grassland, E47
- Triodia Hummock Grassland, E15
- Triodia Hummock Grassland, E25
- Triodia Hummock Grassland, E49
- Triodia Hummock Grassland, E55
- Triodia Open Hummock Grassland, E14
- Triodia Open Hummock Grassland, E45
- Triodia Open Hummock Grassland, E9

1:25,000

0 0.225 0.45 0.9 1.35 km

N

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Fig. 2.7: Vegetation of the local area surrounding OB32

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

Created 29/01/2015. Size: A3

3. METHODS

3.1 Database Review

Four SRE fauna databases were searched (in April 2013) for terrestrial SRE records within a search area surrounding the Development Envelope as described below in Table 3.1. Following a number of additional recent surveys conducted by Biologic in the sub-regional area, further verification of WAM species records was requested in 2015 to confirm that the information was up to date. The fauna databases reviewed comprised the following:

- Department of Parks and Wildlife (DPaW) NatureMap database;
- Atlas of Living Australia (ALA 2013);
- WA Museum (WAM) Arachnida/ Myriapoda database; and
- WAM Mollusca database.

Table 3.1: SRE Fauna databases used for the review

Database	Parameters
NatureMap	40 km radius around 23°17`50”S and 119°47`30"E
ALA	50 km radius around 23°17`50”S and 119°47`30"E
WAM Arachnida	Bounding box (approx.150 km x 100 km) Northwest 22°45”S and 119°20"E Southeast 23°35”S and 120°47"E
WAM Mollusca	Bounding box (approx.150 km x 100 km) Northwest 22°45”S and 119°20"E Southeast 23°35”S and 120°47"E

SRE species records resulting from the surveys listed below in Section 3.2 were also included in the review.

3.2 Review of Previous Studies

In addition to the WAM database results, reports from SRE invertebrate surveys carried out within 50 km of the Development Envelope were reviewed. Prior to the current survey, a limited amount of SRE survey work had previously been conducted within the Development Envelope. Reports from relevant surveys are listed below:

- Orebody 24-25 SRE Invertebrate Survey (Biologic 2014a);
- Orebody 19-31 SRE Invertebrate Survey (Biologic 2014b);
- Orebody 31 Targeted SRE Survey and EIA (Biologic 2014c);
- Brockman Ophthalmia SRE Survey (Biologic 2014d);
- Orebody 24/25 Upgrade Terrestrial Invertebrate Short-range Endemic Assessment (Outback Ecology 2008a - conducted partially within the Development Envelope);
- OB24/OB25 Short-Range Endemic Study, Case Study Pseudoscorpions (ENV 2008 - conducted partially within the Development Envelope);

- Orebody 35 Short-range Endemic Invertebrate Survey Report (Biologic 2012a);
- Assessment of Terrestrial Short-range Endemic Invertebrates in the Orebody 35-Western Ridge Area near Newman, Western Australia (AMBS 2011);
- South-West Jimblebar SRE Survey (Biologic 2013);
- Wheelarra Hill North SRE Survey (Rapallo 2011); and
- Jimblebar SRE Survey (Outback Ecology 2009).

3.3 SRE Survey Methods (OB24-25 SRE Survey)

The OB24-25 SRE Survey comprised a variety of active sampling techniques conducted at 124 sites over two seasons (April-May 2013 and August 2013), targeting trapdoor spiders, selenopid spiders, scorpions, millipedes, pseudoscorpions, land snails, and isopods. The survey design and sampling methodologies were carried out in accordance with the following documents:

- Environmental Protection Authority (EPA) Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004);
- Guidance Statement No. 20 Sampling of Short Range Endemic Fauna for Environmental Impact Assessment in Western Australia No. 20 (EPA 2009); and
- BHP Billiton Iron Ore's (2009) Guidance for SRE Surveys in the Pilbara Region (SPR-IEN-EMS-013).

3.3.1 Site selection

The OB24-25 SRE Survey targeted habitats considered suitable for SRE invertebrates in the Pilbara region, including Gorges/ deep gullies, Ridges/ breakaways, Shallow/ open gullies, Vegetation groves and Drainage foci. Dispersal habitats such as Drainage lines, and open habitats such as Plains were also sampled to provide representation and coverage, despite the reduced likelihood of restricted fauna occurring in such areas. In total, 124 sites were sampled across two seasons, with the first survey undertaken at the end of the wet season in late April-May 2013, and the second survey during the dry season in late August 2013.

The total sampling effort within the Development Envelope during the OB24-25 SRE Survey is considered to include ten sites in total, comprising nine sites within the Development Envelope (namely sites 7, 43, 44, 45, 100, 101, 102, 114, and 118), plus one site (site 125) that was located on the western boundary of the Development Envelope (Figure 3.1). Six of these sites were sampled twice; *i.e.* sampling was repeated during the wet season and the dry season of 2013. In addition, one site was sampled once during the wet season of 2013, and the remaining three sites were sampled once during the dry season of 2013 (Biologic 2014a) (Figure 3.1). The sampling effort within the Development Envelope reflected the relative suitability of the types of habitats present, and the sites were placed to provide adequate representation of the available habitats.

779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

Legend

OB23-25 Approved disturbance

OB32 Development Envelope

SRE Fauna sampling

First survey (April-May 2013)

Second survey (August 2013)

Both surveys

1:37,000

0 0.35 0.7 1.4 2.1 km

N

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Orebody 32 East AWT SRE Impact Assessment

Fig. 3.1: SRE sampling effort - Biologic OB24-25 Survey

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

Created 29/01/2015. Size: A3

3.3.2 Active foraging

Active foraging was undertaken at each site for 1.5 person hours, involving various hand collection techniques relevant to the following microhabitats:

- Under rocks, within cracks and crevices: suitably sized rocks were over turned, and rocky microhabitats were actively searched for rock dwelling species.
- Woody debris: larger logs and woody debris were investigated and over turned searching for detritivores.
- Vegetation and tree bark: significant vegetation (*e.g.* Mulga, and fig trees) were actively searched, including underneath sheets of bark.
- Burrow searching: active searches were undertaken for mygalomorph spider and scorpion burrows within suitable habitats. Note: searches for burrows were undertaken during foraging time and also whilst walking through the Study Area, but time taken to excavate burrows was counted as additional to foraging time.

3.3.3 Leaf litter sieving

Leaf litter and humus was placed in a leaf litter sieve at the site and agitated to divide the sample into three grades (> 7 mm, > 3 mm, < 3 mm). Each grade was thoroughly searched for target SRE species such as pseudoscorpions, millipedes, snails, and small scorpions. The maximum volume of litter in the sieve was approximately 4808 cm^3, and up to two sifts were conducted at each site, providing sufficient leaf litter was available.

3.3.4 Soil sieving

Topsoil (to approximately 10 cm below surface) was collected from the base of large, and/ or, significant trees and shrubs. The topsoil was sieved through a 1.4 mm sieve to separate soil from debris and gravel, and both grades (> 1.4 mm and < 1.4 mm) were thoroughly searched for specimens; primarily aestivating micro-snails and pseudoscorpions. The maximum volume of the soil sieve was 1570 cm^3 and up to two sifts were conducted at each site, provided the soil was friable enough and deep enough to allow collection.

3.3.5 Specimen preservation

Specimens were preserved and stored according to current WAM guidelines (WAM 2013). All specimens were euthanised in 100 % ethanol to preserve DNA for sequencing. Isopods, mygalomorph spiders and *Urodacus* scorpions were transferred to 75 % ethanol for storage, with the third right leg removed and stored in 100 % ethanol for DNA studies.

All specimens were vouchered at the WAM for identification, except for the isopods and scorpions, which were sent directly to Dr Simon Judd and Dr Erich Volschenk for identification, prior to vouchering at the WAM. The pseudoscorpions, spiders and millipedes were identified by Dr Amber Beavis, Dr Mark Castalanelli and Dr Catherine Car, while the land snails were identified by Mr Corey Whisson.

3.3.6 SRE Status Categorisation

The SRE status categories used in this report follow the WAM (2013) categorisation for SRE invertebrates (Table 3.4, Appendices 3 and 4). This system is based upon the 10,000 km^2 range criterion proposed by Harvey (2002), and uses three broad categories to deal with varying levels of taxonomic certainty that may apply to any given taxon (Table 3.4).

Under this system, "Potential SRE" status is the default categorisation for species within the typical SRE taxonomic groups including mygalomorph spiders, selenopid spiders, land snails, pseudoscorpions, scorpions, and isopods, unless sufficient evidence exists to confirm widespread or confirmed SRE status.

Potential SRE status is sub-categorised by what is currently known about the species in question; *i.e.* whether there are B) habitat indicators, C) morphology indicators, D) molecular evidence, or E) a weight of general knowledge and experience with the group that suggests a reasonable likelihood that the species could be SRE. In terms of SRE likelihood, the more evidence that exists under sub categories B, C, D, and E, the greater the likelihood that further investigation will confirm that the species is a SRE.

Table 3.2: SRE categorisation used by WAM taxonomists (Appendices 3 and 4).

	Taxonomic Certainty	**Taxonomic Uncertainty**
Distribution <10,000 km^2	**Confirmed SRE** • A known distribution of < 10,000 km^2. • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling.	**Potential SRE** • Patchy sampling has resulted in incomplete knowledge of geographic distribution. • Incomplete taxonomic knowledge. • The group is not well represented in collections. • Category applies where there are significant knowledge gaps. **SRE Sub-categories may apply:** A) Data Deficient B) Habitat Indicators C) Morphology Indicators D) Molecular Evidence E) Research & Expertise
Distribution >10,000 km^2	**Widespread (not SRE)** • A known distribution of > 10,000 km^2. • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling.	

However, the WAM category A) 'data deficient' is different; this category indicates that the current taxonomic data or specimen collection records are insufficient to adequately assess the SRE status of the species in question. The current assessment considers `data deficient` taxa to be unable to be assessed as Potential SRE species at the current time, owing to a lack of taxonomic information or geographical context.

Within this report, the categorisation of SRE fauna is presented within the context of the results of on-site habitat assessment, habitat connectivity, and ecological information collected during the field survey. This aims to provide a more holistic approach toward the

assessment of SRE likelihood incorporating taxonomy, ecological information, species distributions, and habitat information. The potential risks/ impacts to confirmed or putative SRE species are then discussed at scales relevant to the development project, the wider local area (including areas not proposed for development) and the wider region/ sub-regional area.

3.3.7 Habitat Assessment and SRE Likelihood Assessment

Habitats and microhabitats in the Development Envelope were assessed in accordance with BHP Billiton Iron Ore's Guidance for Short-Range Endemic Invertebrate Surveys in the Pilbara Region (SPR-IEN-EMS-013) (BHP Billiton Iron Ore 2009). These assessments were based on the various protective qualities of the habitat, *e.g.* landform, aspect, and vegetation, and the presence of suitable microhabitats within rocks, leaf litter, soil and woody debris. The habitat assessments were aimed at determining the suitability of each site as SRE habitat, and hence the likelihood that each site may contain SRE fauna. The habitat assessment was based on three major factors influencing SRE habitat suitability; isolation, protection and habitat complexity, as briefly outlined below and illustrated in Figure 3.2.

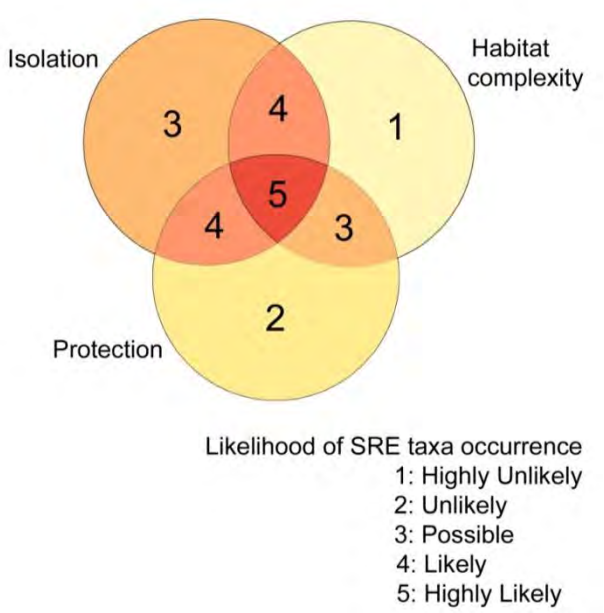


Figure 3.2: Habitat assessment diagram.

Isolation: based on the level of connectivity between sites, which share similar habitat characteristics. Isolation is the most important factor when it comes to the level of risk, as any fauna with limited dispersal characteristics, regardless of the habitat preference, will likely be, at least, an isolated population. Examples include islands and mountaintops; in the Pilbara, peaks like Mount Meharry have been shown to harbour significant SRE species (Durrant 2011).

Protection: this primarily covers protection from exposure. With respect to the Pilbara region however, protection from disturbance is also very important for the long term viability of SRE habitats and communities, *i.e.* protection from fire, flood and invasive species.

Protection is provided at two levels; the site level where the structural composition of the site (aspect, slope *etc.*) can provide protection from exposure and disturbance by providing physical barriers (*e.g.* gorges and gullies); and the habitat level where certain microhabitat characteristics, associated with habitat complexity, provide more direct protection, particularly from exposure (*i.e.* leaf litter, rocky substrates, canopy cover and soil depth).

Habitat complexity**:** this factor drives species richness and often abundance at a site, *i.e.* the more complex a site is, the more species and individuals it is likely to contain. This is particularly important, as a number of SRE groups are predators; therefore the richness and abundance of prey species are critical to their survival.

Complexity, with respect to SREs, is based around a number of microhabitat types:

- Leaf litter: both depth, coverage, and structural variation;
- Rocky substrates: loose rocks, cracks and crevices;
- Woody debris: size, abundance and decomposition rate of dead wood;
- Vegetation variation: flora richness and structural variation; and
- Soil: depth, texture, and structural variation.

Likewise, the complexity of the habitat is important to detritivore SRE taxa, such as isopods, millipedes and some snails, which rely upon decaying leaf litter, woody debris and organic matter for survival. Examples in the Pilbara include deep gullies and gorges, where most of the above microhabitat types occur; these therefore tend to be species-rich areas.

3.3.8 Habitat Mapping

The habitats of the Development Envelope and the surrounding local area were classified into broad habitat zones that reflect major changes in the important landform features, drainage features and vegetation features which influence SRE likelihood. The information used to classify and map the habitat zones included vegetation mapping (Onshore Environmental 2014), topographical contours, drainage information, and the results of on-site habitat assessments (OB24-25 SRE Survey, Biologic 2014a). This information was combined with general knowledge of the Development Envelope gained from the field survey, onsite photography and site observations, and mapped in alignment with recent, high resolution aerial photography obtained from BHP Billiton Iron Ore (Biologic 2014a).

The resulting map of SRE habitat zones is an indicative interpretation, based on a combination of the sources listed above. It is acknowledged that specific habitat and microhabitat characteristics that influence SRE likelihood may vary significantly within each habitat zone. Multiple different (but related) habitat types can occur within each habitat zone, and the level of congruence between the spatial extent of a habitat type and the broader zone within which it occurs depends upon the habitat type and the zone in question.

For example, the Drainage zone aligns with the extent of Drainage line habitats, as these habitats are clearly distinct from all surrounding habitats. Drainage line habitats within the Drainage zone can be assumed to be highly connected/ continuous both because of the high level of congruence with the habitat zone, and because they are generally highly connected, linear habitats.

In contrast, the Low hills zone contains a number of slightly different rocky/ mountainous habitats such as Rocky outcrops, Ridges/ breakaways, Shallow/ open gullies, Gorges/ deep gullies, and Hillslope/ footslopes. Although all of these habitat types are related to mountainous landforms, they all differ in terms of their spatial extent throughout the zone (*i.e.* their congruence with the zone in which they occur), and in terms of their individual connectivity, and suitability for SRE fauna.

Owing to the differences in habitat and microhabitat requirements for each SRE taxon, and the limitations of sampling, it is not practical, or useful for the assessment, to identify every gully, outcrop, hillslope, ridge *etc.* as a habitat zone in its own right; therefore these types of mountainous habitats are mapped as a combined zone (Low hills), and the extent of interconnected rocky/ mountainous habitats within the Low hills zone is discussed in terms of the wider zone boundary. However, this does not mean that the Low hills zone is uniform in habitat/ microhabitat characteristics, or SRE suitability throughout its total extent. In addition, various SRE species may differ in their preferred habitat types within this wider zone (*e.g. Karaops* spiders may be able to disperse throughout the Low hills zone, provided sufficient rock cracks and crevices occur, whereas *Antichiropus* millipedes may be restricted to individual, highly sheltered Gorges/ deep gullies within the wider zone).

3.4 Limitations

There are several general limitations in regard to the completeness of SRE fauna surveys, particularly with regard to the target fauna living in cryptic habitats, occurring in low numbers, and being generally difficult to detect. Despite this, it is not considered that the OB24-25 SRE Survey (Biologic 2014a) suffered from any specific constraints in relation to the number of samples, the coverage of SRE habitat types, the inclusion of seasonal data, the environmental conditions, or the sampling and taxonomic methods used to detect the target fauna.

In terms of survey intensity, the sampling within the Development Envelope did not suffer any limitations in regard to inaccessible habitats, major disturbances (except for fire, which is discussed below in section 3.4.2), or a lack of seasonal sampling. The relatively low number of sites sampled within the Development Envelope (10) was mainly attributed to the small size of the area and the relatively low diversity of suitable habitats present. The sites were placed so as to be representative of the main types SRE habitat present and to provide adequate geographical coverage within the limited area available.

3.4.1 Habitat zone mapping

The estimated extent of habitat zones mapped in Figure 4.5 is an indicative interpretation only, based on aerial photography, habitat assessment at sites visited, and general knowledge of the area obtained by field survey. Microhabitat characteristics that influence SRE prospectivity may vary significantly within the inferred extent of each habitat zone. The estimated extent of habitat zones was mapped for descriptive purposes only and should not be regarded as a precise map of the extent of suitable microhabitat characteristics for any given species, or as a reliable surrogate for the distribution of any species or assemblage. Where SRE habitat zones have been used to infer the potential extent of suitable habitats for key species within the EIA (Figures 4.6, 4.7, 4.8), this inference is indicative only, and is subject to the limitations of the data collected on-site, as well as the limitations of current taxonomic and ecological knowledge.

3.4.2 Fire

In January/ February 2013 a large area north of Newman was affected by extensive fires in the local area surrounding the Development Envelope (Figure 3.3).

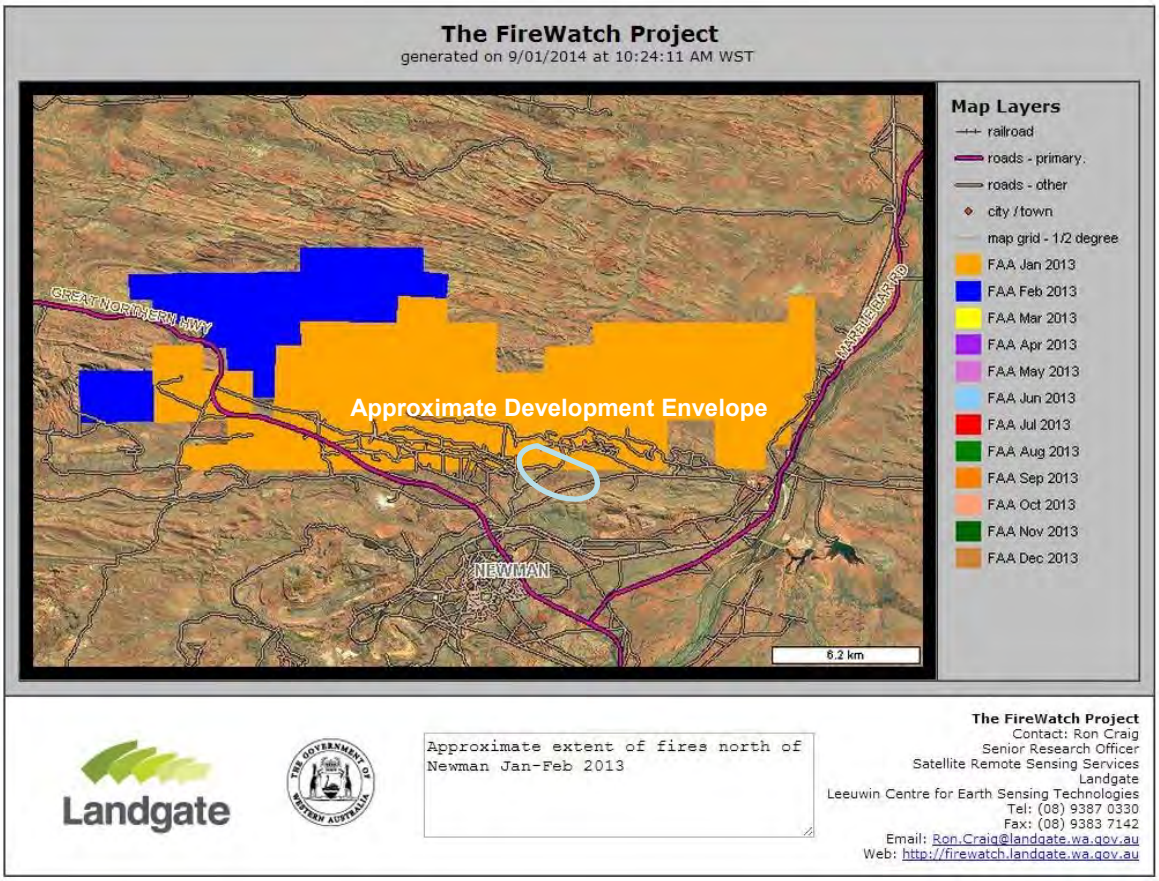


Figure 3.3. Extent of fires Jan-Feb 2013 relative to an approximated representation of the Development Envelope (data from Landgate Firewatch Project accessed online January 2014 at http://firewatch.landgate.wa.gov.au)

Only three of the sites within the Development Envelope (sites 7, 118 and 125) were partially burnt at the time of the OB24-25 SRE Survey (Figure 3.4). The nearest completely burnt sites were approximately 200 - 400 m to the west (over the opposite side of Homestead Creek) at sites 35 and 36, but the fire was patchy throughout the areas immediately west of the Development Envelope, in comparison to the extensive, comprehensively burnt areas to the north of Orebody 24. Based on the minor impacts of fire at only three sites within the Development Envelope, it can be assumed that the fauna data and habitat data from within the Development Envelope was not significantly affected by fire.

However, the vast majority of the local area to the north, west and east of the Development Envelope had been partially or completely burnt, depending upon slope and aspect characteristics of each site (Figure 3.4). This may have somewhat affected the ability to make habitat-based comparisons between inside and outside of the Development Envelope, and may have reduced the accuracy of some of the inferred habitat zone boundaries in burnt areas by removing evidence of changes in vegetation structure. In either case, the assessment of species distribution for the key SRE species discussed herein was based more on the locations where each of the species were found outside of the Development Envelope, rather than inferences regarding habitat connectivity between the Development Envelope and the immediate surrounding areas.

779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

Sources: Esri, DeLorme, USGS, NPS

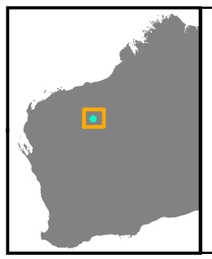
Legend

OB23-25 Approved disturbance

OB32 Development Envelope

Observable impact of fire

- Unburnt
- Partially burnt
- Highly/ recently burnt



1:37,000

0 0.35 0.7 1.4 2.1 km

N

biologic

BHP Billiton Iron Ore

Orebody 32 SRE Impact Assessment

Fig. 3.4 Sites affected by fire - Biologic OB24-25 SRE Survey

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

Created 29/01/2015. Size: A3

4. RESULTS

4.1 Database Searches

The DPaW NatureMap and ALA databases contained no records of SRE species or conservation significant invertebrate species within the respective search areas. The WAM databases reported 14 SRE species within the search area, including selenopid spiders, mygalomorph spiders, polydesmid millipedes, isopods, and scorpions (Table 4.1). Recent SRE surveys at Orebody 24-25 and Orebody 19-31 (Biologic 2014a, 2014b) revealed a further 18 Confirmed and Potential SRE species within the wider local area surrounding the Development Envelope. Figures 4.1 and 4.2 show the locations of these Confirmed and Potential SRE species.

Table 4.1: Confirmed and Potential SRE species known to occur within the database search area. Data from WAM and BHP Billiton Iron Ore databases.

Higher Taxon	Morphospecies	Orebody 35	Orebody 24-25	Orebody 19-31* Wheelarra North	Jimblebar Wheelarra Hill	Davidson Creek	Brockman Ophthalmia	Total
Selenopidae								
	Karaops `ARA003-DNA`			15				**15**
	Karaops `ARA004-DNA`			10				**10**
	Karaops `ARA005-DNA`		32					**32**
	Karaops sp. indet. (juv.)						1	**1**
Mygalomorphae								
	Aganippe `MYG085`				1			**1**
	Aganippe `MYG384-DNA`			1				**1**
	Aname `MYG098`	2						**2**
	Aname `MYG205`	3						**3**
	Aname `MYG206`	3						**3**
	Aname aragog				1			**1**
	Aurecocrypta `MYG315-DNA`		1					**1**
	Conothele `MYG385-DNA`		1					**1**
	Cethegus `MYG299-DNA`		6					**6**
	Kwonkan `MYG094`				1			**1**
	Missulena occatoria grp.				3			**3**
	Synothele `MYG116`				1			**1**
Pseudoscorpiones								
	Feaella `PSE080` (Confirmed SRE)		5					**5**
	Synsphyronus `sp. indet. (juv.)`			1				**1**
	Xenolpium `PSE079`			10				**10**
Polydesmida								
	Antichiropus `DIP014`	7						**5**
	Antichiropus `DIP015`	2						**2**
	Antichiropus `DIP042`				1			**1**
	Antichiropus `sp. indet. (juv.)`			2				**2**
Scorpiones								

Higher Taxon	Morphospecies	Orebody 35	Orebody 24-25	Orebody 19-31* Wheelarra North	Jimblebar Wheelarra Hill	Davidson Creek	Brockman Ophthalmia	Total
	Urodacus `Davidson creek`					4		**4**
Isopoda								
	Buddelundia sp. nov.				1			**1**
	Buddelundia `10NM`			123				**123**
	Buddelundia `16NM`	1	224					**225**
	Buddelundia `36NM`			4				**4**
	Buddelundia `49`		9	100				**109**
	Buddelundia `78`		115					**115**
	Buddelundia `79`		3					**3**
	Buddelundia `80`		3				1	**4**
	Buddelundiinae `OB24`		5					**5**
	Buddelundiinae `WN`			5				**5**
Total species		**6**	**11**	**9**	**7**	**1**	**2**	

760000 765000 770000 775000 780000 785000 790000 795000 800000 805000 810000 815000 820000 825000 830000

7445000 7440000 7435000 7430000 7425000 7420000 7415000 7410000 7405000

Legend

- Mining Lease AML244SA
- OB32 Development Envelope

Mining/ Exploration Locations

- Exploration
- Operations

Species, SRE status

- Aganippe 'sp. MYG384-DNA', Potential SRE
- Aganippe `MYG085`, Confirmed SRE
- Aname `MYG098`, Confirmed SRE
- Aname `MYG205`, Confirmed SRE
- Aname `MYG206`, Confirmed SRE
- Aname aragog, Confirmed SRE
- Aurecocrypta 'MYG315-DNA', Potential SRE
- Cethegus 'MYG299-DNA', Potential SRE
- Conothele 'MYG385-DNA', Potential SRE
- Missulena occatoria-group, Confirmed SRE
- Feaella 'PSE080', Confirmed SRE
- Synsphyronus `sp. indet. (juv.)`, Potential SRE
- Synsphyronus `sp. nov. 8/1 Pilbara`, Potential SRE
- Xenolpium 'PSE079', Potential SRE
- Karaops 'ARA003-DNA', Potential SRE
- Karaops 'ARA004-DNA', Potential SRE
- Karaops 'ARA005-DNA', Potential SRE
- Karaops`sp. indet. (juv)`, Potential SRE

731 m 595 m 694 m 743 m 546 m 950 m 1046 m 552 m 552 m 665 m 711 m 710 m 778 m 757 m 573 m

Great Northern Hwy

Antgan Creek

Turtescue River

OB 23/24/25

OB 18

OB 31

Mt Whaleback

NEWMAN

OB 29/30/35

Jimblebar (Wheelarra Hill)

Newman Airport

1:195,000

0 1.75 3.5 7 10.5 km

N

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BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.1: Records of SRE arachnid species from the sub-regional area (reports and fauna databases)

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

Created 29/01/2015. Size: A3

765000 770000 775000 780000 785000 790000 795000 800000 805000 810000 815000 820000 825000

7435000 7430000 7425000 7420000 7415000 7410000 7405000 7400000

743 m
546 m
552 m
552 m
1046 m
719 m
665 m
802 m
710 m
778 m
757 m
711 m
604 m
613 m

Kalgan Creek
Fortescue River
Great-Northern-Hwy
Great-Northern-Hwy
Shovelanna Creek
Newman Airport

OB 23/24/25
OB 18
OB 31
OB 29/30/35
Mt Whaleback
NEWMAN
Jimblebar (Wheelarra Hill)

Legend

- Mining Lease AML244SA
- OB32 Development Envelope

Mining/ Exploration Locations

- Exploration
- Operations

Species, SRE status

- Antichiropus `DIP014`, Confirmed SRE
- Antichiropus `DIP015`, Confirmed SRE
- Antichiropus `DIP042`, Confirmed SRE
- Antichiropus `sp. indet. (juv.)`, Potential SRE
- Buddelundia '10NM', Potential SRE
- Buddelundia '16NM', Potential SRE
- Buddelundia '36NM', Potential SRE
- Buddelundia '49', Potential SRE
- Buddelundia '78', Potential SRE
- Buddelundia '79', Potential SRE
- Buddelundia '80', Potential SRE
- Buddelundia sp. nov., Potential SRE
- Buddelundiinae 'OB24', Potential SRE
- Buddelundiinae 'WN', Potential SRE

1:165,000

0 1.5 3 6 9 km

N

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BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.2: Records of non-arachnid SRE species from the sub-regional area (reports and fauna databases)

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

Created 29/01/2015. Size: A3

4.2 Previous Surveys

A number of previous SRE surveys have been conducted within the wider regional area; where data was available, the study areas and survey effort from these surveys are shown in Figure 4.3.

4.2.1 Orebody 24-25 SRE Survey (Biologic 2014a)

The methods and survey design of this survey have been presented in detail in section 3.3. This survey sampled 9 sites within the Development Envelope and one site on the western boundary. The sampling detected one confirmed SRE species; the pseudoscorpion, *Feaella* `PSE080`, and the following 10 species considered to be Potential SREs:

- a selenopid spider - *Karaops* `ARA005-DNA`;
- three mygalomorph spiders - *Aurecocrypta* `MYG315-DNA`, *Cethegus* `MYG299-DNA`, and *Conothele* `MYG385-DNA`; and
- six species of isopods - *Buddelundia* `16NM`; *Buddelundia* `49`; *Buddelundia* `78`; *Buddelundia* `79`; *Buddelundia* `80`; and Buddelundiinae `OB24`.

Of these species, the confirmed SRE pseudoscorpion *Feaella* `PSE080`, the mygalomorph spider *Conothele* `MYG385-DNA` and the isopod *Buddelundia* `80` were considered to be of high conservation value because they were only recorded from restricted mountainous habitats. This survey's habitat assessment results from within the Development Envelope are presented in Appendix 2, and the faunal results are presented in Table 4.2.

4.2.2 Orebody 19-31 SRE Survey (Biologic 2014b)

This survey sampled 163 sites throughout Orebody 17, Orebody 19, Orebody 31, Wheelarra North and Mesa Gap, approximately 35 km east of the Development Envelope. The survey was conducted over two seasons in March and September 2013, collecting mygalomorph spiders, selenopid spiders, scorpions, pseudoscorpions, snails, millipedes, and isopods. Habitats targeted for sampling included gorges/ deep gullies, ridges/ breakaways, rocky outcrops, shallow/ open gullies, vegetation groves, drainage lines, drainage foci and plains. The survey methods used were active foraging, leaf litter sifting, soil sifting, burrow excavation, and vegetation/ bark searching.

The Orebody 19-31 survey detected 10 species considered to be Potential SREs:

- The mygalomorph spider, *Aganippe* `MYG384-DNA`;
- Two selenopid spiders, *Karaops* `ARA003-DNA` and *K.* `ARA004-DNA`;
- Two pseudoscorpions, *Synsphyronus* `sp. indet. (juv.)` and *Xenolpium* `PSE079`;
- The millipede, *Antichiropus* `sp. indet. (juv.)`; and
- Four isopods, *Buddelundia* `36NM`, *Buddelundia* `10NM`, *Buddelundia* `49`, and Buddelundiinae `WN`.

760000 765000 770000 775000 780000 785000 790000 795000 800000 805000 810000 815000 820000 825000 830000 835000

7430000 7425000 7420000 7415000 7410000 7405000 7400000 7395000 7390000

Hamersley

Fortescue

Augustus

OB 23/24/25

OB 18

Mt Whaleback

OB 29/30/35

Jimblebar (Wheelarra Hill)

Legend

Mining/ Exploration Locations

- Exploration
- Operations
- \+ SRE sites (habitat, opportunistic, and sampling)
- OB32 Development Envelope

Previous survey (reference)

- Orebody 35/ Western Ridge (AMBS 2011)
- Orebody 35 Additional Area (Biologic 2012)
- Jimblebar SRE Survey (Outback Ecology 2009)
- South West Jimblebar (Biologic 2013)
- Orebody 19-31 SRE Survey (Biologic 2014b)
- Orebody 31 Targeted Survey and EIA of SRE Fauna (Biologic 2014c)
- Orebody 24-25 SRE Survey (Biologic 2014a)
- Orebody 24-25 Upgrade SRE Survey (Outback Ecology 2008)
- Orebody 24-25 SRE Study, Case Study Pseudoscorpions (ENV 2008)
- Wheelarra North SRE Survey (Rapallo 2011)

1:190,000

0 1.75 3.5 7 10.5 km

N

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BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.3: Previous SRE survey areas and sites within the sub-regional area (habitat, opportunistic and sampling sites)

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

Created 29/01/2015. Size: A3

Of the Potential SRE species, the selenopid spiders, *Karaops* `ARA003-DNA` and *K.* `ARA004-DNA`, the millipede, *Antichiropus* `sp. indet. (juv.)`, the pseudoscorpion *Xenolpium* `PSE079`, and two of the isopods (*Buddelundia* `36NM` and Buddelundiinae `WN`) were considered to be of high conservation value because they belong to groups with a high likelihood of being SRE, and they were only recorded from restricted mountainous habitats.

4.2.3 Orebody 31 targeted survey (Biologic 2014c)

Thirty five (35) sites were sampled by active foraging, litter/soil sifting and habitat assessment at Orebody 31 and Wheelarra North, approximately 40 km east of the Development Envelope in June 2014. The objective of the survey was to investigate the distribution of a Potential SRE pseudoscorpion, *Xenolpium* PSE079. The survey successfully determined that *Xenolpium* PSE079 occurred beyond the Orebody 31 project area, within some of the more common low-sloping habitats such as low hills and outcrops, hill slopes/ footslopes, ridges/ breakaways, and shallow gullies; however, because of the widespread, flat sandplains surrounding the Orebody 31/ Wheelarra North area, it was considered that the species was still highly likely to be restricted to the local area, and it is still regarded as a Potential SRE.

4.2.4 Brockman Ophthalmia Project SRE Survey (Biologic 2014d)

SRE sampling (active foraging and litter/soil sifting) and habitat assessment was undertaken at 63 sites across a long, narrow study area located approximately 10 km north of the Development Envelope in March 2014. Nine major SRE habitat types were assessed throughout the study area, including Gorges/ Deep Gullies, Ridges/ Breakaways, Boulder Piles/ Tor, Shallow Gullies, Vegetation Groves, Drainage Lines, Shrubland, Hillslope/ Footslopes and Stony Plains. Two Potential SRE taxa were recorded; an unidentified juvenile selenopid spider (*Karaops* sp. indet. juv.) and an isopod, *Buddelundia* sp. `80`, which was previously known from the Biologic (2014a) OB24-25 SRE Survey. The SRE status of the juvenile *Karaops* spider could not be assessed without further DNA analysis, and although the detection of *Buddelundia* sp. `80` represented a range extension, the species distribution is still within the nominal limits for a SRE species.

4.2.5 OB24-OB25 Short-Range Endemic Study, Case Study Pseudoscorpions (ENV 2008)

A targeted survey and DNA analysis of pseudoscorpions was undertaken at Orebody 24-25 from 7-12 March 2006, comprising 12 sites immediately north, east and south of the Development Envelope, but none within it. The survey comprised targeted searching for pseudoscorpions in habitats such as range crests, range slopes, breakaways, gullies and gorges. The specimens were frozen in liquid nitrogen to preserve DNA, and a pedipalp was dissected and placed in 80 % ethanol to allow for morphological identifications (ENV 2008). The survey detected three lineages of pseudoscorpions from three different genera (*Indolpium*, *Euryolpium* and *Austrohorus*) in the family Olpiidae. The three lineages clearly

corresponded to at least three different species, but the study was inconclusive about whether or not the species` distributions and the level of genetic divergence within these species indicated a potential dispersal barrier between Orebody 24 and Orebody 25 (ENV 2008).

4.2.6 Orebody 24-25 Upgrade SRE Survey (Outback Ecology 2008)

This survey sampled eight sites at OB24-25 in April and June 2008, comprising several sites immediately north and east of the Development Envelope, but none within it. Habitats such as south facing slopes, ridges, gullies, and vegetation groves were sampled by dry pitfall trapping, targeted searches, leaf litter extraction, soil sifting, and nocturnal searching with UV lights. The target groups included mygalomorph spiders, scorpions, snails, millipedes and pseudoscorpions. Two millipede species identified as possible SRE taxa, Paradoxosomatidae sp. (juveniles) and *Austrostrophus stictopygus* were collected from south to south-east facing ridgelines and rocky slopes. *Austrostrophus stictopygus* is now known to be widespread throughout the Pilbara and is not considered SRE (C. Car, WAM pers. comm. 2013). To the best of our knowledge, the identification and SRE status of Paradoxosomatidae sp. (juveniles) have not been further resolved since the time of the survey. This family is known to include a number of SRE species in the genus *Antichiropus*, although additional adult specimens or DNA analyses would be required to further resolve the identification and SRE status of the specimens collected from this survey.

4.2.7 Orebody 35-Western Ridge SRE Survey (AMBS 2011)

This survey sampled 30 sites at Orebody 35/ Western Ridge approximately 20 km southwest of the Development Envelope in March/ May and August 2010. SRE habitats such as gorges and gullies and south/ southeast facing slopes were targeted, as well as more open habitats such as minor outwashes, valley floors, and low rolling hills. Sampling was conducted by wet and dry pitfall trapping, targeted searches, and soil sampling. The target groups comprised mygalomorph spiders, scorpions, snails, millipedes and pseudoscorpions. Seven species were originally identified as possible SRE taxa; three mygalomorph spiders (*Aname* `MYG205`, *A.* `MYG206` and *A.* `MYG098`), two paradoxosomatid millipedes (*Antichiropus* `OB_1` and *A.* `OB_2`), one pseudoscorpion (*Austrochthonius* sp.) and one scorpion (*Urodacus* `pilbara 12`). All of the species, other than the *Aname* spiders, were recorded primarily or exclusively in habitats that had high SRE potential (AMBS 2011). The *Aname* species were all recorded in open floodplains, which was unlikely to be restricted due to its widespread occurrence and high connectivity (AMBS 2011). Subsequent information from the WAM has indicated that the *Austrochthonius* pseudoscorpions and the scorpion *Urodacus* `pilbara 12` are no longer considered to be Potential SRE species. The two species of *Antichiropus* (`OB_1` and `OB_2`) have been re-named *A.* `DIP014` and *A.* `DIP015` respectively, and are still considered to be Potential SRE taxa (A. Beavis, pers. comm. 2013).

4.2.8 Orebody 35 Additional SRE Survey (Biologic 2012a)

This survey sampled 30 sites in an additional area at Orebody 35, approximately 20 km southwest of the current Development Envelope in September 2011. SRE habitats such as gorges and deep gullies, steep south/ southeast facing slopes, and ridges were targeted. Sampling was conducted by active foraging, leaf litter searching, and soil sifting. The target groups comprised mygalomorph spiders, scorpions, snails, isopods, millipedes and pseudoscorpions. The survey collected seven species from groups such as pseudoscorpions, land snails, scorpions and spirobolid millipedes, although none of the species were found to be SRE.

4.2.9 South-West Jimblebar SRE Survey (Biologic 2013)

This survey sampled 30 sites in an area southwest of the Jimblebar Mine, approximately 35 km east-southeast of the Development Envelope in February 2013. The habitats available for sampling comprised Mulga woodland, low ridges/ outcrops, and tall open shrubland. Sampling was conducted by active foraging, leaf litter sifting, soil sifting, and burrow excavations. The target groups comprised mygalomorph spiders, scorpions, snails, isopods, millipedes and pseudoscorpions. A new species of isopod, *Buddelundia* sp. nov., collected from a single specimen on an isolated low ridge/ outcrop, was considered to be a Potential SRE. This was the first survey in the local area to target isopod fauna, and the lack of regional context information available limited the ability to clarify this species' SRE status, and the species has not been collected in any other surveys to date (S. Judd pers. comm. 2014).

4.2.10 Wheelarra Hill North SRE Survey (Rapallo 2011)

This survey sampled 47 sites within the Wheelarra Hill North and Mesa Gap areas, approximately 35 km east of the Development Envelope in May 2011. Habitats such as south facing slopes, minor creek lines, gorge/ gullies, and plains were sampled by targeted searches and leaf litter extraction, and two sites in gorge/ gullies and creek lines were sampled by dry pitfall trapping. The survey targeted mygalomorph spiders, selenopid spiders, pseudoscorpions, scorpions, millipedes, and land snails. None of the taxa detected were found to be SRE species.

4.2.11 Jimblebar SRE Survey (Outback Ecology 2009)

This survey sampled 14 sites (including eight pit trapping sites and six opportunistic sites) within the Wheelarra Hill (Jimblebar) Mine lease, approximately 40 km east of the Development Envelope in August 2008 and February 2009. Habitats such as south facing slopes, ridges, breakaways, gullies, minor drainage lines, and Mulga groves were sampled by dry pitfall trapping, targeted searches, leaf litter extraction, soil sifting, and nocturnal searching with UV lights. The target groups included mygalomorph spiders, scorpions, snails, millipedes and pseudoscorpions. None of the species detected were found to be SRE at the time of the survey but subsequent taxonomic revisions of some of the material collected have

found that the Potential SRE species *Aganippe* `MYG085`, *Aname aragog*, and *Missulena occatoria* grp. occur in the area.

4.3 SRE Invertebrate Fauna Results

Table 4.2 shows that a combined total of 15 taxa (species and morphospecies) were detected within the Development Envelope during the OB24-25 SRE Survey, comprising three Potential SRE taxa and 12 widespread or data-deficient taxa (Biologic 2014a). None of these taxa were found to be restricted to the Development Envelope.

The three Potential SRE taxa occurring within the Development Envelope comprised:

- The mygalomorph spider *Cethegus* `MYG299-DNA` (WAM category `D` molecular evidence); and
- Two isopods, *Buddelundia* `16NM`, and *Buddelundia* `49`.

Further details regarding the three Potential SRE taxa that occur within the Development Envelope are presented in Section 4.3.1 below, and full faunal results for each site within the Development Envelope are presented in Appendix 1.

Table 4.2: SRE faunal results from within the Development Envelope and the surrounding local area (data from OB24-25 SRE Survey, Biologic 2014a). Taxa occurring within the Development Envelope are highlighted orange. Non-SRE taxa detected within the Development Envelope are tabled on the following page.

Higher taxon	Species	SRE Status	Inside Development Envelope*	Outside Development Envelope	Total
Araneomorphae					
Selenopidae	*Karaops* `ARA005-DNA`	Potential SRE		32	32
Mygalomorphae					
Barychelidae	*Aurecocrypta* `MYG315-DNA`	Potential SRE		1	1
Ctenizidae	*Conothele* `MYG385-DNA`	Potential SRE		1	1
Dipluridae	*Cethegus* `MYG299-DNA`	Potential SRE	4	2	6
Pseudoscorpiones					
Feaellidae	*Feaella* `PSE080`	Confirmed SRE		5	5
Garypidae	*Synsphyronus* `sp. nov. 8/1 Pilbara`	Potential SRE		1	1
Isopoda					
Armadillidae	*Buddelundia* `16NM`	Potential SRE	11	213	224
	Buddelundia `49`	Potential SRE	2	7	9
	Buddelundia `78`	Potential SRE		115	115
	Buddelundia `79`	Potential SRE		3	3
	Buddelundia `80`	Potential SRE		3	3
	Buddelundiinae sp. `OB24`	Potential SRE		5	5
Total SRE species			**3**	**12**	**12**
Total SRE individuals			**17**	**388**	**405**

Higher taxon	Species	SRE Status	Inside Development Envelope*	Outside Development Envelope	Total
NON-SRE TAXA WITHIN DEVELOPMENT ENVELOPE					
Mygalomorphae					
Nemesiidae	*Aname mellosa*	Widespread	2	1	3
Pseudoscorpiones					
Atemnidae	*Oratemnus* `sp.`	Data deficient	5	31	36
Olpiidae	*Austrohorus* `sp.`	Data deficient	1	10	11
	Beierolpium `sp. 8/2`	Data deficient	1	4	5
	Beierolpium `sp. 8/4`	Data deficient	2	405	407
Scorpiones					
Buthidae	*Lychas bituberculatus*	Widespread	1	2	3
Isopoda					
Armadillidae	*Buddelundia* `15`	Widespread	1	3	4
Mollusca					
Pupillidae	*Gastrocopta hedleyi*	Widespread	44	182	226
	Gastrocopta larapinta	Widespread	17	72	89
	Gastrocopta mussoni	Widespread	91	253	344
	Pupoides cf. *beltianus*	Widespread	38	120	158
	Pupoides cf. *pacificus*	Widespread	2	51	53
Total non-SRE species			**12**	**12**	**12**
Total non-SRE individuals			**205**	**1134**	**1339**

* Note specimens from site 125 were considered to be inside the Development Envelope, as this site was on the western boundary of the Development Envelope.

4.3.1 Potential SRE taxa within the Development Envelope

***Cethegus* `MYG299-DNA`**

Cethegus `MYG299-DNA` is a member of the Dipluridae, a family of curtain-web building mygalomorph spiders that do not live in burrows, but build curtain webs at the base of large shrubs and trees, and among woody debris. The species was confirmed (using COI DNA analysis, as per Appendix 3) from three sites sampled during the OB24-25 SRE Survey, including one site within the Development Envelope, and two sites approximately 7 km to the east (Figure 4.4). Despite being regarded as a Potential SRE, due to its current distribution being <10,000 km^2, *Cethegus* `MYG299-DNA` has also been previously detected at Hope Downs 4 and Jimblebar (G. Dolman pers. comm. 2013, Appendix 3) (Figure 4.1).

***Buddelundia* `16NM` and *Buddelundia* `49`**

Of the three species of isopods detected in the Development Envelope, *Buddelundia* `16NM` and *Buddelundia* `49` were regarded as Potential SREs, while *Buddelundia* `15` is known to be regionally widespread (*i.e.* distribution >10,000 km^2) (S. Judd pers. comm. 2013). Despite being regarded as Potential SREs, due to their current distributions being <10,000 km^2, both *Buddelundia* `16NM` and *B.* `49` were relatively widespread throughout the local area surrounding the Development Envelope (Figure 4.4), and records of both species have been found further afield, respectively at Orebody 35 (S. Judd pers. comm. 2013), and at Orebody 19/ Orebody 31/ Wheelarra North (Biologic 2014b) (Figure 4.2).

779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000

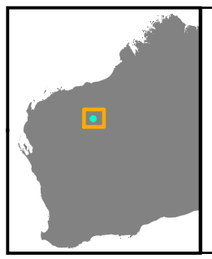
7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

Legend

- OB23-25 Approved disturbance
- OB32 Development Envelope

Potential SRE species

- Karaops 'ARA005-DNA'
- Aurecocrypta 'MYG315-DNA'
- Cethegus 'MYG299-DNA'
- Conothele 'MYG385-DNA'
- Buddelundia '16NM'
- Buddelundia '49'
- Buddelundia '78'
- Buddelundia '79'
- Buddelundia '80'
- Buddelundiinae 'OB24'
- Feaella 'PSE080' (Confirmed SRE)
- Synsphyronus `sp. nov. 8/1 Pilbara`



1:37,000

0 0.35 0.7 1.4 2.1 km

N

biologic

BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.4: Potential SRE species from OB32 and surrounds

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

Created 29/01/2015. Size: A3

4.4 Habitat Zones

Biologic 2014a categorised the habitats of the local area surrounding the Development Envelope into eight habitat zones that broadly reflected major changes in landform features, drainage features and vegetation features. Figure 4.5 shows the following eight habitat zones:

1. Main ranges zone - comprising the two major mountain ranges at Orebody 24 and Orebody 25. The dominant habitat types comprised Gorges/ deep gullies, Shallow/ open gullies, and Ridges/ breakaways, with some areas of Vegetation groves and Drainage foci. Overall SRE suitability was high due to highly sheltered, complex rocky habitats.
2. Northern ridges zone - comprising a series of moderately tall, parallel ridges striking northwest-southeast to the north of the Orebody 24 range. The habitat types present were mainly Gorges/ deep gullies, Ridges/ breakaways, and Hillslopes/ footslopes. Overall SRE suitability was high due to highly sheltered, complex rocky habitats.
3. Low hills zone - including the low hills/ ridges of the Development Envelope, this zone featured smaller, lower foothills adjacent to the Main ranges zone. The main habitat types were small Gorges/ deep gullies, Shallow/ open gullies, Ridges/ breakaways and Hillslopes/ footslopes. Overall SRE suitability was moderate due to fewer sheltered/ complex rocky habitats present.
4. Major gorge zone - a large, deeply incised gorge/ gully system occurring in the Orebody 24 range. The habitat types sampled within this zone were Gorges/ deep gullies, Ridges/ breakaways, Shallow/ open gullies, and Vegetation groves. Overall SRE suitability was high due to highly sheltered, isolated, complex rocky habitats.
5. Steep gullies zone - a series of steep gullies and gorges scattered throughout the Main ranges zone. The habitat types sampled within this zone were Gorges/ deep gullies, Shallow/ open gullies, Ridges/ breakaways, and Vegetation groves. Overall SRE suitability was high due to highly sheltered, isolated, complex rocky habitats.
6. Drainage zone - occurring immediately adjacent the western boundary of the Development Envelope, this zone featured riparian habitats associated with the major drainage lines such as Homestead Creek. Drainage line habitats were the only SRE habitat types present, and the overall suitability was moderate, as these habitats are well-connected and not highly complex.
7. Stony plain zone - open stony habitats downslope from the flanks of Main ranges and Low hills zones. The habitat types sampled within this zone were Plains, Vegetation groves, and low Ridges/ breakaways. The overall SRE suitability was low, as these habitats were mostly extensive and not highly complex.
8. Sandplain zone - including the majority of the Development Envelope, this zone featured extensive, alluvial floodplains and generally flat sandplains. The habitat types sampled within this zone were Plains and Vegetation groves, and the overall SRE suitability was low, as these habitats were generally extensive, lacking shelter and habitat complexity.

778000 779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000 793000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

OB 24 OB 23 OB 25

Legend

- Existing Mining Operations
- OB23-25 Approved disturbance
- OB32 Development Envelope

Habitat type on-site

- Drainage foci
- Drainage line
- Gorge/ deep gully
- Shallow/ open gully
- Ridge/ breakaway
- Hillslope/ footslope
- Vegetation grove
- Plain

SRE Habitat zone

- Main ranges zone
- Northern ridges zone
- Low hills zone
- Major gorge zone
- Steep gullies zone
- Drainage zone
- Stony plain zone
- Sandplain zone
- Disturbed

1:38,000

0 0.35 0.7 1.4 2.1 km

N

biologic

BHP Billiton Iron Ore

Orebody 32 Eats AWT SRE Impact Assessment

Fig. 4.5: Indicative extent of SRE habitat zones within the OB32 Development Envelope and surrounds

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

Created 29/01/2015. Size: A3

The Development Envelope comprised only the Low hills and Sandplains habitat zones, which were respectively regarded as having moderate or low suitability for SRE fauna overall. Neither of these habitat zones was restricted to the Development Envelope.

4.5 Inferred Extent of Likely Habitats for Potential SRE Species

The indicative extent of likely habitats for each of the Potential SRE species found within the Development Envelope is inferred based on the extent of habitat zones within which they were detected during the OB24-25 SRE Survey. This inferred extent is an indicative local area estimate only based on the results of the OB24-25 SRE Survey; each species is known to occur more widely within the sub-regional area, as shown in Figures 4.1 and 4.2.

4.5.1 *Cethegus* `MYG299-DNA`

This species was found within the Drainage and Sandplain habitat zones at sites featuring Drainage line habitats and Vegetation groves where there was sufficient woody debris and large shrubs to allow it to build curtain webs (Figure 4.6). Owing to the species` microhabitat requirement for large woody debris, trees or shrubs, *Cethegus* `MYG299-DNA` may have been under-sampled throughout the burnt areas of the Drainage and Sandplain habitat zones to the north of Orebody 24 and to the west of the Development Envelope. These areas were affected by recent fires at the time of the OB24-25 SRE Survey (Biologic 2014a), and little woody material remained on-site. Following the re-establishment of large, woody vegetation after the fire, it is highly likely that the species would be able to recolonise these burnt areas.

(A) **(B)**

Figure 4.6 *Cethegus* `MYG299-DNA` curtain webs developed around A) the base of a shrub at site 121, and B) woody debris at site 43

The species has previously been recorded at Jimblebar and the Hope Downs 4 mine, which indicates a sub-regional distribution much wider than the local area surrounding the Development Envelope (Figure 4.1). Based on current habitat information and regional records, the inferred extent of habitat for this species within the Development Envelope represents a very minor proportion of the wider potential habitat for the species in the local area and the broader sub-region (Figures 4.7, 4.1).

778000 779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000 793000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

OB 24

OB 23

OB 25

Legend

- Existing Mining Operations
- OB23-25 Approved disturbance
- OB32 Development Envelope
- Records of Cethegus 'MYG299-DNA'
- Inferred potential habitat for Cethegus 'MYG299-DNA'

1:38,000

0 0.35 0.7 1.4 2.1 km

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BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.7: Inferred extent of potential habitat for Cethegus 'MYG299-DNA' within the local area surrounding OB32 East

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

Created 29/01/2015. Size: A3

4.5.2 *Buddelundia* `16NM`

Buddelundia `16NM` was one of the most abundant and frequently detected species throughout the local area surrounding the Development Envelope (Table 4.2), and was almost always detected from rocky/ mountainous habitats such as Gorges/ deep gullies, Ridges/ breakaways, and Shallow/ open gullies. The vast majority of specimens were collected from under rocks or in rock cracks and crevices, indicating that this species is most likely a rocky habitat specialist.

Figure 4.8 shows that the species was detected only from rocky or mountainous habitat zones such as the Main ranges, Major gorge, Steep gullies, and Low hills habitat zones. Although these types of habitats can be individually discontinuous, collectively they provide a well-connected network of suitable habitat for this species which is common and extensive throughout the local area surrounding the Development Envelope.

This species has also been previously recorded at Orebody 35, which indicates a sub-regional distribution beyond the local area surrounding the Development Envelope. Based on current information, the extent of likely habitat for this species inside of the Development Envelope boundaries (a small area of the Low Hills habitat zone) represents a very minor proportion of the wider likely habitat for the species in the local area (refer Figure 4.8) and the broader sub-region (Figure 4.2).

4.5.3 *Buddelundia* `49`

Buddelundia `49` was detected from nine sites in the area surrounding the Development Envelope, mostly in the Low hills, Sandplains and Drainage habitat zones in the western and far eastern parts. The species was primarily collected from leaf litter, which would generally indicate more widely occurring suitable microhabitats than would be expected for rocky-habitat specialist taxa.

As suggested in Section 4.5.1, the recent fires in areas to the north, west, and north east of the Development Envelope during the OB24-25 SRE Survey may have affected the observed distribution of this species. Assuming that the species prefers leaf litter habitats, fire is likely to be a major reason for the discrepancy between the abundance and local distribution of *Buddelundia* `49` observed at Orebody 24-25 (9 specimens from 9 sites) (Figure 4.9), and Orebody 19-31 (100 specimens from 52 sites, none of which were affected by recent fires) (Figure 4.2, Table 4.1).

This species has been recorded frequently and in large numbers at Orebody 17, Orebody 19, Orebody 31, and Wheelarra North (Biologic 2014b, Table 4.1, Figure 4.2), which indicates a sub-regional distribution much wider than the local area surrounding the Development Envelope. Based on current information, the extent of likely habitat for this species inside of the Development Envelope boundaries represents a very minor proportion of the wider likely habitat for the species in the local area (refer Figure 4.9) and the broader sub-region.

778000 779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000 793000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

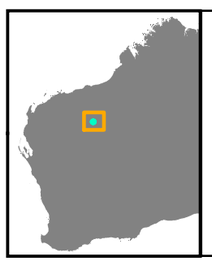
OB 24

OB 23

OB 25

Legend

- Existing Mining Operations
- OB23-25 Approved disturbance
- OB32 Development Envelope
- Records of Buddelundia '16NM'
- Inferred potential habitat for Buddelundia '16NM'



1:38,000

0 0.35 0.7 1.4 2.1 km

N

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Orebody 32 East AWT SRE Impact Assessment

Fig. 4.8: Inferred extent of potential habitat for Buddelundia '16NM' within the local area surrounding OB32 East

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

Created 29/01/2015. Size: A3

778000 779000 780000 781000 782000 783000 784000 785000 786000 787000 788000 789000 790000 791000 792000 793000

7424000 7423000 7422000 7421000 7420000 7419000 7418000 7417000 7416000

OB 24

OB 23

OB 25

Legend

- Existing Mining Operations
- OB23-25 Approved disturbance
- OB32 Development Envelope
- Records of Buddelundia '49'
- Inferred potential habitat for Buddelundia '49'

1:38,000

0 0.35 0.7 1.4 2.1 km

N

biologic

BHP Billiton Iron Ore

Orebody 32 East AWT SRE Impact Assessment

Fig. 4.9: Inferred extent of potential habitat for Buddelundia '49' within the immediate local area surrounding OB32 East

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

Created 29/01/2015. Size: A3

5. IMPACT ASSESSMENT

5.1 Potential Impacts

Potential impacts on SRE fauna and habitats from the proposed development may include:

- Direct impacts *i.e.* the removal of SRE habitat or complete loss of SRE values resulting from:
  - Mining and earthworks;
  - Construction of infrastructure; and
  - Vegetation clearing.
- Indirect impacts *i.e.* more subtle or gradual degradation of SRE habitat values via changes to the physical condition of habitats and microhabitats associated with vegetation, landforms, and drainage features. Indirect impacts may include:
  - Habitat fragmentation (creation of barriers to species movement, increased edge effects);
  - Alteration to surface drainage patterns or groundwater hydrology (via effects on drainage and vegetation-based habitats);
  - Spread of introduced flora or fauna species that may degrade the quality of terrestrial habitats;
  - Alteration of fire regimes (effects on vegetation-based habitats);
  - Spills and contamination (localised effects); and
  - Vibration, noise and dust (localised effects near active mining areas).

5.2 Direct Impacts to Species and Habitats

Assessment of direct impacts on SRE values is limited to species and their habitats that occur within the Development Envelope. This includes three Potential SRE species, *Cethegus* `MYG299-DNA`, *Buddelundia* `16NM`, and *Buddelundia* `49` (Figure 4.4), and SRE habitats within the Low hills and Sandplain habitat zones (Figure 4.5). Table 5.1 summarises the types of potential impacts, impact pathways, and the magnitude of impacts to key SRE species and their habitats occurring within the Development Envelope.

Owing to the fact that each of the key SRE species, *Cethegus* `MYG299-DNA`, *Buddelundia* `16NM`, and *Buddelundia* `49` are known to occur beyond the Development Envelope and even beyond the local area surrounding the Development Envelope (Table 5.1, Figures 4.1, 4.2 and 4.4), the proposed development is expected to have a negligible direct impact on SRE species.

Similarly, each of the Potential SRE species were recorded within a range of habitat zones that are extensive throughout the local area surrounding the Development Envelope (Table 5.1). Owing to the relatively small size of the Development Envelope in comparison to the wider extent of similar habitats, the impact on SRE habitats from the proposed development is expected to be low.

Table 5.1: Summary of potential impacts to key SRE species and habitats.

Records inside/ outside Development Envelope	Inferred potential habitat	Potential impacting processes	Magnitude of impact
***Cethegus* `MYG299-DNA`**			
4 inside 5 outside (Orebody 24, Jimblebar, Hope Downs 4)	Drainage, and Sandplain zones Extensive beyond the Development Envelope and surrounding local area	Minor decrease in habitat due to mining, construction, and vegetation clearing within the Development Envelope	**Negligible impact** Species and habitat occurs widely beyond the Development Envelope.
***Buddelundia* `16NM`**			
11 inside 214 outside (Orebody 24-25, Orebody 35)	Main ranges, Major gorge, Low hills, and Steep gullies zones Extends beyond the Development Envelope and surrounding local area	Minor decrease in habitat due to mining, construction, and vegetation clearing within the Development Envelope	**Negligible impact** Species and habitat occurs widely beyond the Development Envelope.
***Buddelundia* `49`**			
2 inside 116 outside (Orebody 24-25, Orebody 19-31)	Stony plain, Sandplain, Low hills, and Drainage zones Extensive beyond the Development Envelope and surrounding local area	Minor decrease in habitat due to mining, construction, and vegetation clearing within the Development Envelope	**Negligible impact** Species and habitat occurs widely beyond the Development Envelope.

5.3 Indirect Impacts

Owing to the relatively small size of the Development Envelope in comparison to the wider extent of habitats within the Low hills and Sandplains habitat zones, the proposed development is not expected to result in SRE habitat fragmentation.

Based on the relatively small size of the Development Envelope in relation to the local catchments/ sub-catchments, the mostly flat topography within the Development Envelope and the lack of any major drainage lines running through it, any land surface changes within the Development Envelope are expected to have a minimal impact on local surface hydrology. Although the western boundary of the Development Envelope runs alongside Homestead Creek, it is not expected that the proposed development would cause any interruption of the natural flow regime of Homestead Creek. The proposed development comprises above water-table mining, therefore no major changes to groundwater hydrology are expected to occur.

Owing to the relatively small size of the Development Envelope in comparison to nearby active mining areas at Orebody 24, Orebody 25 and Orebody 23, the risk of indirect impacts to SRE habitats from environmental incidents or vibration/ noise/ dust is expected to be no greater than what has already been approved for the current mining operations. Any indirect impacts from environmental incidents such as introduced flora/ fauna species, fire, and spills/ contamination would be expected to be further managed by the extension of current environmental management processes in place at the Orebody 24, Orebody 25 and Orebody 23 mining areas.

6. SIGNIFICANT OUTCOMES

The key SRE values recorded within the Development Envelope include three Potential SRE species: a mygalomorph spider, *Cethegus* `MYG299-DNA`, and two isopods, *Buddelundia* `16NM`, and *Buddelundia* `49`.

The potential impacts to SRE species from the proposed development are considered negligible, as none of the Potential SRE species are restricted to the Development Envelope. Each of the three Potential SRE species has been recorded widely within in the local area surrounding the Development Envelope as well as from regional specimens further afield.

The potential impacts to SRE habitats within the Development Envelope are expected to be low, as each of the SRE habitat types within the Development Envelope were considered to offer moderate to low suitability for SRE species and were found to extend widely throughout the surrounding local area beyond the Development Envelope.

The potential risk of indirect impacts is also expected to be low, owing to the relatively small size of the Development Envelope in comparison to the wider local habitats, and due to the extension of current environmental management processes in place at the nearby Orebody 24, Orebody 25 and Orebody 23 mining areas.

7. REFERENCES

(ALA) Atlas of Living Australia (2013) Explore your Area. Data search tool. Accessed April 2013. Available online at: http://biocache.ala.org.au/explore/your-area#-35.27412|149.11288000000002|12|ALL_SPECIES

(AMBS) Australian Museum Business Services (2011) Assessment of Terrestrial Short-Range Endemic Invertebrates in the OB35-Western Ridge Area near Newman, Western Australia. Report to BHP Billiton Iron Ore Pty Ltd. Sydney.

Allen, G.R., Midgley, S.H. and Allen, M. (2002). Field Guide to the Freshwater Fishes of Australia. CSIRO Publishing, Melbourne, Vic.

Australian Natural Resource Atlas (2008). "Biodiversity Assessment – Pilbara". Australian Natural Resource Atlas. http://www.anra.gov.au. Last accessed June 2010.

Beard (1975) Pilbara. Explanatory Notes and Map Sheet 5, 1:1 000 000 series Vegetation Survey of Western Australia. University of Western Australia Press: Nedlands.

BHP Billiton Iron Ore (2009) BHP Billiton Iron Ore's Guidance for Short-Range Endemic Invertebrate Surveys in the Pilbara Region (SPR-IEN-EMS-013); Central Pilbara Region Short-Range Endemic Assessment Scope, Approach and Methods. BHP Billiton Iron Ore, 20 March 2009.

Biologic (2012) Biologic Environmental Survey. OB35 Short-range Endemic Invertebrate Survey. Report to BHP Billiton Iron Ore. Perth.

Biologic (2013) Biologic Environmental Survey. South-West Jimblebar Short-range Endemic Invertebrate Survey. Report to BHP Billiton Iron Ore. Perth.

Biologic (2014a) Biologic Environmental Survey. Orebody 24-25 Short-range Endemic Invertebrate Survey. Report to BHP Billiton Iron Ore. Perth.

Biologic (2014b) Biologic Environmental Survey. Orebody 19-31 Short-range Endemic Invertebrate Survey. Report to BHP Billiton Iron Ore. Perth.

Biologic (2014c) Biologic Environmental Survey. Orebody 31 Targeted Short-range Endemic Invertebrate Survey and Environmental Impact Assessment. Report to BHP Billiton Iron Ore. Perth.

Biologic (2014d) Biologic Environmental Survey. Brockman Ophthalmia Project Short-range Endemic Invertebrate Survey. Report to Brockman Iron Ltd. Perth.

(BoM) Bureau of Meteorology (2014). Online Climate Data. Database: http://www.bom.gov.au/. Last accessed July 2014.

Durrant, B.J. (2011) Short-range endemism in the Central Pilbara. Unpublished report to BHP Billiton Iron Ore. Perth, WA.

ENV (2008) OB24-OB25 Short-Range Endemic Study Pseudoscorpions (Chelicerata: Arachnida). Report to BHP Billiton Iron Ore MPD JV Asset Development Projects. Perth, WA.

(EPA) Environmental Protection Authority (2002) Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection. Perth, WA.

(EPA) Environmental Protection Authority (2004) Guidance for the Assessment of Environmental Factors (in accordance with the *Environmental Protection Act 1986*). Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. No. 56. Perth, WA.

(EPA) Environmental Protection Authority (2009) Guidance for the Assessment of Environmental Factors (in accordance with the *Environmental Protection Act 1986*). Sampling of Short Range Endemic Fauna for Environmental Impact Assessment in Western Australia. No. 20. Perth, WA.

Harvey, M.S. (2002). Short-range endemism among the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**: 555-570.

Johnson, M.S., Hamilton, Z.R, Murphy, C. E., MacLeay, C. A., Roberts, B., & Kendrick, P.G. (2004). Evolutionary genetics of island and mainland populations of Rhagada (Gastropoda: Pulmonata) in the Pilbara Region, Western Australia. Australian Journal of Zoology 52: 341-355.

Kendrick, P. (2001) Pilbara 3 (PIL3 – Hamersley subregion). In: May, J. and McKenzie, N (Eds.), *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*. Department of Conservation and Land Management, Perth.

Main, B.Y., Sampey, A. and West, P.L.J. (2000) Mygalomorph spiders of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* Supplement **61**: 281-293.

McKenzie, N. J. and Hook, J. (1992). Interpretations of the Atlas of Australian Soils. Consulting Report to the Environmental Resources Information Network (ERIN). CSIRO Division of Soils Technical Report 94/1992.

McKenzie, N.L., van Leeuwen, S. and Pinder, A.M. (2009) Introduction to the Pilbara Biodiversity Surveys, 2002-2007. *Records of the Western Australian Museum* Supplement **78**:3-90.

Northcote, K. H. with Beckmann, G. G., Bettenay, E., Churchward, H. M., Van Dijk, D. C., Dimmock, G. M., Hubble, G. D., Isbell, R. F., McArthur, W. M., Murtha, G. G., Nicolls, K. D., Paton, T. R., Thompson, C. H., Webb, A. A. and Wright, M. J. (1960-1968). Atlas of Australian Soils, Sheets 1 to 10. With explanatory data (CSIRO Aust. and Melbourne University Press: Melbourne).

Onshore Environmental (2014) Onshore Environmental Consultants. Regional Vegetation Mapping of BHP Billiton Iron Ore Pilbara Tenure. Report to BHP Billiton Iron Ore Pty Ltd.

Outback Ecology (2008) Orebody 24-25 Upgrade Terrestrial Invertebrate Short-range Endemic Assessment. Report to BHP Billiton Iron Ore Pty Ltd.

Outback Ecology (2009) Jimblebar Iron Ore Project Terrestrial Invertebrate Short-range Endemic Assessment. Report to BHP Billiton Iron Ore Pty Ltd.

Ponder, W.F. and Colgan, D.J. (2002). What makes a narrow-range taxon? Insights from freshwater snails. *Invertebrate Systematics* **16**: 571-582.

Rapallo (2011) Wheelarra Hill – North, SRE Survey. Final Summary Report for BHP Billiton. Report to BHP Billiton Iron Ore. Rapallo, Perth, Western Australia

RPS Aquaterra (2012) Mining Area C Operations Environmental Management Plan (Revision 5) – B and P4 deposits surface water assessment. Unpublished report to BHP Billiton Iron Ore Pty Ltd.Shepherd, D., Beeston, G and Hopkins, A. (2002) Native Vegetation in Western Australia. Extent, Type *and Status. Resource Management Technical Report 249*. Department of Agriculture, South Perth.

Thackway, R. and Cresswell, I.D. (1995) An interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4. Australian Nature Conservation Agency: Canberra, Australia.

Thorne, A.M. and Tyler, I.M., (1997). Mt Bruce, Western Australia (2nd Edition). Map Sheet and explanatory notes. 1:250 000 geological series. Sheet SF50-11. Geological Survey of WA.

Tyler, I. M., Hunter, W. M. & Williams, I. R. (1991). Newman, Western Australia. 1:250,000 Geological Series – Explanatory Notes. Geological Survey of Western Australia.

Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92. Department of Agriculture, South Perth.

(WAM) Western Australian Museum (2013). WAM Taxonomic Services Submission Guidelines. Last revised June 2013. Guidelines prepared by Western Australian Museum, Perth.

Appendix 1: Faunal Results within the Development Envelope

Numbers of individuals sampled from sites within the development envelope (OB24-25 SRE Survey, Biologic 2014a)

Higher taxon	Morphospecies	Habitat Type:	Gorge/ deep gully	Shallow/ open gully	Hillslope/ footslope		Drainage line	Vegetation groves				Plain	Total
		Site:	44	45	101	118	125	100	102	114	43	7	
Mygalomorphae													
Dipluridae	*Cethegus* `MYG299`										4		4
Nemisiidae	*Aname* `sp. indet.`				1								1
	Aname mellosa							1					1
Pseudoscorpiones													
Atemnidae	*Oratemnus* `sp.`					3					1	1	5
Olpiidae	Olpiidae `gen. sp. indet. (juv.)`								2		2		4
	Austrohorus `sp.`										1		1
	Beierolpium `sp. 8/2`		1										1
	Beierolpium `sp. 8/4`						2						2
	Indolpium `sp.`				2								2
Scorpiones													
Buthidae	*Lychas bituberculatus*		1										1
Isopoda													
Armadillidae	*Buddelundia* `15`									1			1
	Buddelundia `16NM`		7	2		2							11
	Buddelundia `49`						1			1			2
Gastropoda													
Pupillidae	*Gastrocopta hedleyi*									26	18		44
	Gastrocopta larapinta						14		3				17
	Gastrocopta mussoni							56	26	9			91
	Pupoides cf. *beltianus*							32	1	4	1		38
	Pupoides cf. *pacificus*							2					2
Total			**9**	**2**	**3**	**5**	**17**	**91**	**32**	**41**	**27**	**1**	**228**

Appendix 2: Habitat Data within the Development Envelope

Summary of habitat and microhabitat data from sites within the Development Envelope (OB24-25 SRE Survey, Biologic 2014a)

Site	Habitat type	SRE Suit-ability	Rocky Microhabitats	Slope & Aspect	Drainage & Moisture	Vegetation Cover	Vegetation Cover Score	Disturbances
7	Plain	0	Alluvial/ detrital gravels	N/A	N/A	Burnt Mulga, *Triodia*	N/A	Partial Fire
43	Vegetation grove	2	Alluvial/ detrital gravels	N/A	N/A	Mulga	Mod	N/A
44	Gorge/ deep gully	4	Cliff, caves, outcrop, boulders	Mod/High; SW	Gully	*Eucalyptus*, mixed shrubs	Low	Mod/High weeds
45	Shallow/ open gully	3	Outcrop, caves, boulders	Mod/High; NW	Gully	*Eucalyptus*, *Triodia*	N/A	Mod/High weeds
100	Vegetation grove	2	Alluvial/ detrital	Low; SW	N/A	Mulga	Low	N/A
101	Hillslope/ footslope	2	Minor outcrop	Mod; East	N/A	*Eucalyptus*, mixed shrubs, *Triodia*	N/A	N/A
102	Vegetation grove	2	Alluvial/ detrital gravels	N/A	N/A	*Eucalyptus*, Mulga, *Cenchrus**	Low	High weeds
114	Vegetation grove	2	Alluvial/ detrital gravels	N/A	Sheet flow	Mulga, mixed *Acacia*, *Triodia*	Mod	Mod weeds
118	Hillslope/ footslope	1	Boulders	Mod/Low; South	Gully	Burnt *Eucalyptus*, *Triodia*	N/A	Partial Fire
125	Drainage line	1	Alluvial/ detrital gravels	N/A	Creek, moisture	*Eucalyptus*, mixed shrubs, burnt grasses	Low	Partial Fire

Site	Leaf Litter Microhabitat	Leaf Litter Suitability Score	Woody debris Score	Soil Microhabitat	Soil Suitability Score	Burrows Observed
7	Mulga, patchy	Mod	Mod	Loam	Mod/High	
43	Mulga, common	Mod	Mod	Deep Loam minor gravel	Mod/High	Curtain web
44	*Eucalyptus*, scarce	Mod/Low	Mod	Skeletal, Gravelly Loam	Low	
45	Negligible	N/A	Low	Skeletal, Gravelly Silty loam	Low	
100	Mulga, dense	Mod/High	Mod/High	Humus, Gravelly Clay-Loam	Mod/High	Mygal.
101	*Eucalyptus*, patchy	Mod	Low	Loam-Sand	Mod/Low	Mygal.
102	Mulga, *Eucalyptus*, common	Mod/Low	Mod	Clay-Loam	High	Mygal.
114	Mulga, patchy	Mod	Low	Deep Loam-Sand	Mod	
118	*Eucalyptus*, scarce	Low	Low	Limited Loam	Mod	
125	Mixed, patchy	Mod	Low	Alluvial, Gravelly Sand	Low	Curtain web

Appendix 3: WAMTS217/235 DNA Analysis Report

Molecular Identification of Mygalomorphae and Araneomorphae from N. Newman, Western Australia

Brief report to *Biologic Environmental*

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Summary

A total of 51 spiders, sixteen of the infraorder Mygalomorphae and 35 of the infraorder Araneomorphae and family Selenopidae were collected from between 5 and 7 km north of Newman, Western Australia and lodged into the Western Australian Museum collection by Biologic Environmental (see Table 1 for specimen details). The main objectives of the Museum's Molecular Systematics Unit (MSU) were to use COI DNA barcoding to: 1) determine how many different species are present within the material, and 2) observe if the identified species have been detected anywhere else from the existing WAM records/ specimens.

DNA was extracted from legs of all 51 specimens and DNA barcoding sequences (CO1) were amplified by PCR in the MSU and sequenced by the Australian Genomic Research Facility (AGRF) Perth node. DNA sequences were BLASTED against the Western Australian Museum DNA database and combined with DNA sequences from the WAM DNA database to generate simple distance-based trees to determine genetic relationships and species status.

A summary of specimen identifications together with their SRE status is presented in Table 1. A full explanation of the SRE categories used by the Western Australian Museum is in Appendix 1.

Table 1. Summary of WAMTS206/247 species identifications and SRE status

Infraorder	Family	Genus	Species	Number of specimens	SRE status	SRE sub-category
Mygalomorphae	Nemisiidae	*Aname*	*mellosa*	1	Widespread	
Mygalomorphae	Nemesiidae	*Aname*	'sp.' *morphology only*	2	Potential	(A) Juvenile
Mygalomorphae	*Ctenizidae*	*Conothele*	`MYG385-DNA`	1	Potential	(A) New species (C) Molecular evidence
Mygalomorphae	*Dipluridae*	*Cethegus*	`MYG299-DNA`	6	Potential	(A) Lack of taxonomic information & geographic context (C) Molecular evidence
Mygalomorphae	*Barychelidae*	*Aurecocrypta*	`MYG315-DNA`	1	Potential	(A) Lack of taxonomic information & geographic context (C) Molecular evidence
Araneomorphae	*Selenopidae*	*Karaops*	`ARA005-DNA`	32	Potential	(A) New species (C) Molecular evidence

Shaded cells represent potential SRE taxa according to CO1 barcoding DNA sequence data

Results

Of the 51 specimens submitted for molecular identification, 50 COI DNA barcodes were successfully PCR amplified and 48 were successfully sequenced. Two specimens were PCR amplified but suffered from sequencing failure or amplification of a pseudogene. Of the 48 queried Araneae COI DNA sequences, eight specimens were identified by initial BLAST searches as by-catch (or non-target species). The remaining 40 DNA sequences were compared to the Western Australian Museum's DNA barcode database. Nine DNA barcode sequences were compared with all Mygalomorphae DNA sequences and 31 DNA barcode sequences were compared to all Selenopidae DNA sequences. To assist with species identification, Neighbour-Joining (distance based) trees were generated including all Mygalomorphae and all Selenopidae, respectively.

DNA distance results are summarised for each distinct species in Table 3. Locality details of WAM specimens matched to the queried specimens are provided in Appendix 2. Individual species identifications are provided in Appendix 3. DNA sequences of queried specimens are provided in Appendix 4.

Table 2. DNA Distance results from BLAST and Neighbour-joining phylogenetic analyses

Infraorder	Family	Genus	Species	Number of specimens	DNA distance results
Mygalomorphae	Nemisiidae	*Aname*	*mellosa*	1 specimen (131250)	Widespread
Mygalomorphae	Ctenizidae	*Conothele*	`MYG385-DNA`	1 specimen (131086)	**New distinct species:** 13.40% divergence from *Conothele* 'MYG294' 12.50% divergence from *Conothele* 'MYG297' 12.14% divergence from *Conothele* 'MYG279'
Mygalomorphae	Dipluridae	*Cethegus*	`MYG299-DNA`	6 specimens (131084; 131243; 131245; 131246; 131247; 131252)	**Allied with *Cethegus* 'MYG299' :** 3.87% average divergence from queried specimens to *Cethegus* 'MYG299' 1.54% average divergence within queried specimens 13.17% average divergence of queried specimens from nearest distinct species 'MYG050'
Mygalomorphae	Barychelidae	*Aurecocrypta*	`MYG315-DNA`	1 specimen (131249)	**Allied with *Aurecocrypta* `MYG315-DNA` :** 8.84% divergence between T131249 and *Aurecocrypta* '`MYG315-DNA` 6.64% average divergence within *Aurecocrypta* '`MYG315-DNA` 13.575% average divergence to nearest distinct species

Table 2. DNA Distance results from BLAST and Neighbour-joining phylogenetic analyses

Infraorder	Family	Genus	Species	Number of specimens	DNA distance results
Araneomorphae	Selenopidae	*Karaops*	`ARA005-DNA`	32 specimens (131087; 131088; 131089; 131090; 131091; 131092; 131093; 131094; 131095; 131096; 131097; 131098; 131099; 131100; 131101; 131102; 131103; 131104; 131223; 131224; 131225; 131227; 131228; 131229; 131230; 131231; 131233; 131234; 131235; 131236; 131238; 131239)	**New distinct species:** 0.18% average divergence within *Karaops* `ARA005-DNA` 5.02% average divergence from *Karaops* 'ARA003-DNA' and 'ARA004-DNA' (WAMTS 206/247)

Shaded cells represent potential SRE taxa according to CO1 barcoding DNA sequence data

Conclusions

The main objectives were to: 1) determine how many different species are present within the material, and 2) observe if the identified species have been detected anywhere else from the existing WAM records/ specimens. According to currently available DNA (COI) sequence data there is evidence for the presence of five species from these sites between 5 and 7 km north of Newman. There are four families of Mygalomorphae represented by four genera and four distinct species and one family of Araneomorph (Selenopidae) represented by one new distinct species.

Three of the four species of Mygalomorphae are represented in the WAM database and therefore found elsewhere. One of these (*Aname mellosa*) is widespread. The other two species (*Cethegus* 'MYG299' and *Aurecocrypta* '`MYG315-DNA`) are represented in the database but remain potential SRE's as the current known distribution is within SRE limits. The fourth species of Mygalomorphae (*Conothele* 'MYG385-DNA') represented by one specimen represents a new species and therefore is currently not represented in the WAM DNA database. Thus there is no current evidence that other specimens from this distinct species have been detected at any other locations and are therefore it is a potential SRE (new species; molecular evidence).

The new distinct species of Araneomorph (Selenopidae) belongs to the genus *Karaops* and is currently not represented in the WAM DNA database. Therefore there is no current evidence that other specimens from this species have been detected at any other locations and it is therefore a potential SRE (new species, molecular evidence). The two newly identified species have been assigned DNA-based evidence codes of *Conothele* 'MYG294' (1 specimens) and `ARA005-DNA` (32 specimens).

The only species overlap with WAMTS206/247 is the widespread Mygalomorphae, *Aname mellosa*. Thus, when comparing the diversity of the two projects there are four species unique to WAMTS217/235 compared to five species unique to WAMTS206/247.

Appendix 1. WAM Short-Range Endemic Categories

	Taxonomic Certainty	Taxonomic Uncertainty
Distribution < 10 000km^2	**Confirmed SRE** • *A known distribution of < 10 000km^2.* • *The taxonomy is well known.* • *The group is well represented in collections and/ or via comprehensive sampling.*	**Potential SRE** • *Patchy sampling has resulted in incomplete knowledge of the geographic distribution of the group.* • *We have incomplete taxonomic knowledge.* • *The group is not well represented in collections.* • *This category is most applicable to situations where there are gaps in our knowledge of the taxon.* **Sub-categories for this SRE designation are outlined below**
Distribution > 10 000km^2	**Widespread (not an SRE)** • *A known distribution of > 10 000km^2.* • *The taxonomy is well known.* • *The group is well represented in collections and/ or via comprehensive sampling.*	

SRE SUB-CATEGORIES

If a taxon is determined to be a "Potential SRE", the following sub-categories will further elucidate this status.

A. *Data Deficient:*
- There is insufficient data available to determine SRE status.
- Factors that fall under this category include:
  - Lack of geographic information.
  - Lack of taxonomic information.
  - The group may be poorly represented in collections.
  - The individuals sampled (e.g. juveniles) may prevent identification to species level.

B. *Habitat Indicators:*
- It is becoming increasingly clear that habitat data can elucidate SRE status.

C. *Morphology Indicators:*
- A suite of morphological characters are characteristic of SRE taxa.

D. *Molecular Evidence:*
- If molecular work has been done on this taxon (or a close relative), it may reveal patterns congruent or incongruent with SRE status.

E. *Research & Expertise:*
- Previous research and/ or WAM expertise elucidates taxon SRE status.
- This category takes into account the expert knowledge held within the WAM.

Appendix 2. Details of registered WAM samples belonging to the same species as queried specimens, according to current CO1 barcoding DNA sequence data

Infraorder	Family	Genus	Species	WAM Reg. No.	Site	Latitude	Longitude	Collection Method	Habitat
Mygalomorphae	Dipluridae	*Cethegus*	`MYG299-DNA`	91710	Hope Downs 4, ca. 100 km NW. Newman, HD4-6	-23.1544	119.582		
				91711	Hope Downs 4, ca. 100 km NW. Newman, HD4-4	-23.1474	119.519		
				95410	Jimblebar minesite, 35 km E. of Newman	-23.3789	120.257	active search	
Mygalomorphae	Barychelidae	*Aurecocrypta*	`MYG315-DNA`	93462	Hope Downs 4, ca. 30 km NW. Newman, HD4-16, 20	-23.0914	119.171		rocky slopes with boulders, occ. Eucalypts
				93465	Hope Downs 4, ca. 30 km NW. Newman, HD4-3, 10	-23.1533	119.529		open eucalypt over mixed shrubs and Triodia
				116787	Mudlark, 108 km W. of Newman	-23.0425	118.729	by hand	dug from burrow
				116800	Mudlark, 108 km W. of Newman	-23.0397	118.766	by hand	dug from burrow
				105894	Area C, 97.6 km NW. of Newman	-23.0106	118.86		Dug from burrow
				103910	West Angelas, 98 km SE. of Tom Price	-23.1419	118.615		dug from burrow
				91895	10 km NE. of Newman, Ore-body 24, site 06-6B	-23.3038	119.804	active search	
				91896	10 km NE. of Newman, Ore-body 24, site 07-7C	-23.3079	119.815	active search	

Appendix 3. Specimen details and species identifications

WAM Reg. No.	Field No.	WAMTS	Infraorder	Family	Genus	Species	Locality	Notes on molecular work
131084	43-HS-T1-W-BES0338	WAMTS217	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	"Homestead" ca. 6km N of Newman	
by-catch	59-OB24-T1-W-BES0407	WAMTS217						
131086	72-OB25-T1-S-BES0154	WAMTS217	Mygalomorphae	Ctenizidae	*Conothele*	'MYG385'	Orebody 25 ca. 5km N of Newman	
131242	15-HS-T2-B-BES0889	WAMTS235	Mygalomorphae	Nemesiidae	*Aname*	'sp.' *morphology only*	"Homestead" ca. 6km N of Newman	pseudogene amplified
131243	29-OB24-T2-W-BES0816	WAMTS235	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	Orebody 24 ca. 7km N of Newman	
by-catch	42-OB24-T2-R-BES0769	WAMTS235						
131245	43-HS-T2-W-BES0847	WAMTS235	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	"Homestead" ca. 6km N of Newman	
131246	43-HS-T2-W-BES0866	WAMTS235	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	"Homestead" ca. 6km N of Newman	
131247	43-HS-T2-W-BES0884	WAMTS235	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	"Homestead" ca. 6km N of Newman	
by-catch	62-OB24-T2-R-BES0636	WAMTS235						
131249	80-OB25-T2-B-BES0852	WAMTS235	Mygalomorphae	Barychelidae	*Aurecocrypta*	'MYG315'	Orebody 25 ca. 5km N of Newman	
131250	100-HS-T2-B-BES0868	WAMTS235	Mygalomorphae	Nemisiidae	*Aname*	*mellosa*	"Homestead" ca. 6km N of Newman	
131251	101-HS-T2-B-BES0895	WAMTS235	Mygalomorphae	Nemisiidae	*Aname*	'sp.' *morphology only*	"Homestead" ca. 6km N of Newman	sequencing failed
131252	121-HS-T2-W-BES0843	WAMTS235	Mygalomorphae	Dipluridae	*Cethegus*	'MYG299'	"Homestead" ca. 6km N of Newman	
by-catch	123-HS-T2-W-BES0888	WAMTS235						
by-catch	131-HS-T2-B-BES0850	WAMTS235						
131087	05-OB24-T1-R-BES0047	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131088	09-OB24-T1-R-BES0145	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	

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WAM Reg. No.	Field No.	WAMTS	Infraorder	Family	Genus	Species	Locality	Notes on molecular work
131089	17-OB24-T1-R-BES0501	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131090	46-OB24-T1-R-BES0577	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131091	47-OB24-T1-R-BES0766	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131092	50-OB24-T1-R-BES0834	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131093	53-OB24-T1-R-BES0166	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131094	53-OB24-T1-R-BES0758	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131095	55-OB24-T1-R-BES0389	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131096	74-OB25-T1-R-BES0094	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'sp.' *morphology only*	Orebody 25 ca. 5km N of Newman	no amplification
131097	81-OB25-T1-R-BES0588	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
131098	85-OB24-T1-R-BES0213	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131099	85-OB24-T1-R-BES0477	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131100	89-OB24-T1-R-BES0408	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131101	92-OB24-T1-R-BES0538	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131102	93-OB24-T1-R-BES-0473	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131103	94-OB24-T1-R-BES0234	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131104	94-OB24-T1-R-BES0450	WAMTS217	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131223	05-OB24-T2-R-BES0117	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131224	16-OB24-T2-R-BES0267	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	

Appendix 3. Specimen details and species identifications

WAM Reg. No.	Field No.	WAMTS	Infraorder	Family	Genus	Species	Locality	Notes on molecular work
131225	30-OB25-T2-R-BES0419	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
by-catch	44-HS-T2-R-BES0160	WAMTS235						
131227	47-OB24-T2-R-BES0644	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131228	49-OB24-T2-R-BES0174	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131229	49-OB24-T2-R-BES0404	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131230	49-OB24-T2-R-BES0568	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131231	50-OB24-T2-R-BES0750	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
by-catch	51-OB24-T2-R-BES0576	WAMTS235						
131233	77-OB25-T2-R-BES0836	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
131234	81-OB25-T2-R-BES0859	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
131235	82-OB25-T2-R-BES0522	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
131236	83-OB25-T2-R-BES0478	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 25 ca. 5km N of Newman	
by-catch	93-OB24-T2-R-BES0282	WAMTS235						
131238	94-OB24-T2-R-BES0095	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	
131239	99-OB24-T2-R-BES0276	WAMTS235	Araneomorphae	Selenopidae	*Karaops*	'ARA005-DNA'	Orebody 24 ca. 7km N of Newman	

Appendix 4. COI DNA sequence data for queried Mygalomorphae and Araneomorphae specimens

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