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**Orebody 31 Terrestrial Vertebrate  
Fauna Environmental Impact  
Assessment**

**BHP Billiton Iron Ore Pty Ltd**

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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) under Section 38 of the *Environmental Protection Act 1986* (EP Act) to develop new mining areas at Orebody 31 (OB31). It is located approximately 40 kilometres (km) east of Newman Township in the Pilbara region of Western Australia and situated to the east of the existing OB17/18 Mine within Mineral Lease ML244SA. The ore resource at OB31 has been estimated at approximately 500 million tonnes (Mt). BHP Billiton Iron Ore is currently considering two development options for this resource. The first is a base option of 15 Mtpa as a long-term replacement for OB18 and the second is a growth option of 30 Mtpa. The area to be developed has been divided under 'Indicative Mine Disturbance Area' and the 'Indicative Infrastructure Corridor Area'. These are commonly referred to as the 'Project Area' in this report.

The scope of this report is to provide an assessment of potential impacts to terrestrial vertebrate fauna resulting from the proposed development. The report provides:

- A comprehensive literature and database review of all fauna surveys, fauna records and Conservation Significant Fauna recorded within the Project Area; and
- Details of potential impacts arising from the proposed project.

A total of 17 fauna surveys have been completed within and in the immediate vicinity of the Project Area since 1994. These include one desktop review (comprising a database search and review of previous relevant surveys), five Level 1 surveys (comprising a desktop review as well as a reconnaissance field survey), six single-season Level 2 surveys (comprising a desktop review with a more robust field sampling programme including trapping over one season) and five two-season Level 2 surveys (comprising a desktop review with a more robust field sampling programme including trapping over two seasons). Seven of these studies partially overlapped with the Project Area. The results of these surveys together with the latest information from database searches were used to compile lists of the vertebrate fauna occurring and potentially occurring in the Project Area.

A total of 194 vertebrate fauna species have been recorded during the surveys which overlap the Project Area, consisting of 25 native mammal species (plus seven introduced species), 81 bird species, 78 reptile species and three amphibian species. An additional 76 species comprising nine native and two introduced mammals, 44 birds, 17 reptiles and four amphibians are likely to occur in the area.





Six fauna species of conservation significance have been recorded within the Project Area:

#### Mammals

- Brush-tailed Mulgara *Dasyercus blythi* – Listed as Priority 4 by the WA Department of Parks and Wildlife (DPaW);
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

#### Birds

- Australian Bustard *Ardeotis australis* – DPaW Priority 4;
- Bush Stone-Curlew *Burhinus grallarius* - DPaW Priority 4;
- Rainbow Bee-eater *Merops ornatus* – Listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and on Schedule 3 of the *Wildlife Conservation Act 1950* (WC Act); and
- Fork-tailed Swift *Apus pacificus* – EPBC Act Migratory, WC Act Schedule 3.

According to online databases and previous surveys in the vicinity, an additional 11 conservation significant species have been recorded from adjoining areas or identified as likely to occur in the area. Of these, only the Oriental Plover (possible), Pilbara Olive Python (unlikely but possible) and Pilbara Flat-headed Blindsnake (likely) may potentially occur within the Project Area due to availability of suitable habitats.

Five major fauna habitats were identified within the Project Area: Minor Drainage Line, Sand Plain, Crest/ Slope, Drainage Area and Gorge/ Gully. Of these, the Sand Plain and Gorge/ Gully were considered to be of high importance because this habitat provides potential breeding, shelter and/or foraging habitat for a number of conservation significant fauna. The maximum disturbance area within the Project Area is estimated to be 4054.64 ha, of which 3300.32 ha comprises the 'Indicative Mine Disturbance Area' and 754.32 ha comprises the 'Indicative Infrastructure Corridor Area'. Relative to the total area of the IBRA subregions in the Pilbara, these disturbance areas amount to less than 0.2 % of each subregion and no more than 0.4 % of any of the land systems' total extent within Pilbara. All habitat types identified within the Project Area are well represented outside the Project Area and in the region in general.

Loss and fragmentation of fauna habitat, direct mortality during land clearing, fauna entrapment, collision with vehicles, barriers to movement, habitat degradation due to fire, dust, introduced species and altered hydrology, and behavioral impacts due to noise, vibrations and light were identified as potential impacts to fauna arising from the



proposed project. The cumulative impacts identified were loss of habitat, barriers to movement and changes to surface water flow.

With the implementation of suggested management measures (provided separately), residual potential impacts are expected to be minor for all the conservation significant fauna species recorded in the Project Area.





## 1 INTRODUCTION

### 1.1 Location

Orebody 31 (OB31) is located approximately 40 kilometres (km) east of Newman Township in the Pilbara region of Western Australia (Figure 1.1). OB31 is situated to the east of the existing Orebody 17/18 (OB17/18) Mine within Mineral Lease ML244SA, which is subject to the *Iron Ore (Mount Newman) Agreement Act 1964*. OB31 has not previously been developed and as such is considered a greenfield development.

### 1.2 Other operations

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) currently operates a number of iron ore mines and associated rail and port infrastructure within the Pilbara region of Western Australia.

Current mining operations in proximity to OB31 include:

- Newman Joint Venture hub, located approximately two km west of Newman Township, which consists of Mount Whaleback and Orebodies 29, 30 and 35;
- OB17/18 Mine, located approximately 30 km east of Newman Township;
- Wheelarra Hill (Jimblebar) Mine, located approximately 40 km east of Newman Township and five to 10 km south of OB31; and
- Orebodies 23, 24 and 25, located approximately eight km northeast of Newman Township.

The closest operations to OB31 are the OB17/18 Mine and Wheelarra Hill (Jimblebar) Mine.

### 1.3 Project Description

The OB17/18 Mine is reaching the end of its economic life, with available ore reserves expected to be depleted by mid 2017. Additional ore sources are required to provide sufficient blend feed in order to maintain the current level of iron ore production from the Eastern Pilbara mines.

The ore resource at OB31 has been estimated at approximately 500 million tonnes (Mt). BHP Billiton Iron Ore is currently considering two development options for this resource. The first is a base option of 15 Mtpa as a long-term replacement for OB18 and the second is a growth option of 30 Mtpa.

Open pits will be developed using conventional drill and blast techniques with ore sent through a proposed new primary crusher at OB31. For the base option (15



Mtpa), crushed ore will be transported via an overland conveyor to stockpiles at the OB17/18 Mine, then railed to the Mount Whaleback Mine, where it will be blended with the ore produced by the Newman Joint Venture. However, the OB31 ore body is estimated to be up to 80% below water table, thus significant dewatering of the ore body will be required to provide dry mining conditions.

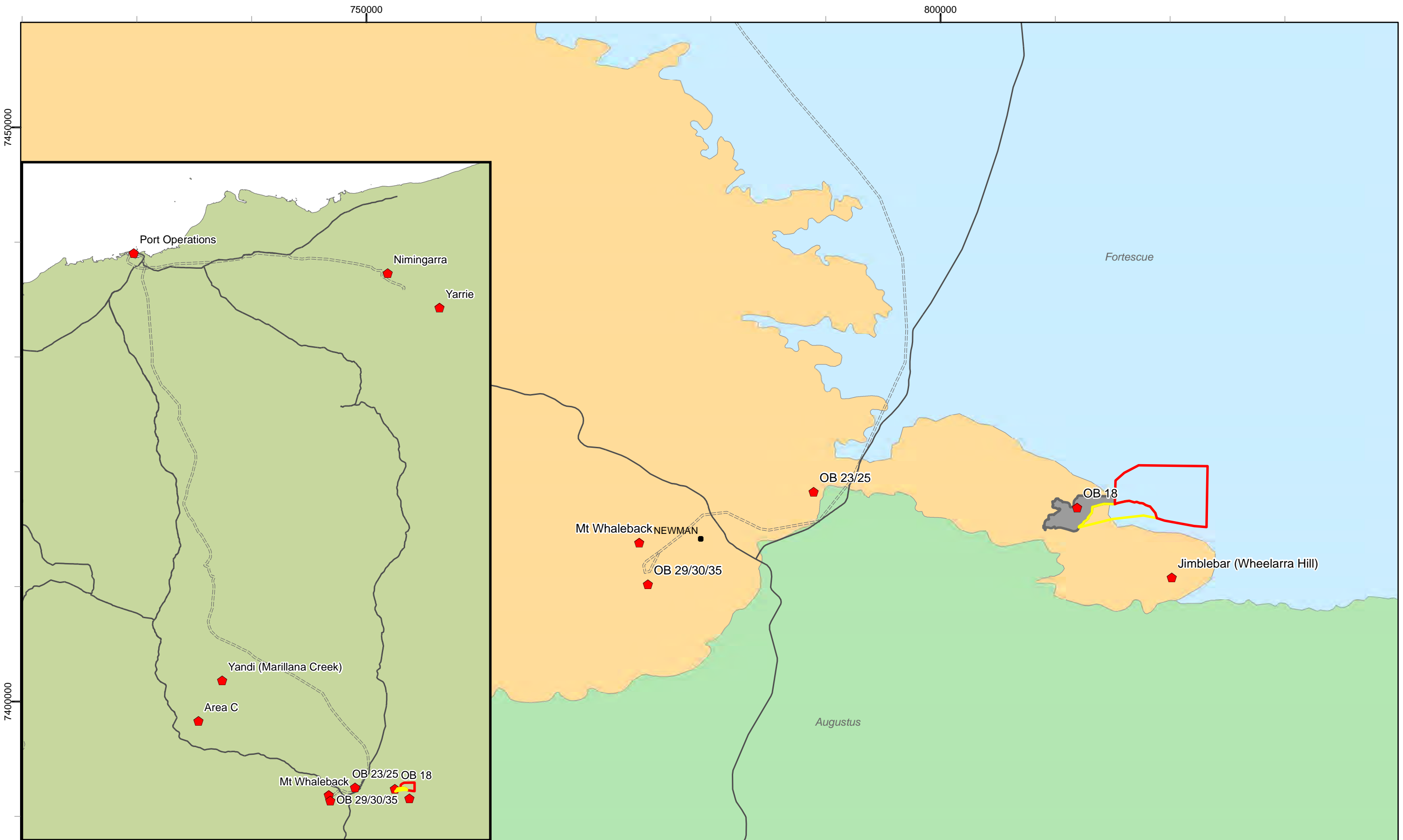
Under the growth option (30 Mtpa), 15 Mtpa will be sent via an overland conveyor to ore stockpiles at the OB17/18 mine with the remaining 15 Mtpa sent via conveyor to ore stockpiles at the Wheelarra Hill (Jimblebar) Mine. Ore from both the OB17/18 Mine and Wheelarra Hill (Jimblebar) Mine will be railed to the Mt Whaleback Mine and blended with ore produced by the Newman Joint Venture.

Non-mineralised waste rock will be hauled to new OSAs at OB31 or used to backfill the OB31 or OB18 pits.

The proposed OB31 project consists of the following:

- one single open pit;
- three new OSAs;
- a primary crushing facility;
- haulage (heavy vehicles (HV)) and light vehicles (LV) access roads linking OB31 to existing OB17/18 Mine infrastructure;
- an overland conveyor to existing infrastructure at the OB17/18 Mine and/or Wheelarra Hill (Jimblebar) Mine;
- power, water, fibre optic cable and other associated services which may be required along road and/or conveyor alignments;
- topsoil and vegetation stockpiles;
- offices, ablutions, LV and HV parking areas, laydown areas, hydrocarbon storage facilities, Ammonium Nitrate (ANFO) storage facilities and magazine areas and other ancillary facilities; and
- water infrastructure including dewatering/potable/monitoring water bores, diesel generator sets, pipelines, turkeys nests and/or other storage facilities as required.

The area to be developed has been divided under 'Indicative Mine Disturbance Area' and the 'Indicative Infrastructure Corridor Area' (Figure 1.2). These are commonly referred to as the 'Project Area' in this report.



## Legend

- |   |   |                         |
|---|---|-------------------------|
| ◆ BHP Billiton Iron Ore Mining Operations | □ Indicative mine disturbance area        | <b>IBRA sub-regions</b> |
| ● Pilbara Towns                           | ▬ Indicative infrastructure corridor area |                         |
| — Pilbara Hwy                             | ■ Existing OB18 Part IV area              |                         |
| === Pilbara Rail                          |   |                         |
|   |   | ■ Augustus              |
|   |   | ■ Fortescue             |
|   |   | ■ Hamersley             |



## BHP Billiton Iron Ore Orebody 31 Project

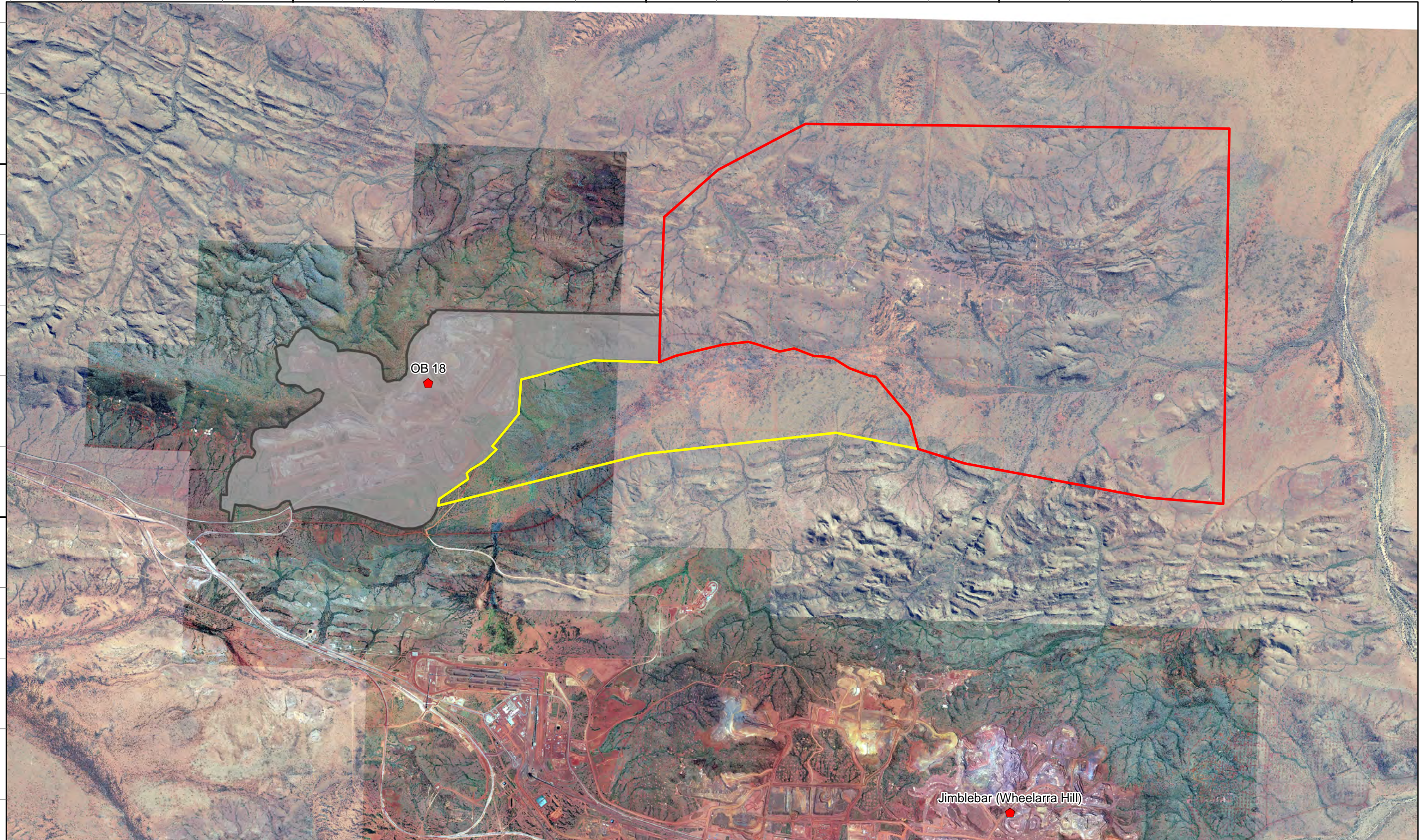
**Fig. 1.1: Regional location and IBRA regionalisation**

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



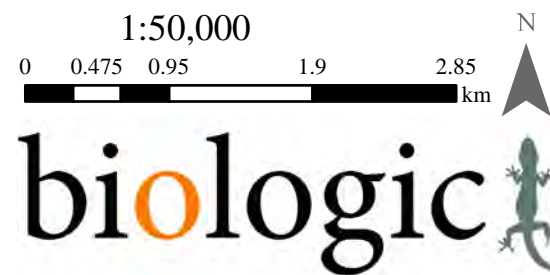
810000 815000 820000 825000

7420000  
7415000



**Legend**

- ◆ BHP Billiton Iron Ore Mining Operations
- Existing OB18 Part IV area
- Indicative OB31 Mine Disturbance Area
- Indicative Infrastructure Corridor Area



**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 1.2: OB31 Indicative Disturbance Areas**

Created 17/04/2014  
Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994





## 2 EXISTING ENVIRONMENT

### 2.1 Biogeography

Broadly, the Project Area lies on the southern 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 Project Area lies in the Hamersley and Fortescue Plains subregions (Figure 1.1). Hamersley subregion 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 Fortescue Plains subregion contains the Fortescue Marsh, which is listed as a nationally important wetland (Environment Australia 2001) and is a proposed Ramsar site (DEC 2009). Outside the marsh, this subregion is characterised by River Red Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines and deeply incised gorge systems (Kendrick 2001).

### 2.2 Climate

The Pilbara region has a semi-desert to tropical climate. Rainfall events within the region are often sporadic and can occur within both summer and winter months, but mostly during the former season. Summer rainfall is a result of either tropical storms in the north or tropical cyclones that impact upon the coast and move inland. The winter rainfall is generally lighter and is the result of cold fronts moving north easterly across the state (Leighton 2004). The average annual rainfall ranges from about 200 to 350 mm, but there are significant fluctuations between years (Department of Water 2012) with up to 1200 mm falling in certain locations in some years (Niewiarowski & Reisinger 2007).

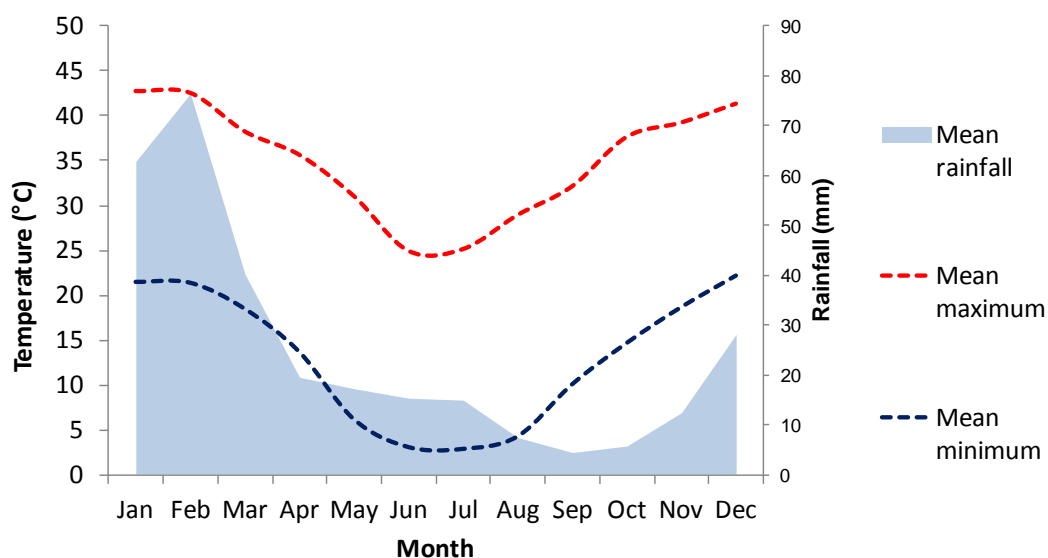
Temperatures vary significantly throughout the year with average maximum summer temperatures reaching 35°C to 40°C and winter temperatures generally fluctuating between 22°C and 30°C.

The climate of the OB31 area is semi-arid, hot and mostly dry, with an average annual rainfall of 317.8 mm at Newman Aero (Figure 2.1). Most rainfall generally occurs in the summer rain season from December to June with occasional major deluge events from cyclones during the summer. Massive rainfall is associated with the summer cyclone season. These large rainfall events can result in flash flooding



and extensive overland flooding. Watercourses are generally dry for most of the year and only flow after significant rainfall events. Creek flows subside rapidly after flooding, often within a few days to a week. River systems can flow for several weeks to a month, following a flood event before drying up. However, water is retained in waterholes along the watercourses and in rock pools in gorges for many months into the dry season.

Scattered thunderstorms provide the majority of non-cyclonic rain with an average of 15 to 20 thunderstorms occurring each year, again mostly during summer. Infrequent and unreliable winter rain also occurs. Daily temperatures are often greater than 40°C for extended periods during summer.



**Figure 2.1** Longer-term climatic averages at Newman (Bureau of Meteorology 2014)

### 2.3 Geology

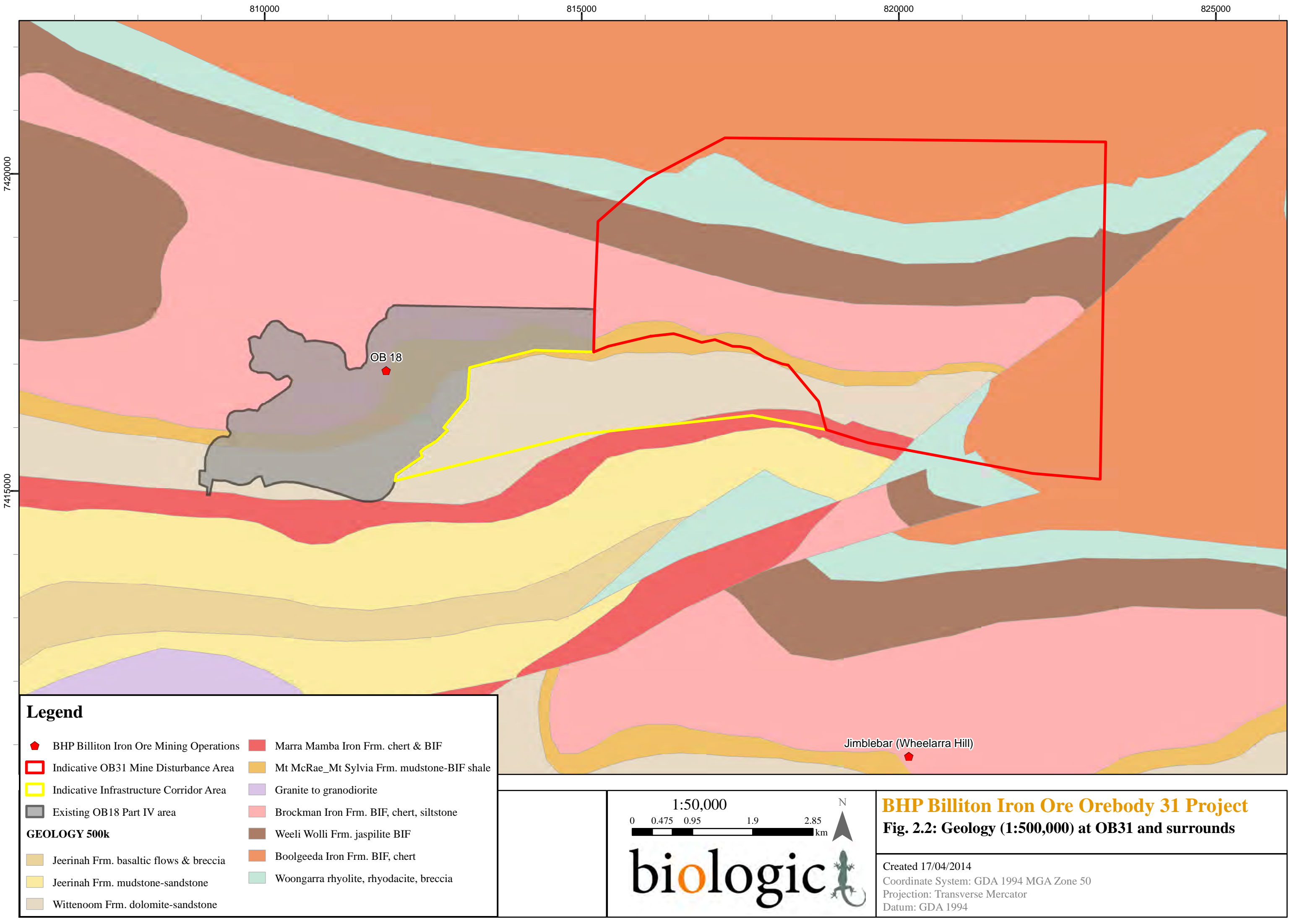
The Project Area is underlain by bedrock of Late Archaean to Early Proterozoic age, of the Hamersley and Fortescue Groups. In this area, the younger Hamersley Group consists mainly of Banded Iron Formation (BIF), acid to intermediate volcanics and minor shale, intruded by dolerite sills. The Fortescue Group consists mainly of mafic volcanics, mudstone, chert and shale, with minor dolerite sills (Thorne and Tyler 1997). The bedrock strata strike mainly east-west, although major faulting and folding has occurred, particularly within south eastern parts. Following Tyler *et al.* (1991) (refer Figure 2.2), the major geological formations of the Project Area include, from north to south:





1. Boolgeeda Iron Formation: fine-grained, finely laminated banded iron-formation, mudstone, siltstone and chert. Occurs extensively in the north and east of the Project Area;
2. Wongarra rhyolite: rhyolite/ rhyodacite as sills or flows; commonly porphyritic, phenocrysts of quartz, feldspar, minor tuff and jaspilitic BIF. Occurs in a thin band in the north east of the Project Area, and within the folded/ faulted geologies of the south east;
3. Weeli Wolli Formation: interlayered jaspilitic BIF, mudstone, siltstone and metadoleritic sills. Occurs in the north west, north east, and south east (due to folding/ faulting);
4. Brockman Iron Formation: banded iron-formation, chert, mudstone and siltstone with minor shale. An extensive band stretches from west to east throughout the Project Area, aligning with the major strike ridges;
5. Mount McRae Shale and Mount Sylvia Formation: interbedded shale, chert, BIF and dolomite. A thin band follows the southern slopes of the Brockman Iron Formation;
6. Wittenoom Formation: metamorphosed dolomite, dolomitic mudstone, chert, and felsic to mafic volcanic sandstone. Occurs on the central valley floor that stretches east to west; and
7. Marra Mamba Iron Formation: metamorphosed chert, BIF, mudstone, and siltstone. Occurs in two thin bands in the south-central part of the Project Area, aligning with a series of minor ridges and rocky slopes.

Areas to the north and east of the Project Area feature Manganese group/ Turee Creek group sandstones, siltstones, conglomerates, and chert, while a large granite/ granodiorite unit occurs to the immediate south (Figure 2.2). Several minor unallocated groups also occur in the local area, including gabbro sills/ dykes, metamorphosed BIF, and undivided ultramafic rocks (metamorphosed peridotite, dunite, pyroxene peridotite, and serpentinite/ talc schist).





## 2.4 Soils

On the strike ridges, areas of exposed bedrock are flanked by Cainozoic-Quaternary colluvial/ alluvial deposits (*i.e.* scree, gravel, sand, and silt). On the ridges and hilltops, soils are a thin mixture of silt and gravel, or virtually absent. The slopes and valley floors are generally characterised by gravelly sandy loam to loam-clay with the proportions of rocks and gravel declining as slope decreases (although remaining high in patches). The central palaeochannel running through the valley floor from south-central to central eastern parts is characterised by deep clay-loam to clay soils, with surface gravels only. Alluvial deposits along drainage lines include a mixture of gravel, sand, silt and clay, with pebbles in the major creek beds. In the north and east of the Project Area, extensive sand plains occur, with coarse to fine, silty red sands. The CSIRO Atlas of Australian Soils (Northcote *et al.* 1960-1968) identifies two major soil units within the Project Area (Figure 2.3):

1. Mz25 - Plains associated with the Fortescue valley. Surface cover of stony gravels close to the ranges and hills: chief soils are acid red earths with some neutral red earths; red-brown hardpan is absent. Soils with predominantly chemical limitations (naturally low in nutrients). Low A1 horizon organic content. Found only in the north east of the Project Area; and
2. Fa13 - Ranges of banded jaspilite (BIF) and chert along with shales. Soils with predominantly physical limitations (shallow-skeletal soils). Low A1 horizon organic content. Found throughout the majority of the Project Area.

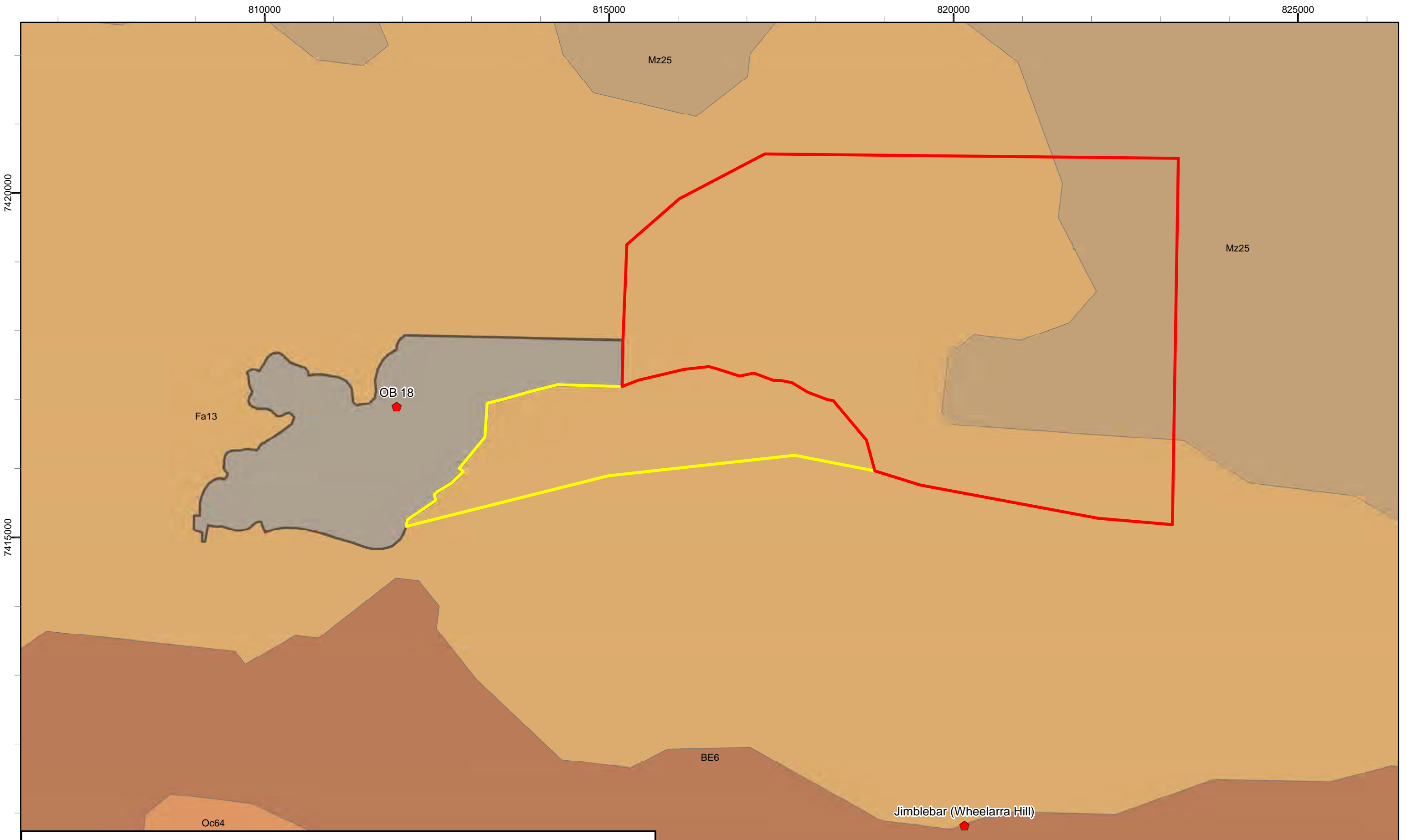
## 2.5 Topography and Landforms

The Project Area is located on the far eastern extent of the Hamersley Ranges which dominate the topography of the central and eastern Pilbara region. The major topographical features are a series of deeply dissected strike ridges running north-west to south-east throughout the Project Area and its immediate surrounds (Figure 2.4). The tallest single range in the area is the peak at Ninga (OB19) (793 m AHD) which occurs in the western part of the Project Area to the immediate west of the existing mining operations at OB18. This range occurs in the southern-most edge of a roughly rectangular area of high relief (approx. 500 m - 650m AHD) extending outside the Project Area to the north and west for approximately 6 - 8 km, until it meets the Fortescue River valley (Figure 2.4).

The south eastern part of the Project Area is also occupied by a series of undulating hills and low folded/ faulted ridgelines (approx. 510 - 570m AHD) that occur on the northern flanks of Wheelarra Hill (715 m AHD). This mountainous area extends



beyond the Project Area to the immediate south (Figure 2.4) around the existing mining operations at Wheelarra Hill (Jimblebar). The two major mountainous areas are separated from each other by a palaeodrainage channel and associated plains stretching from the south west of the Project Area to the far central east. This central palaeochannel is also bordered by a series of low hills and heavily weathered ridges to the south (within the Mesa Gap area), and a series of isolated low hills and outcrops to the north east (within the eastern part of the OB31 area) (Figure 2.4). Surrounding the Project Area to the north east and the far south west are extensive alluvial plains, where the Hamersley IBRA sub-region gives way to the Fortescue sub-region (to the north east) and the Augustus sub-region (to the south west) (Figure 1.1).



**Legend**

- |   |   |
|---|---|
| BHP Billiton Iron Ore Mining Operations | BE6 Extensive flat and gently sloping plains                              |
| Indicative OB31 Mine Disturbance Area   | Fa13 Ranges of banded jaspilite, chert, shales                            |
| Indicative Infrastructure Corridor Area | Mz25 Fortescue plains, acid-neutral red earths, surface gravels, calcrete |
| Existing OB18 Part IV area              | Oc64 Low stony hills, dissected pediments on granite                      |

CSIRO Atlas of Australian Soils

1:50,000

0 0.475 0.95 1.9 2.85 km

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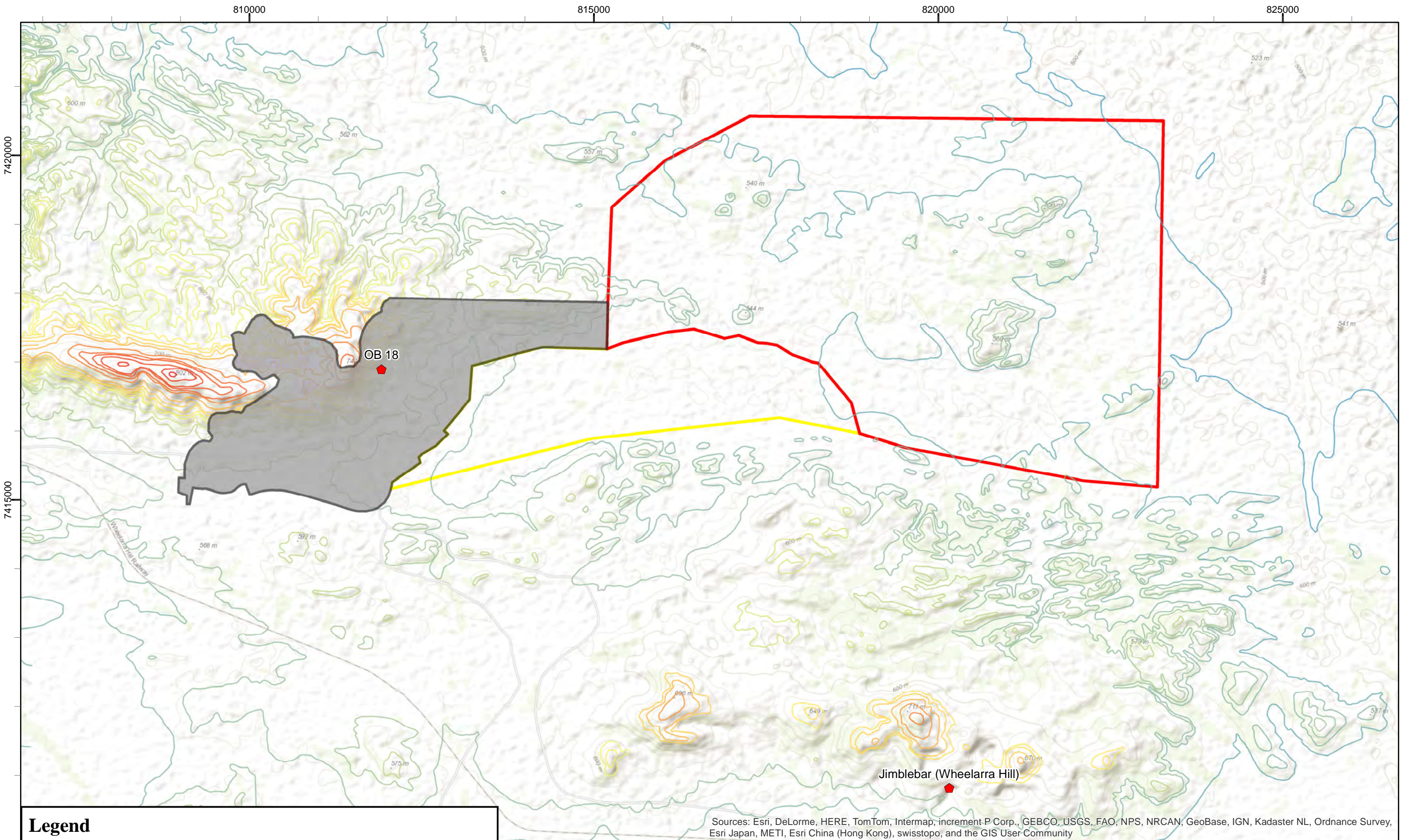


**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 2.3: Soils at OB31 and surrounds**

Created 17/04/2014  
Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994





**Legend**

- |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| BHP Billiton Iron Ore Mining Operations | 500 | 520 | 530 | 540 | 550 | 560 | 570 | 580 | 590 | 600 | 610 | 620 | 630 | 640 | 650 | 660 | 670 | 680 | 690 | 700 | 710 | 720 | 730 | 740 | 750 | 760 | 770 | 780 | 790 | 800 |
| Indicative OB31 Mine Disturbance Area   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Indicative Infrastructure Corridor Area |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Existing OB18 Part IV area              |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| <b>ELEVATION (mAHD)</b>                 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

1:50,000

0 0.475 0.95 1.9 2.85 km

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 2.4: Topography of OB31 and surrounds**

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994





## 2.6 Surface Hydrology

The Project Area is located in the upper portion of the Fortescue River catchment, which drains to the Fortescue Marsh (RPS Aquaterra 2012). The Project Area is located adjacent to an east flowing tributary of Jimblebar Creek (Figure 2.5). This creek is a temporary, inland, dryland water course that flows east through the 16 km long valley to join Jimblebar Creek downstream of Innawally Pool. The creek has a catchment area of 67 km<sup>2</sup>. The creek is dry outside of seasonal rainfall events.

The broad central valley running central/ west to east throughout the Project Area forms a palaeodrainage channel which is filled with clay soils and shows evidence of periodic flooding/ sheet flows.

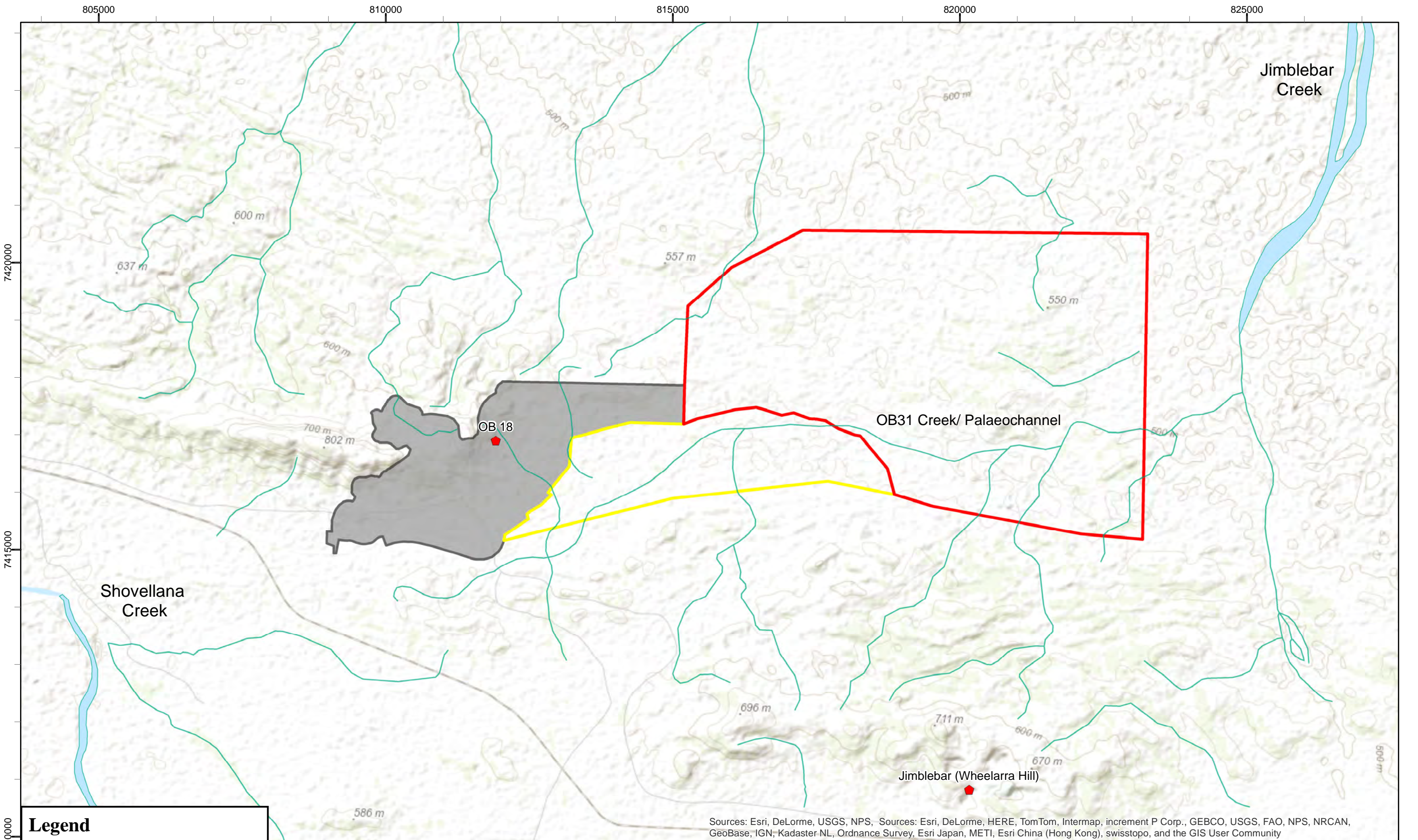
The average annual rainfall at Newman is approximately 310 mm, but rainfall occurs mainly as tropical summer storms, and annual totals vary widely. Drainage lines flow only after prolonged heavy rain, as short-duration flooding with rapid peaks and slightly less rapid decline. Along major watercourses, including the Fortescue River, water tends to pond and may persist as pools for several weeks to months.

## 2.7 Land Systems

Van Vreeswyk *et al.* (2004) classified and mapped the Land Systems of the Pilbara. Land types and land systems are classified according to similarities in landform, soil, vegetation, geology and geomorphology. The Project Area lies across four Land Systems as described in van Vreeswyk *et al.* (2004) (Table 2.1) and shown in Figure 2.6:

- Boolgeeda Land System (BGD): Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and Mulga shrublands.
- McKay Land System (MCK): Hills, ridges, plateaux remnants and breakaways of meta sedimentary rocks supporting hard Spinifex grasslands;
- Newman Land System (NEW): rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands; and
- Washplain (WSP): Hardpan plains supporting groved Mulga shrublands.





**Legend**

- ◆ BHP Billiton Iron Ore Mining Operations
- Minor watercourses
- Major watercourses
- ▭ Indicative OB31 Mine Disturbance Area
- ▭ Indicative Infrastructure Corridor Area
- ▭ Existing OB18 Part IV area

Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

1:60,000

00.5123

km

N

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 2.5: Drainage at OB31 and surrounds**

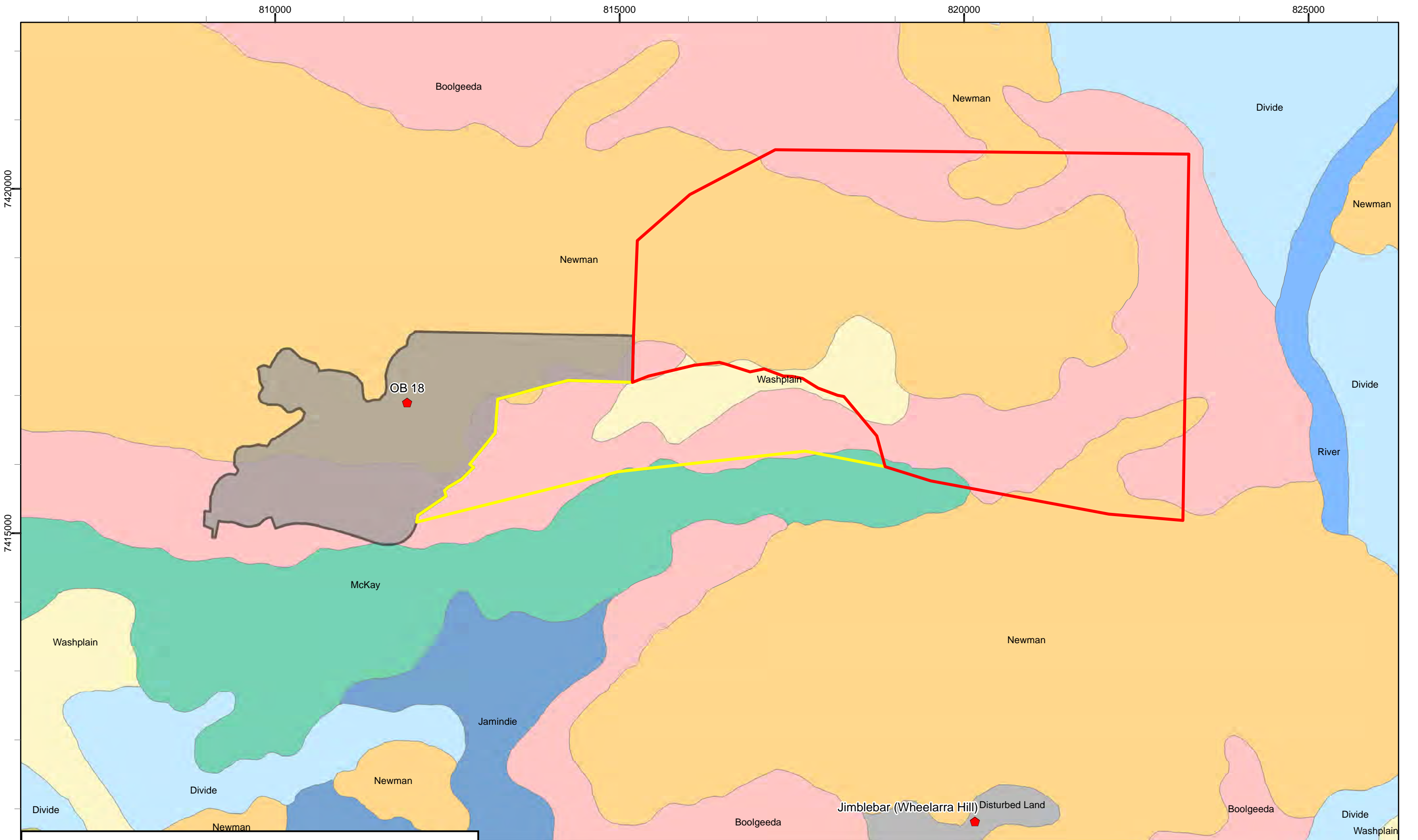
Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994





**Legend**

BHP Billiton Iron Ore Mining Operations

Indicative OB31 Mine Disturbance Area

Indicative Infrastructure Corridor Area

Existing OB18 Part IV area

Boolgeeda

Cadgie

Disturbed Land

Divide

Jamindie

McKay

Newman

River

Washplain

**Land System**

1:50,000

00.4750.951.92.85

km

N

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 2.6: Land Systems of OB31 and surrounds**

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994



**Table 2.1** Landforms, soils and vegetation types of the Land Systems present within the Project Area

Landform	Soil	Vegetation
<b>Boolgeeda Land System</b>		
Low hills and rises	Stony soils and red shallow loams	Hummock grasslands of <i>Triodia wiseana</i> and other <i>Triodia</i> spp. with very scattered <i>Acacia</i> shrubs.
Groves	Red loamy earths	Moderately close woodlands or tall shrublands of <i>A. aneura</i> 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 <i>A. aneura</i> , <i>A. atkinsiana</i> , <i>Corymbia hamersleyana</i> with sparse low shrubs and hummock and tussock grasses. Occasionally hummock grasslands of <i>T. pungens</i> .
Stony lower plains	Red loamy earths	Hummock grasslands <i>T. wiseana</i> , <i>T. lanigera</i> or <i>T. pungens</i> . Also scattered to moderately close tall shrublands of <i>A. aneura</i> and other <i>Acacias</i> with hard and soft spinifex ground layer.
Stony slopes and upper plains	Red shallow loams or red loamy earths	Hummock grasslands of <i>T. lanigera</i> , <i>T. wiseana</i> or scattered tall shrublands of <i>Acacia aneura</i> , <i>A. ancistrocarpa</i> , <i>A. atkinsiana</i> and other <i>Acacias</i> , occasional <i>Eucalyptus</i> trees and prominent hard spinifex ground layer.
<b>McKay Land System</b>		
Breakaways	Stony soils	Very scattered to scattered shrublands with <i>Acacia aneura</i> or other <i>Acacias</i> and <i>Triodia</i> spp. understory. Also <i>Triodia</i> spp. hummock grasslands.
Drainage floors	Red loamy earths with river bed soils in channels	Scattered tall shrublands/ woodlands with <i>Acacia</i> and <i>Eucalyptus</i> spp. and hummock grass <i>Triodia</i> spp. understory.
Hills, ridges and plateaux remnants	Stony soils	Hummock grasslands of <i>Triodia lanigera</i> , <i>T. wiseana</i> with isolated to scattered <i>Acacia</i> spp. shrubs or <i>Eucalyptus leucophloia</i> trees.
Lower footslopes	Red shallow loams	Hummock grasslands of <i>Triodia</i> spp. with isolated to scattered <i>Acacia</i> spp. shrubs or <i>Eucalyptus leucophloia</i> trees. Less frequently with <i>Triodia pungens</i> .
Stony plains	Red deep loamy duplex soils, minor red shallow loams, red shallow sandy duplex soils	Hummock grasslands of <i>Triodia wiseana</i> , <i>T. spp.</i> with isolated to very scattered <i>Acacia</i> spp. shrubs and occasional eucalypt trees. Occasionally hummock grasslands of <i>Triodia pungens</i> .



Landform	Soil	Vegetation
<b>Newman Land System</b>		
Lower slopes	Stony soils on upper margins with red loams on lower margins	Hummock grasslands <i>Triodia wiseana</i> , <i>T. brizoides</i> with very scattered to scattered shrubs and trees including <i>Acacia</i> and <i>Senna</i> spp., <i>Grevillea wickhamii</i> , <i>Eucalyptus leucophloia</i> 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 <i>Triodia pungens</i> with very scattered shrubs. Larger floors and channels support tall shrublands/ woodlands of <i>Acacia</i> spp. and <i>Eucalyptus victrix</i> 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 <i>Triodia wiseana</i> , <i>T. brizoides</i> , <i>T. plurinervata</i> with very scattered to scattered shrubs and trees including <i>Acacia</i> and <i>Senna</i> spp., <i>Grevillea wickhamii</i> , <i>Eucalyptus leucophloia</i> and other eucalypts.
Stony plains	Stony soils, red shallow loams with red loamy earths.	Hummock grasslands of <i>Triodia wiseana</i> , <i>T. spp.</i> with isolated to very scattered shrubs of <i>Acacia</i> and <i>Senna</i> spp. and occasional eucalypt trees. Occasionally hummock grasslands of <i>Triodia pungens</i> .
<b>Washplain Land System</b>		
Alluvial hardpan plains	Red deep sandy duplex and red deep loamy duplex soils.	Herbfields with isolated shrubs or very scattered to scattered shrublands of <i>Acacia aneura</i> , <i>Eremophila cuneifolia</i> other eremophilas, <i>Senna</i> spp. and small <i>Maireana</i> spp.
Groves	Red loamy earths, deep red/ brown non-cracking clays	Moderately close to closed <i>Acacia aneura</i> woodlands or tall shrublands with numerous undershrubs and scattered grasses such as <i>Chrysopogon fallax</i> and <i>Digitaria coenicola</i> .
Sand Plains	Red deep sands.	Hummock grasslands of <i>Triodia</i> spp. with very scattered or scattered shrubs.
Stony plains	Red loamy earths, deep red/brown non-cracking clays and minor self-mulching cracking clays.	Very scattered shrublands of <i>Acacia aneura</i> , <i>Senna</i> and <i>Eremophila</i> spp. and occasional tussock grasses.
Tracts receiving through flow	Red deep loamy duplex soils and red loamy earths	Moderately close to closed woodlands or tall shrublands of <i>Acacia aneura</i> with scattered low shrubs and occasional perennial grasses.



## 2.8 Vegetation

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). The Project Area is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia as per 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. The valley plains mainly carry Mulga low woodlands to shrubland (*Acacia aneura*) with some areas of open *Triodia* grassland. Shepherd *et al.* (2002) re-assessed the mapping of Beard (1975), updated the vegetation boundaries to account for clearing in the intensive land use zone, and divided some larger vegetation units into small units. Vegetation type 82, described by Shepherd *et al.* (2002) corresponds with 'ranges and valley plains' of Beard (1975) as described above.

Onshore (2014) mapped the vegetation of the north eastern part of the Project Area, broadly aligning with the indicative mine disturbance area (Figure 2.7). Onshore (2014) identified 35 vegetation associations within 15 broad floristic formations. Table 2.2 lists the details of these vegetation associations, providing a detailed legend for the vegetation types mapped in Figure 2.7.

Syrinx (2012) mapped the vegetation of the Wheelerra Hill North region, which includes the southern section of the indicative mine disturbance area (Figure 2.7). They identified 25 vegetation associations within nine broad floristic formations (some outside the Project Area). Table 2.3 lists the details of these vegetation associations, providing a detailed legend for the vegetation types mapped in Figure 2.7.





**Table 2.2.** Vegetation associations, landforms and soil types of the northern section of the Project Area (Onshore 2014)

Veg Code	Floristic Formation	Vegetation Association	Veg Condition
1a	Acacia Low Open Forest	Low Open Forest (to Low Woodland) of <i>Acacia aptaneura</i> , <i>Acacia paraneura</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Open Scrub (to High Shrubland) of <i>Acacia balsamea</i> , <i>Acacia wanyu</i> and <i>Acacia monticola</i> over Open Hummock Grassland of <i>Triodia pungens</i> forming mulga groves on floodplains and on minor drainage lines through undulating ironstone ridges, hills and valleys	Very Good
1b		Low Open Forest of <i>Acacia aptaneura</i> , <i>Acacia paraneura</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Open Scrub of <i>Acacia wanyu</i> , <i>Acacia tetragonophylla</i> and <i>Acacia bivenosa</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill on minor drainage lines through undulating ironstone ridges, hills and valleys	Very Good
2a	Acacia Low Woodland	Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Acacia ayersiana</i> over High Shrubland of <i>Acacia subcontorta</i> over Open Hummock Grassland of <i>Triodia basedowii</i> on stony loam plains	Excellent
2b		Low Woodland of <i>Acacia citrinoviridis</i> , <i>Eucalyptus victrix</i> and <i>Acacia pruinocarpa</i> over High Shrubland of <i>Acacia monticola</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Petalostylis labicheoides</i> over Open Tussock Grassland of <i>Themeda triandra</i> and <i>Eriachne tenuiculmis</i> on medium drainage line	Very Good
3	Acacia Closed Scrub	Closed Scrub (to Closed Low Forest) of <i>Acacia aptaneura</i> and <i>Corymbia aspera</i> over Tussock Grassland of <i>Panicum effusum</i> and <i>Eragrostis flaccida</i> and Open Shrubland of <i>Eremophila fraseri</i> on gilgai drainage zones and flats	Very Good
4a	Acacia Open Scrub	Open Scrub of <i>Acacia ancistrocarpa</i> , <i>Acacia bivenosa</i> and <i>Acacia tenuissima</i> over Hummock Grassland of <i>Triodia pungens</i> with Low Open Mallee of <i>Eucalyptus gamophylla</i> on drainage lines and drainage zones	Very Good
4b		Open Scrub of <i>Acacia monticola</i> and <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill with Scattered Low Trees of <i>Corymbia deserticola</i> subsp. <i>deserticola</i> , <i>Corymbia hamersleyana</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> on minor drainage line dissecting low hills and footslopes	Very Good
5a	Acacia High Shrubland	High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia adsurgens</i> and <i>Acacia elachantha</i> over Open Hummock Grassland of <i>Triodia schinzii</i> and Open Tussock Grassland of <i>Aristida inaequiglumis</i> , <i>Eulalia aurea</i> and <i>Digitaria brownii</i> on footslopes	Good
5b		High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia adsurgens</i> and <i>Acacia elachantha</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida holathera</i> var. <i>holathera</i> and <i>Paraneurachne muelleri</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Corymbia aspera</i> and <i>Hakea lorea</i> subsp. <i>lorea</i> on sandy drainage zones and floodplains	Very Good



Veg Code	Floristic Formation	Vegetation Association	Veg Condition
5c		High Shrubland of <i>Acacia balsamea</i> , <i>Acacia wanyu</i> and <i>Acacia tetragonophylla</i> over Open Shrubland of <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> , <i>Eremophila platycalyx</i> and <i>Senna stricta</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill on undulating plateaux and hill slopes	Very Good
6	<i>Acacia</i> High Open Shrubland	High Open Shrubland of <i>Acacia aptaneura</i> and <i>Acacia paraneura</i> over Scattered Tussock Grasses of <i>Aristida contorta</i> and <i>Aristida inaequiglumis</i> and Scattered Hummock Grasses of <i>Triodia basedowii</i> and <i>Triodia pungens</i> on clay loam flats and stony plains	Very Good
7	<i>Acacia</i> Shrubland	Shrubland of <i>Acacia wanyu</i> , <i>Acacia tetragonophylla</i> and <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> over Low Shrubland of <i>Senna stricta</i> , <i>Eremophila cuneifolia</i> and <i>Scaevola spinescens</i> over Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill on undulating hills, ironstone ridges and valleys	Very Good
8	<i>Eremophila</i> Low Shrubland	Low Shrubland of <i>Eremophila demissa</i> , <i>Eremophila cuneifolia</i> and <i>Lepidium platypetalum</i> with Low Open Woodland of <i>Acacia aptaneura</i> and <i>Acacia paraneura</i> and High Open Shrubland of <i>Acacia wanyu</i> and <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> on low hill crests and slopes	Very Good
9	<i>Sclerolaena</i> Low Shrubland	Low Shrubland of <i>Sclerolaena cuneata</i> , <i>Frankenia setosa</i> and <i>Eremophila cuneifolia</i> with Open Shrubland of <i>Acacia synchronicia</i> and Scattered Low Trees of <i>Acacia aptaneura</i> and <i>Acacia paraneura</i> on gently sloping plains	Very Good
10a	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia angusta</i> and <i>Triodia pungens</i> with Shrubland of <i>Acacia bivenosa</i> and Low Open Mallee of <i>Eucalyptus socialis</i> subsp. <i>eucentrica</i> and <i>Eucalyptus gamophylla</i> on low calcrete hills and rises	Very Good
10b		Hummock Grassland of <i>Triodia angusta</i> with Open Shrubland of <i>Acacia synchronicia</i> , <i>Acacia tetragonophylla</i> and <i>Acacia wanyu</i> over Low Open Shrubland of <i>Eremophila cuneifolia</i> , <i>Lepidium platypetalum</i> and <i>Maireana pyramidata</i> on undulating hills, ironstone ridges and eroded slopes	Very Good
10c		Hummock Grassland of <i>Triodia basedowii</i> and <i>Triodia pungens</i> with High Shrubland (to Open Scrub) of <i>Acacia ancistrocarpa</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Acacia bivenosa</i> and Low Open Woodland of <i>Corymbia hamersleyana</i> on sandy floodplains and levee banks	Very Good
10d		Hummock Grassland of <i>Triodia basedowii</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and High Open Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia pachyacra</i> and <i>Acacia bivenosa</i> on stony Sand Plains	Very Good
10e		Hummock Grassland of <i>Triodia basedowii</i> with Low Woodland of <i>Acacia aptaneura</i> over Open Shrubland of <i>Eremophila forrestii</i> subsp. <i>forrestii</i> and <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> on sandy loam plains	Good
10f		Hummock Grassland of <i>Triodia basedowii</i> , <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill with Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> and <i>Acacia paraneura</i> over Shrubland of <i>Eremophila fraseri</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> on sandy drainage zones	Good



Veg Code	Floristic Formation	Vegetation Association	Veg Condition
10g		Hummock Grassland of <i>Triodia pungens</i> with High Shrubland of <i>Acacia ancistrocarpa</i> and <i>Acacia tenuissima</i> with Low Open Woodland of <i>Eucalyptus xerothermica</i> , <i>Corymbia aspera</i> and <i>Corymbia hamersleyana</i> on clay loam drainage zones	Very Good
10h		Hummock Grassland of <i>Triodia pungens</i> with Shrubland (to Open Scrub) of <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> , <i>Gossypium robinsonii</i> and <i>Acacia maitlandii</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> on sandy floodplain and levee banks	Very Good
10i		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill and <i>Triodia pungens</i> with High Shrubland of <i>Acacia rhodophloia</i> and Low Shrubland of <i>Eremophila exilifolia</i> on ironstone hill slopes	Very Good
10j		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill with High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> and <i>Acacia bivenosa</i> over Low Open Shrubland of <i>Acacia hilliana</i> on footslopes	Very Good
10k		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill with High Shrubland of <i>Acacia wanyu</i> , <i>Acacia bivenosa</i> and <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> over Open Shrubland of <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> on footslopes and lower hill slopes	Excellent
10l		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill with Low Shrubland of <i>Acacia hilliana</i> , <i>Acacia adoxa</i> var. <i>adoxa</i> and <i>Halganina solanacea</i> var. Mt Doreen (G.M. Chippendale 4206) with High Open Shrubland of <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> , <i>Acacia marramamba</i> and <i>Grevillea berryana</i> on hill crests and slopes	Good
11a	Triodia Open Hummock Grassland	Open Hummock Grassland of <i>Triodia basedowii</i> and <i>Triodia pungens</i> over Open Tussock Grassland of <i>Aristida inaequiglumis</i> , <i>Themeda triandra</i> and <i>Digitaria brownii</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> on loamy drainage zones adjacent to floodplains	Good
11b		Open Hummock Grassland of <i>Triodia basedowii</i> and <i>Triodia</i> sp. Shovelanna Hill with Low Open Woodland of <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> and <i>Corymbia hamersleyana</i> and High Open Shrubland of <i>Eremophila platycalyx</i> , <i>Acacia wanyu</i> and <i>Acacia synchronicia</i> on stony rises, plains and footslopes	Very Good
11c		Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia</i> sp. Shovelanna Hill with Low Open Woodland of <i>Corymbia ferriticola</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and Open Shrubland of <i>Astrotricha hamptonii</i> , <i>Dodonaea pachyneura</i> and <i>Acacia maitlandii</i> on faces of large open ravines and occasionally cliffs	Excellent
12	Themeda Closed Tussock Grassland	Closed Tussock Grassland of <i>Themeda triandra</i> and <i>Eulalia aurea</i> with Low Open Woodland of <i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Acacia aptaneura</i> and <i>Corymbia aspera</i> and Open Shrubland of <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Acacia ancistrocarpa</i> on plains and drainage zones	Very Good
13a	Themeda Tussock Grassland	Tussock Grassland of <i>Themeda triandra</i> , <i>Digitaria brownii</i> and <i>Aristida inaequiglumis</i> with Low Woodland of <i>Acacia aptaneura</i> and <i>Corymbia hamersleyana</i> and Very Open Hummock Grassland of <i>Triodia basedowii</i> on clay drainage zones and floodplains	Good



Veg Code	Floristic Formation	Vegetation Association	Veg Condition
13b		Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Digitaria brownii</i> with Low Open Woodland (to Low Woodland) of <i>Acacia aptaneura</i> and <i>Acacia paraneura</i> and Open Shrubland of <i>Eremophila fraseri</i> on floodplains	Very Good
13c		Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Digitaria brownii</i> with Low Woodland (to Low Open Woodland) of <i>Acacia aptaneura</i> , <i>Eucalyptus xerothermica</i> and <i>Corymbia hamersleyana</i> and Low Open Shrubland of <i>Isotropis forrestii</i> and <i>Ptilotus obovatus</i> on drainage zones and flats	Very Good
14	Eragrostis Tussock Grassland	Tussock Grassland of <i>Eragrostis eriopoda</i> , <i>Paraneurachne muelleri</i> and <i>Aristida contorta</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Corymbia aspera</i> and Open Shrubland of <i>Acacia melleodora</i> and <i>Senna artemisioides</i> subsp. <i>oligophylla</i> on gently sloping sandy loam plains	Very Good
15	*Cenchrus Tussock Grassland	Tussock Grassland of * <i>Cenchrus ciliaris</i> with Low Open Woodland of <i>Acacia citrinoviridis</i> , <i>Acacia aptaneura</i> and <i>Corymbia hamersleyana</i> and High Shrubland of <i>Gossypium robinsonii</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Petalostylis labicheoides</i> on sandy floodplain	Good



**Table 2.3** Vegetation associations, landforms and soil types of the southern section of the Project Area (Syrinx 2012)

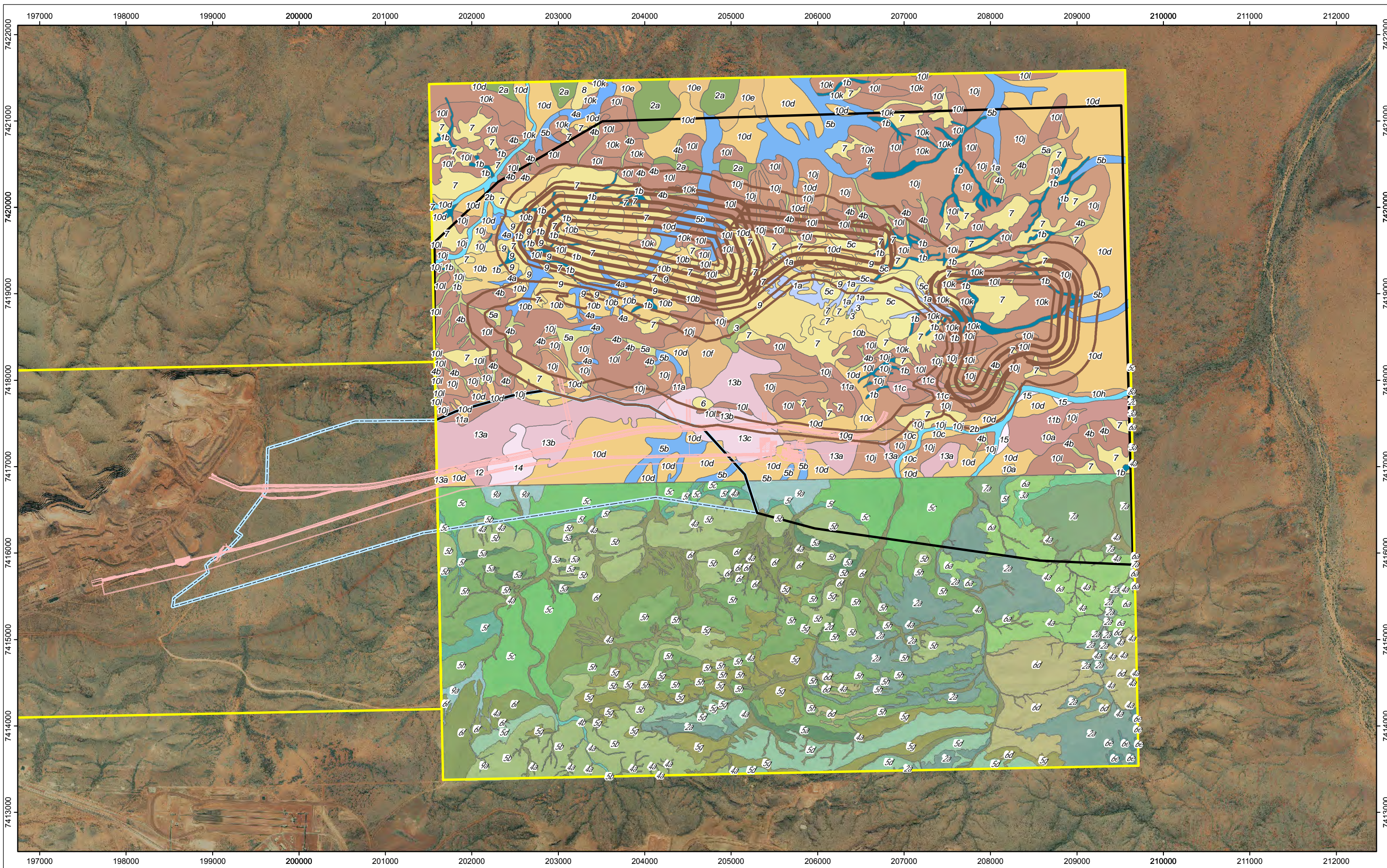
Veg Code	Floristic formation	Vegetation Association
2a	Acacia Low Woodland	Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia ? pteraneura</i> and <i>Acacia pruinocarpa</i> over Open Hummock Grassland of <i>Triodia epactia</i> and <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) with Shrubland of <i>Acacia wanyu</i> , <i>Acacia tetragonophylla</i> and <i>Senna stricta</i>
2c		Low Woodland of <i>Acacia aptaneura</i> and <i>Corymbia hamersleyana</i> over Very Open Shrubland of <i>Acacia wanyu</i> , <i>Acacia ancistrocarpa</i> and <i>Eremophila forrestii</i> subsp.(indet) over Very Open Hummock Grassland of <i>Triodia epactia</i> and <i>Triodia lanigera</i>
2d		Low Woodland of <i>Acacia ? aptaneura</i> , <i>Acacia mulganeura</i> and <i>Ficus brachypoda</i> over High Open Shrubland of <i>Acacia monticola</i> , <i>Grevillea wickhamii</i> subsp. (indet) and <i>Acacia wanyu</i> over Very Open Tussock Grassland of <i>Eragrostis cumingii</i> , <i>Amphipogon sericeus</i> and <i>Themeda triandra</i>
3a	Acacia Low Open Woodland	Low Open Woodland of <i>Acacia aptaneura</i> and <i>Acacia pruinocarpa</i> over High Open Shrubland of <i>Acacia tetragonophylla</i> and <i>Acacia synchronicia</i> over Very Open Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835)
4a	Acacia High Shrubland	High Shrubland of <i>Acacia monticola</i> , <i>Rulingia luteiflora</i> and <i>Gossypium robinsonii</i> with Low Woodland of <i>Corymbia hamersleyana</i> , <i>Eucalyptus victrix</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> , <i>*Cenchrus ciliaris</i> and <i>Cymbopogon procerus</i>
4b		High Shrubland of <i>Acacia monticola</i> , <i>Acacia hamersleyensis</i> and <i>Petalostylis labicheoides</i> over Open Hummock Grassland of <i>Triodia melvillei</i> , <i>Triodia epactia</i> and <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) with Low Open Woodland of <i>Corymbia ferritcola</i> and <i>Ficus brachypoda</i>
5a	Triodia Hummock Grassland	Hummock Grassland of <i>Triodia brizoides</i> , <i>Triodia epactia</i> and <i>Triodia angusta</i> with Open Shrubland of <i>Acacia tetragonophylla</i> and <i>Acacia synchronicia</i> with Very Open Woodland of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Acacia ? pteraneura</i>
5b		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S. van Leeuwen 3835) with Low Open Shrubland of <i>Acacia hilliana</i> , <i>Acacia adoxa</i> var. <i>adoxo</i> and <i>Halgania solanacea</i> var. Mt Doreen (G.M. Chippendale 4206) with Scattered Low Trees of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Acacia pruinocarpa</i>
5c		Hummock Grassland of <i>Triodia lanigera</i> and <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) with Open Shrubland of <i>Hakea lorea</i> subsp. <i>lorea</i> , <i>Acacia ancistrocarpa</i> and <i>Acacia adsurgens</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i> and <i>Acacia pruinocarpa</i>
5d		Hummock Grassland of <i>Triodia brizoides</i> , <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) and <i>Triodia epactia</i> with Open Shrubland of <i>Acacia tetragonophylla</i> , <i>Eremophila fraseri</i> subsp. <i>fraseri</i> and <i>Senna glutinosa</i> subsp. <i>pruinosa</i>





Veg Code	Floristic formation	Vegetation Association
5f		Hummock Grassland of <i>Triodia lanigera</i> and <i>Triodia epactia</i> with High Open Shrubland of <i>Acacia bivenosa</i> , <i>Acacia ancistrocarpa</i> and <i>Acacia tenuissima</i> with Very Open Mallee of <i>Eucalyptus gamophylla</i>
5g		Hummock Grassland of <i>Triodia epactia</i> , <i>Triodia brizoides</i> and <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835), with Low Open Woodland of <i>Acacia aptaneura</i> , <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Acacia pruinocarpa</i> over Scattered Shrubs of <i>Acacia tetragonophylla</i> , <i>Scaevola acacioides</i> and <i>Acacia wanyu</i>
5h		Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835), <i>Triodia epactia</i> and <i>Triodia brizoides</i> with High Open Shrubland of <i>Acacia bivenosa</i> and <i>Acacia tetragonophylla</i> with Scattered Low Trees of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> and <i>Acacia aptaneura</i>
6a	Triodia Open Hummock Grassland	Open Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) with Low Open Shrubland of <i>Halgania solanacea</i> var. Mt Doreen (G.M. Chippendale 4206), <i>Gompholobium</i> sp. Pilbara (N.F. Norris 908) and <i>Acacia adoxa</i> var. <i>adoxo</i>
6b		Open Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835), <i>Triodia epactia</i> and <i>Triodia brizoides</i> with Low Open Woodland of <i>Acacia aptaneura</i> , <i>Acacia</i> ? <i>pteraneura</i> (hybrid?) and <i>Acacia rhodophloia</i> over Open Shrubland of <i>Acacia tetragonophylla</i> , <i>Acacia adsurgens</i> and <i>Senna glutinosa</i> subsp. <i>glutinosa</i>
6c		Open Hummock Grassland of <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) and <i>Triodia epactia</i> with Low Open Shrubland of <i>Acacia hilliana</i> , <i>Sida</i> sp. <i>excedentifolia</i> (J.L. Egan 1925) and <i>Senna glutinosa</i> subsp. <i>pruinosa</i> with Scattered Trees of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>
6d		Open Hummock Grassland of <i>Triodia brizoides</i> and <i>Triodia epactia</i> with Low Open Shrubland of <i>Eremophila fraseri</i> subsp. <i>fraseri</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> and <i>Senna artemisioides</i> subsp. <i>helmsii</i>
7a	Triodia Very Open Hummock Grassland	Very Open Hummock Grassland of <i>Triodia lanigera</i> and <i>Triodia</i> sp. Shovelanna Hill (S.van Leeuwen 3835) with Scattered Shrubs of <i>Grevillea wickhamii</i> subsp. (indet), <i>Acacia ancistrocarpa</i> and <i>Hakea lorea</i> subsp. <i>lorea</i> with Scattered Trees of <i>Corymbia hamersleyana</i>
8a	Mixed Tussock Grassland	Tussock Grassland of <i>Eulalia aurea</i> , <i>Themeda triandra</i> and <i>Aristida inaequiglumis</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Acacia aptaneura</i> and <i>Acacia citrinoviridis</i> over Open Shrubland of <i>Acacia ancistrocarpa</i> , <i>Gossypium robinsonii</i> and <i>Acacia pyrifolia</i>
9a	Mixed Open Tussock Grassland	Open Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida inaequiglumis</i> and <i>Aristida contorta</i> with Open Shrubland of <i>Acacia monticola</i> , <i>Acacia ancistrocarpa</i> and <i>Grevillea wickhamii</i> subsp. <i>aprica</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i>







Legend

Onshore Environmental Vegetation Mapping

Acacia Low Open Forest

- 1a

Low Open Forest (to Low Woodland) of *Acacia aptaneura*, *Acacia paraneura* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Scrub (to High Shrubland) of *Acacia balsamea*, *Acacia wanyu* and *Acacia monticola* over Open Hummock Grassland of *Triodia pungens* forming mulga groves on floodplains and on on minor drainage lines through undulating ironstone ridges, hills and valleys
- 1b

Low Open Forest of *Acacia aptaneura*, *Acacia paraneura* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Scrub of *Acacia wanyu*, *Acacia tetragonophylla* and *Acacia bivenosa* over Open Hummock Grassland of *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* on minor drainage lines through undulating ironstone ridges, hills and valleys

Acacia Low Woodland

- 2a

Low Woodland of *Acacia aptaneura*, *Acacia catenulata* subsp. *occidentalis* and *Acacia ayersiana* over High Shrubland of *Acacia ?cuthbertsonii* over Open Hummock Grassland of *Triodia basedowii* on stony loam plains
- 2b

Low Woodland of *Acacia citrinoviridis*, *Eucalyptus victrix* and *Acacia pruinocarpa* over High Shrubland of *Acacia monticola*, *Acacia pyrifolia* var. *pyrifolia* and *Petalostylis labicheoides* over Open Tussock Grassland of *Themeda triandra* and *Eriachne tenuiculmis* on medium drainage line

Acacia Closed Scrub

- 3

Closed Scrub (to Closed Low Forest) of *Acacia pteraneura* and *Corymbia aspera* over Tussock Grassland of *Panicum effusum* and *Eragrostis flaccida* and Open Shrubland of *Eremophila fraseri* on gilgai drainage zones and flats

Acacia Open Scrub

- 4a

Open Scrub of *Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia tenuissima* over Hummock Grassland of *Triodia pungens* with Low Open Mallee of *Eucalyptus gamophylla* on drainage lines and drainage zones
- 4b

Open Scrub of *Acacia monticola* and *Grevillea wickhamii* subsp. *hispidula* over Open Hummock Grassland of *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* with Scattered Low Trees of *Corymbia deserticola* subsp. *deserticola*, *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* on minor drainage line dissecting low hills and footslopes

Acacia High Shrubland

- 5a

High Shrubland of *Acacia ancistrocarpa*, *Acacia adsurgens* and *Acacia elachantha* over Open Hummock Grassland of *Triodia schinzii* and Open Tussock Grassland of *Aristida inaequiglumis*, *Eulalia aurea* and *Digitaria brownii* on footslopes
- 5b

High Shrubland of *Acacia ancistrocarpa*, *Acacia adsurgens* and *Acacia elachantha* over Open Tussock Grassland of *Themeda triandra*, *Aristida holathera* var. *holathera* and *Paraneurachne muelleri* with Low Open Woodland of *Corymbia hamersleyana*, *Corymbia aspera* and *Hakea lorea* subsp. *lorea* on sandy drainage zones and floodplains
- 5c

High Shrubland of *Acacia balsamea*, *Acacia wanyu* and *Acacia tetragonophylla* over Open Shrubland of *Senna glutinosa* subsp. x *luerssenii*, *Eremophila platycalyx* and *Senna stricta* over Open Hummock Grassland of *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* on undulating plateaux and hill slopes

Acacia High Open Shrubland

- 6

High Open Shrubland of *Acacia aptaneura* and *Acacia paraneura* over Scattered Tussock Grasses of *Aristida contorta* and *Aristida inaequiglumis* and Scattered Hummock Grasses of *Triodia basedowii* and *Triodia pungens* on clay loam flats and stony plains

Acacia Shrubland

- 7

Shrubland of *Acacia wanyu*, *Acacia tetragonophylla* and *Senna glutinosa* subsp. x *luerssenii* over Low Shrubland of *Senna stricta* , *Eremophila cuneifolia* and *Scaevola spinescens* over Open Hummock Grassland of *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* on undulating hills, ironstone ridges and valleys

Eremophila Low Shrubland

- 8

Low Shrubland of *Eremophila compacta*, *Eremophila cuneifolia* and *Lepidium platypetalum* with Low Open Woodland of *Acacia aptaneura* and *Acacia paraneura* and High Open Shrubland of *Acacia wanyu* and *Senna glutinosa* subsp. x *luerssenii* on low hill crests and slopes

Sclerolaena Low Shrubland

- 9

Low Shrubland of *Sclerolaena cuneata*, *Frankenia setosa* and *Eremophila cuneifolia* with Open Shrubland of *Acacia synchronicia* and Scattered Low Trees of *Acacia aptaneura* and *Acacia paraneura* on gently sloping plains

Triodia Hummock Grassland

- 10a

Hummock Grassland of *Triodia angusta* and *Triodia pungens* with Shrubland of *Acacia bivenosa* and Low Open Mallee of *Eucalyptus socialis* subsp. *eucentrica* and *Eucalyptus gamophylla* on low calcrete hills and rises

- 10b

Hummock Grassland of *Triodia angusta* with Open Shrubland of *Acacia synchronicia*, *Acacia tetragonophylla* and *Acacia wanyu* over Low Open Shrubland of *Eremophila cuneifolia*, *Lepidium platypetalum* and *Maireana pyramidalis* on undulating hills, ironstone ridges and eroded slopes
- 10c

Hummock Grassland of *Triodia basedowii* and *Triodia pungens* with High Shrubland (to Open Scrub) of *Acacia ancistrocarpa*, *Acacia pyrifolia* var. *pyrifolia* and *Acacia bivenosa* and Low Open Woodland of *Corymbia hamersleyana* on sandy floodplains and levee banks
- 10d

Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and High Open Shrubland of *Acacia ancistrocarpa*, *Acacia pachyacra* and *Acacia bivenosa* on stony sandplains
- 10e

Hummock Grassland of *Triodia basedowii* with Low Woodland of *Acacia pteraneura* over Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Senna glutinosa* ssp. x *luerssenii* on sandy loam plains
- 10f

Hummock Grassland of *Triodia basedowii*, *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* with Low Woodland of *Acacia aptaneura*, *Acacia pruinocarpa* and *Acacia paraneura* over Shrubland of *Eremophila fraseri* and *Eremophila forrestii* subsp. *forrestii* on sandy drainage zones
- 10g

Hummock Grassland of *Triodia pungens* with High Shrubland of *Acacia ancistrocarpa* and *Acacia tenuissima* with Low Open Woodland of *Eucalyptus xerothermica*, *Corymbia aspera* and *Corymbia hamersleyana* on clay loam drainage zones
- 10h

Hummock Grassland of *Triodia pungens* with Shrubland (to Open Scrub) of *Acacia pyrifolia* var. *pyrifolia*, *Gossypium robinsonii* and *Acacia maitlandii* with Low Open Woodland of *Corymbia hamersleyana* on sandy floodplain and levee banks
- 10i

Hummock Grassland of *Triodia* sp. *Shovelanna Hill* and *Triodia pungens* with High Shrubland of *Acacia rhodophloia* and Low Shrubland of *Eremophila exilifolia* on ironstone hill slopes
- 10j

Hummock Grassland of *Triodia* sp. *Shovelanna Hill* with High Shrubland of *Acacia ancistrocarpa*, *Grevillea wickhamii* subsp. *hispidula* and *Acacia bivenosa* over Low Open Shrubland of *Acacia hilliana* on footslopes
- 10k

Hummock Grassland of *Triodia* sp. *Shovelanna Hill* with High Shrubland of *Acacia wanyu*, *Acacia bivenosa* and *Grevillea wickhamii* subsp. *hispidula* over Open Shrubland of *Senna glutinosa* subsp. x *luerssenii* on footslopes and lower hill slopes
- 10l

Hummock Grassland of *Triodia* sp. *Shovelanna Hill* with Low Shrubland of *Acacia hilliana*, *Acacia adoxa* var. *adoxa* and *Halgania solanacea* with High Open Shrubland of *Grevillea wickhamii* subsp. *hispidula*, *Acacia marramamba* and *Grevillea berryana* on hill crests and slopes

Triodia Open Hummock Grassland

- 11a

Open Hummock Grassland of *Triodia basedowii* and *Triodia pungens* over Open Tussock Grassland of *Aristida inaequiglumis*, *Themeda triandra*and *Digitaria brownii* with Low Open Woodland of *Corymbia hamersleyana* on loamy drainage zones adjacent to floodplains
- 11b

Open Hummock Grassland of *Triodia basedowii* and *Triodia* sp. *Shovelanna Hill* with Low Open Woodland of *Acacia aptaneura*, *Acacia pruinocarpa* and *Corymbia hamersleyana* and High Open Shrubland of *Eremophila platycalyx*, *Acacia wanyu* and *Acacia synchronicia* on stony rises, plains and footslopes
- 11c

Open Hummock Grassland of *Triodia pungens* and *Triodia* sp. *Shovelanna Hill* with Low Open Woodland of *Corymbia ferriticola* and *Eucalyptus leucophloia* subsp. *leucophloia* and Open Shrubland of *Astrotricha hamptonii*, *Dodonaea pachyneura* and *Acacia maitlandii* on faces of large open ravines and occasionally cliffs

Themeda Closed Tussock Grassland

- 12

Closed Tussock Grassland of *Themeda triandra* and *Eulalia aurea* with Low Open Woodland of *Hakea lorea* subsp. *lorea*, *Acacia aptaneura* and *Corymbia aspera* and Open Shrubland of *Acacia pyrifolia* var. *pyrifolia* and *Acacia ancistrocarpa* on plains and drainage zones

Themeda Tussock Grassland

- 13a

Tussock Grassland of *Themeda triandra*, *Digitaria brownii* and *Aristida inaequiglumis* with Low Woodland of *Acacia aptaneura* and *Corymbia hamersleyana* and Very Open Hummock Grassland of *Triodia basedowii* on clay drainage zones and floodplains
- 13b

Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Digitaria brownii* with Low Open Woodland (to Low Woodland) of *Acacia aptaneura* and *Acacia paraneura* and Open Shrubland of *Eremophila fraseri* on floodplains
- 13c

Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Digitaria brownii* with Low Woodland (to Low Open Woodland) of *Acacia aptaneura*, *Eucalyptus xerothermica* and *Corymbia hamersleyana* and Low Open Shrubland of *Isotropis forrestii* and *Ptilotus obovatus* on drainage zones and flats

Eragrostis Tussock Grassland

- 14

Tussock Grassland of *Eragrostis eriopoda*, *Paraneurachne muelleri* and *Aristida contorta* with Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and *Corymbia aspera* and Open Shrubland of *Acacia melleodora* and *Senna artemisioides* subsp. *oligophylla* on gently sloping sandy loam plains

\*Cenchrus Tussock Grassland

- 15

Tussock Grassland of *\*Cenchrus ciliaris* with Low Open Woodland of *Acacia citrinoviridis*, *Acacia aptaneura* and *Corymbia hamersleyana* and High Shrubland of *Gossypium robinsonii*, *Acacia pyrifolia* var. *pyrifolia* and *Petalostylis labicheoides* on sandy floodplain

Legend

Syrinx Vegetation Mapping

Acacia Low Woodland

- 2a

Low Woodland of *Acacia aptaneura*, *Acacia ? pteraneura* and *Acacia pruinocarpa* over Open Hummock Grassland of *Triodia epactia* and *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) with Shrubland of *Acacia wanyu*, *Acacia tetragonophylla* and *Senna stricta*
- 2c

Low Woodland of *Acacia aptaneura* and *Corymbia hamersleyana* over Very Open Shrubland of *Acacia wanyu*, *Acacia ancistrocarpa* and *Eremophila forrestii* subsp.(indet) over Very Open Hummock Grassland of *Triodia epactia* and *Triodia lanigera*
- 2d

Low Woodland of *Acacia ? aptaneura*, *Acacia mulganeura* and *Ficus brachypoda* over High Open Shrubland of *Acacia monticola*, *Grevillea wickhamii* subsp. (indet) and *Acacia wanyu* over Very Open Tussock Grassland of *Eragrostis cumingii*, *Amphipogon sericeus* and *Themeda triandra*

Acacia Low Open Woodland

- 3a

Low Open Woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over High Open Shrubland of *Acacia tetragonophylla* and *Acacia synchronicia* over Very Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835)

Acacia High Shrubland

- 4a

High Shrubland of *Acacia monticola*, *Rulingia luteiflora* and *Gossypium robinsonii* with Low Woodland of *Corymbia hamersleyana*, *Eucalyptus victrix* and *Eucalyptus leucophloia* subsp. *leucophloia* over Very Open Tussock Grassland of *Themeda triandra*, *\*Cenchrus ciliaris* and *Cymbopogon procerus*
- 4b

High Shrubland of *Acacia monticola*, *Acacia hamersleyensis* and *Petalostylis labicheoides* over Open Hummock Grassland of *Triodia melvillei*, *Triodia epactia* and *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) with Low Open Woodland of *Corymbia ferriticola* and *Ficus brachypoda*

Triodia Hummock Grassland

- 5a

Hummock Grassland of *Triodia brizoides*, *Triodia epactia* and *Triodia angusta* with Open Shrubland of *Acacia tetragonophylla* and *Acacia synchronicia* with Very Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia ? pteraneura*
- 5b

Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. van Leeuwen 3835) with Low Open Shrubland of *Acacia hilliana*, *Acacia adoxa* var. *adoxa* and *Halgania solanacea* var. Mt Doreen (G.M. Chippendale 4206) with Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa*
- 5c

Hummock Grassland of *Triodia lanigera* and *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) with Open Shrubland of *Hakea lorea* subsp. *lorea*, *Acacia ancistrocarpa* and *Acacia adsurgens* with Scattered Low Trees of *Corymbia hamersleyana* and *Acacia pruinocarpa*
- 5d

Hummock Grassland of *Triodia brizoides*, *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) and *Triodia epactia* with Open Shrubland of *Acacia tetragonophylla*, *Eremophila fraseri* subsp. *fraseri* and *Senna glutinosa* subsp. *pruinosa*

- 5f

Hummock Grassland of *Triodia lanigera* and *Triodia epactia* with High Open Shrubland of *Acacia bivenosa*, *Acacia ancistrocarpa* and *Acacia tenuissima* with Very Open Mallee of *Eucalyptus gamophylla*
- 5g

Hummock Grassland of *Triodia epactia*, *Triodia brizoides* and *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835), with Low Open Woodland of *Acacia aptaneura*, *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia pruinocarpa* over Scattered Shrubs of *Acacia tetragonophylla*, *Scaevola acacioides* and *Acacia wanyu*
- 5h

Hummock Grassland of *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835), *Triodia epactia* and *Triodia brizoides* with High Open Shrubland of *Acacia bivenosa* and *Acacia tetragonophylla* with Scattered Low Trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia aptaneura*

Triodia Open Hummock Grassland

- 6a

Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) with Low Open Shrubland of *Halgania solanacea* var. Mt Doreen (G.M. Chippendale 4206), *Gompholobium* sp. Pilbara (N.F. Norris 908) and *Acacia adoxa* var. *adoxa*
- 6d

Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835), *Triodia epactia* and *Triodia brizoides* with Low Open Woodland of *Acacia aptaneura*, *Acacia ? pteraneura* (hybrid?) and *Acacia rhodophloia* over Open Shrubland of *Acacia tetragonophylla*, *Acacia adsurgens* and *Senna glutinosa* subsp. *glutinosa*
- 6e

Open Hummock Grassland of *Triodia*sp. Shovelanna Hill (S.van Leeuwen 3835) and *Triodia epactia* with Low Open Shrubland of *Acacia hilliana*, *Sida* sp. *excedentifolia* (J.L. Egan 1925) and *Senna glutinosa* subsp. *pruinosa* with Scattered Trees of *Eucalyptus leucophloia* subsp. *leucophloia*
- 6f

Open Hummock Grassland of *Triodia brizoides* and *Triodia epactia* with Low Open Shrubland of *Eremophila fraseri* subsp. *fraseri*, *Senna artemisioides* subsp. *oligophylla* and *Senna artemisioides* subsp. *helmsii*

Triodia Very Open Hummock Grassland

- 7a

Very Open Hummock Grassland of *Triodia lanigera* and *Triodia* sp. Shovelanna Hill (S.van Leeuwen 3835) with Scattered Shrubs of *Grevillea wickhamii* subsp. (indet), *Acacia ancistrocarpa* and *Hakea lorea* subsp. *lorea* with Scattered Trees of *Corymbia hamersleyana*

Mixed Tussock Grassland

- 8a

Tussock Grassland of *Eulalia aurea*, *Themeda triandra* and *Aristida inaequiglumis* with Low Open Woodland of *Corymbia hamersleyana*, *Acacia aptaneura* and *Acacia citrinoviridis* over Open Shrubland of *Acacia ancistrocarpa*, *Gossypium robinsonii* and *Acacia pyrifolia*

Mixed Open Tussock Grassland

- 9a

Open Tussock Grassland of *Themeda triandra*, *Aristida inaequiglumis* and *Aristida contorta* with Open Shrubland of *Acacia monticola*, *Acacia ancistrocarpa* and *Grevillea wickhamii* subsp. *aprica* with Scattered Low Trees of *Corymbia hamersleyana*



### 3 ASSESSMENT METHODS

#### 3.1 Database review

Three databases were searched as part of the review (Table 3.1):

- DPaW's NatureMap database – to determine threatened fauna recorded from the region which also incorporates the results of the Pilbara Biological Survey (DEC 2006);
- DPaW's Threatened Fauna Database - to determine the most up to date threatened fauna recorded from the region; and
- Department of the Environment (DoE) Protected Matters Database – to determine matters of national environmental significance likely to occur within the area based on bioclimatic modelling.

**Table 3.1** Databases used for the review

Provider	Database	Parameters
Department of Parks and Wildlife & WA Museum	NatureMap. Accessed 29 April 2014	Circle of radius 8 km centred on the point - 120°06' 30" E, 23°19' 26" S
Department of the Environment	Protected Matters Database Search Tool. Accessed 23 April 2014	Circle of radius 8 km centred on the point - 120°06' 30" E, 23°19' 26" S
Department of Parks and Wildlife	Threatened Fauna Database search. Accessed 7 February 2013	Circle of radius 30 km centred on the point - 119° 56' 17 " E, 23° 18' 24" S

#### 3.2 Review of baseline and other studies

Seventeen biological surveys have been conducted in the area, out of which seven overlap the Project Area (Table 3.2).



**Table 3.2** Reports used for the review

Survey Title	Consultant	Year	Survey Type
<b>Surveys that overlap with the Project Area</b>			
Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)	ecologia	1995	1 season, with trapping
Mesa Gap Biological Survey (GHD 2008)	GHD	2008	1 season, no trapping
Orebody 18 Fauna Assessment Phase II (ENV 2007a)	ENV Australia	2007	1 season, with trapping
Orebody 31 Fauna Assessment (ENV 2011)	ENV Australia	2011	1 season no trapping
Wheelarra Hill North Fauna Assessment (ENV Australia 2012)	ENV Australia	2012	2 seasons with trapping
OB17 and 18 Vertebrate Fauna Habitats (Biologic 2013a)	Biologic	2013	Desktop assessment
Orebody 31 Vertebrate Fauna Survey (Biologic 2013c)	Biologic	2013	1 season with trapping
<b>Surveys in the vicinity (&lt;15 km)</b>			
Jimblebar Mine Site Biological Survey (BHP Iron Ore Pty Ltd 1994)	BHP Iron Ore	1994	1 season with trapping
Jimblebar Wheelarra Hill 3 Flora and Fauna Assessment (Biota 2004)	Biota	2004	Desktop assessment
Jimblebar-Wheelarra Hill Expansion Biological Survey (ecologia Environmental 2004)	ecologia	2004	1 season with trapping
Jimblebar East Exploration Project Biological Survey (ecologia Environmental 2005)	ecologia	2005	1 season no trapping
Jimblebar Hashimoto Vertebrate Fauna Assessment (ecologia Environmental 2006a)	ecologia	2006	2 season with trapping
Jimblebar Marra Mamba Exploration Biological Survey (ecologia Environmental 2006b)	ecologia	2006	1 season, no trapping
West Jimblebar Fauna Assessment (ENV 2007b)	ENV Australia	2007	1 season, with trapping
Jimblebar Wheelarra Hill Flora and Fauna Assessment (Outback Ecology Services 2009c)	Outback Ecology	2009	2 season with trapping
Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services 2009a)	Outback Ecology	2009	2 season with trapping
Orebody 19 Level 2 Vertebrate Fauna Survey (Biologic 2013b)	Biologic	2013	2 seasons with trapping

### 3.3 Assessment of fauna habitat significance

Fauna habitats were also assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Project Area were sampled and scored for significance (High, Medium or Low) according to the criteria shown in Table 3.3 below. Conservation significant habitats are discussed in Section 4.7.



**Table 3.3** Fauna habitat significance assessment criteria

Score	Criteria
High	Habitat supports EPBC Act listed threatened fauna. OR Habitat for species listed as above is present in the Project Area, and there are records of that species within 50 km of the Project Area. If limited surveys have been undertaken in the vicinity of the Project Area then a precautionary approach will be used and the species will be considered likely to be present. OR Uncommon habitat is critical habitat for a population of DPaW listed Priority fauna. For example, if habitat is limited in the region and the habitat in the Project Area forms a significant portion of the known habitat for a Priority species, it would be scored as High significance. OR Habitat that only occurs in small isolated geographic areas.
Medium	Habitat supports DPaW listed Priority fauna that are largely restricted to that habitat type within the Project Area. OR Habitat supports EPBC Act listed Migratory fauna. OR Habitat supports a particularly diverse and uncommon faunal assemblage. Habitat that occurs throughout region, and does not occur in small or isolated areas, is excluded.
Low	Habitat is widespread, common, and does not solely support any significant fauna.

### 3.4 Taxonomy and nomenclature

The latest checklist of mammals, reptiles and amphibians published by the WA Museum (DPaW and WAM 2014) were used as a guide to the current taxonomy and nomenclature of these groups. This updated list in turn is formulated using up-to-date taxonomical literature. For birds, the current checklist of Australian birds, maintained by Birds Australia, was used. The bird list is based on the most recent review of the systematics and taxonomy of Australian birds by Christidis and Boles (2008).

### 3.5 Assessment of conservation significance

Within Western Australia, all native fauna is protected under the WC Act and any action that has the potential to impact on native fauna needs to be approved by relevant State and/or Federal departments as dictated by the State *Environmental Protection Act 1986* and the Federal EPBC Act.





Some species of fauna that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. For the purposes of this report, these species are called conservation significant species. A summary of applicable legislation and status codes is provided in Table 3.4. Additional information on Status Codes is provided in Appendix B.

A number of migratory bird and marine species are prioritised for conservation under the EPBC Act or international agreements. In addition the International Union for the Conservation of Nature (IUCN) compiles a 'Red List' upon which species at risk of extinction are listed.

For some species there is insufficient information to determine their status. These species are generally considered by the EPA/ DPaW as 'conservation significant' for all development related approvals and are listed on a 'Priority List' which is regularly reviewed and maintained by the DPaW.

DPaW also identifies 'Threatened Ecological Communities' (TECs) that are naturally occurring biological assemblages found to fit into one of the four categories (Table 3.4). Possible TECs that do not meet these survey criteria are added to DPaW's 'Priority Ecological Communities' (PECs) lists under Priorities 1, 2 and 3.

### **3.5.1 Survey limitations**

The limitations of each survey within or overlapping the Project Area are given in Table 3.5. No field work took place during the OB17/18 Vertebrate Fauna Habitat Mapping (Biologic 2013a) and as such, is not included.



Table 3.4 Conservation significance assessment guidelines

Agreement, Act or List	Status Codes
<b>International Level</b>	
The IUCN Red List lists species at risk under nine categories (listed under 'Status Codes').	IUCN Extinct IUCN Extinct in the Wild IUCN Critically Endangered IUCN Endangered IUCN Vulnerable IUCN Near Threatened IUCN Least Concern IUCN Data Deficient IUCN Not Evaluated
Migratory taxa listed under the following international conventions are generally listed as Migratory or Marine under the federal Environment Protection and Biodiversity Conservation Act 1999 (see below): Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and, Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).	Generally listed as Migratory or Marine under the federal Environment Protection and Biodiversity Conservation Act 1999
<b>Federal Level</b>	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) DoE lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent Migratory Marine
Threatened Ecological Communities (TECs) are those that are at risk of extinction.	Critically Endangered Endangered Vulnerable
<b>State Level</b>	
Wildlife Conservation Act 1950 (WC Act) At a state level, native fauna are protected under the Wildlife Conservation Act 1950. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	Schedule 1 Schedule 2 Schedule 3 Schedule 4
DPaW Priority list (DPaW) The DPaW produces a list of Priority species and ecological communities (e.g. Priority Ecological Communities (PECs) or Threatened Ecological Communities (TECs)) that have not been assigned statutory protection under the Wildlife Conservation Act 1950. This system gives a ranking from Priority 1 to Priority 5.	Priority 1 Priority 2 Priority 3 Priority 4 Priority 5



Table 3.5 Identified limitations of field surveys previously undertaken overlapping the Project Area

Survey	Orebody 18 Biological Assessment Survey	Orebody 18 Fauna Assessment Phase II	Mesa Gap Biological Survey	Orebody 31 Fauna Assessment	Wheelarra Hill North Fauna Assessment	Orebody 31 Vertebrate Fauna Survey
<b>Survey information</b>						
Consultant	ecologia	ENV	GHD	ENV	ENV	Biologic
Survey Year	1995	2007a	2008	2011	2012	2012
Type	1 season with trapping	1 season with trapping	1 season with no trapping	1 season with no trapping	2 seasons with trapping	1 season with trapping
Relevance to Proposed Development	Overlaps the Indicative Infrastructure Corridor Area in the west	Overlaps the Indicative Infrastructure Corridor Area in the west	Overlaps both the most of the Indicative Infrastructure Corridor Area and the Indicative Mine Disturbance Area	Overlaps most of the Indicative Mine Disturbance Area	Overlaps the Indicative Mine Disturbance Area in south	Overlaps most of the Indicative Mine Disturbance Area
<b>Survey limitations</b>						
Experience of personnel	Not given	The biologists who executed these surveys included practitioners who are regarded as suitably qualified in their respective fields. • Jason Fraser - Senior Biologist • Greg Harewood - Senior Biologist and Ornithologist • Breanne Cook – Biologist • Brad Maryan - Taxonomy	“qualified ecologists conducted the fauna investigation in conjunction with the flora investigation”	The scientists who undertook this survey were practitioners suitably qualified in their respective fields. • Matthew Love - Senior Zoologist • John Trainer - Zoologist	The biologists that conducted the Level Two surveys included practitioners that are regarded as suitably qualified in their respective fields: • Ron Firth – Principal Zoologist (S1,2) • Colin Trainor – Senior Zoologist (S1, 2) • Matthew Love – Senior Zoologist (S1) • Mike Brown – Zoologist (S1) • John Trainer – Zoologist (S2) • James Sansom – Environmental Biologist (S2) • Chris Knuckey – Field Assistant (S1) • Josh Matthews – Field Assistant (S1)	The field personnel involved in the survey each had five or more years of fauna survey experience. The team collectively had over 70 years of field experience in the region. • Morgan O'Connell – Principal Zoologist • Thomas Rasmussen - Senior Zoologist • Brad Maryan - Senior Zoologist • Drew Gardner - Senior Zoologist • Ruchira Somaweera -Senior Zoologist • Claire Brooks - Zoologist
Disturbances that affected results of survey	Not given	The area had received 36.8 mm of rainfall in the three months prior to the survey, with most of this falling over a two day period during the beginning of September. The day temperatures ranged from low to high 30s, with night temperatures in the mid twenties. These weather conditions were not likely to limit the activity of any faunal group.	Not given	No disturbances affected the outcomes of the survey.	Not given	Heavy rain prevented the sampling between 12:00-18:00 on 6 December, but did not affect the intended night work during the trip. No other disturbances affected the outcomes of the survey.
Completeness	Not given	Not given	The fauna survey undertaken was a reconnaissance survey only and thus only	A complete Level One Fauna survey was undertaken covering the survey area. All	The survey was conducted at seven sites and consisted of 980 pitfall trap nights, 1,960	A Level 1 first season and a Level 2 second season were completed.





Survey	Orebody 18 Biological Assessment Survey	Orebody 18 Fauna Assessment Phase II	Mesa Gap Biological Survey	Orebody 31 Fauna Assessment	Wheelarra Hill North Fauna Assessment	Orebody 31 Vertebrate Fauna Survey
			sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings etc. Many cryptic and nocturnal species would not have been identified during a reconnaissance survey.	conservation significant species deemed to potentially occur in the Project Area have been addressed.	funnel trap-nights, 176 Elliott trap-nights and 316 cage trapnights (pooled over both surveys). A total of 49 person hours of systematic bird surveys, and 19 person hours of nocturnal spotlighting was conducted at the sites, with 1-2 nights of AnaBat acoustic recording at five locations, and 60 person hours searching for evidence of conservation significant fauna (such as Western Pebble-mouse ( <i>Pseudomys chapmani</i> ) mounds and Northern Quoll ( <i>Dasyurus hallucatus</i> ) scats as well as searches for caves suitable for bats.	
Remoteness and/or access problems	Not given	Not given	Not given	Not given	Not given	All sections in the tenement were accessible either by vehicle or on foot; all habitats within the Project Area were surveyed and all habitats considered to be suitable for conservation significant species were surveyed.



## 4 RESULTS

### 4.1 Desktop review

#### 4.1.1 Previous surveys

A review of fauna survey reports relevant to the Project Area was undertaken in November 2013 (Biologic 2013c) to expand upon the review conducted by ENV (2011) and updated further in April 2014. A total of 17 fauna surveys have been completed within and in the immediate vicinity of the Project Area since 1994. These include two desktop reviews (comprising a database search and review of previous relevant surveys), four Level 1 surveys (comprising a desktop review as well as a reconnaissance field survey), six single-season Level 2 surveys (comprising a desktop review with a more robust field sampling programme including trapping over one season) and five two-season Level 2 surveys (comprising a desktop review with a more robust field sampling programme including trapping over two seasons). Seven of these studies partially overlapped with the Project Area.

A summary of the surveys that overlap the Project Area and those in the immediate vicinity (<15 km from the boundaries) is provided in Table 4.1 and are shown in Figures 4.1 and 4.2 respectively. The Jimblebar Wheelarra Hill 3 Flora and Fauna Assessment (Biota 2004) and OB17 and 18 Vertebrate Fauna Habitats (Biologic 2013a) were only desktop surveys, thus not discussed below in Table 4.1. Different sampling methods used during the surveys are shown in Figures 4.3 and 4.4.

Six species of conservation significant fauna were recorded within the Project Area, during the five field surveys that overlapped the Project Area.

#### Mammals

- Brush-tailed Mulgara (*Dasycercus blythi*) - DPaW Priority 4; Status under review by DoE (DSEWPac 2012);
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

#### Birds

- Australian Bustard *Ardeotis australis* – DPaW Priority 4;
- Bush Stone-Curlew *Burhinus grallarius* - DPaW Priority 4;
- Rainbow Bee-eater *Merops ornatus* – EPBC Act Migratory, WC Act Schedule 3; and
- Forktailed Swift *Apus pacificus* – EPBC Act Migratory, WC Act Schedule 3.



**Table 4.1** Survey effort for surveys in the vicinity of the Project Area

Survey	Surveys overlapping the Project Area					Surveys in the vicinity (<15 km)									
	Orebody 18 Biological Assessment Survey	Orebody 18 Fauna Assessment Phase II	Wheelarra Hill North Fauna Assessment	Orebody 31 Fauna Assessment	Orebody 31 Vertebrate Fauna Survey	Jimblebar Biological Survey	Jimblebar-Wheelarra Hill Expansion Biological Survey	Jimblebar East Exploration Project Biological Survey	Jimblebar Hashimoto Vertebrate Fauna Assessment	Jimblebar Marra Mamba Exploration Biological Survey	Jimblebar West Fauna Assessment	Mesa Gap Biological Survey	Jimblebar Wheelarra Hill Flora and Fauna Assessment	Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment	Orebody 19 Level 2 Vertebrate Fauna Survey
Consultant	ecologia	ENV Australia	ENV Australia	ENV Australia	Biologic	BHPB Iron Ore	ecologia	ecologia	ecologia	ecologia	ENV Australia	GHD	Outback Ecology	Outback Ecology	Biologic
Year	1995	2007	2012	2011	2013	1994	2004	2005	2006	2006	2007	2008	2009	2009	2013
Type	1 season with trapping Level 2	1 season with trapping Level 2	2 season with trapping Level 2	1 season with no trapping Level 1	1 season with trapping Level 2	1 season with trapping Level 2	1 season with trapping Level 2	1 season with no trapping Level 1	2 season with trapping Level 2	1 season with no trapping Level 1	1 season with trapping Level 2	1 season with no trapping Level 1	2 season with trapping Level 2	2 season with trapping Level 2	2 season with trapping Level 2
Duration	10 – 19 Aug 1995	18 - 29 Sep 2006	7 – 18 Apr, 4 –13 Oct 2011	28 Feb – 2 Mar 2011, 29 Mar – 1 Apr 2011	2-11 Oct 2013, 2-6 Dec 2013 (night work)	11-22 Jun 1994	9 Feb – 13 Mar 2004	8 Feb – 14 Feb 2005	26 Aug – 16 Sep 2005, 6 – 15 Feb 2006	2-28 May 2006	14-21 May 2007	Oct 2007	4-15 Jun 2008, 25 Sep – 2 Oct 2008	4 to 15 Jun 2008, 27 Sep -3 Oct 2008	24 May – 6 Jun 2013, 27 Aug – 6 Sep 2013
No. of trapping sites	6	5	7	none	5	18	5	45	6	none	1	none	5	9	6
Site type	2 lines of 10 medium Elliott traps plus 10 pitfalls open between 7 and 10 nights.	5 cage traps, 10 medium Elliott traps, 20 funnel traps, 20 pot traps open for 9 nights	Trap lines of 10 Elliott, 1 pitfall, 2 funnel, 2 cage traps	none	Each trap site with trap lines of 10 pitfall (5 buckets and 5 pipes), 20 funnel, 20 Elliot and 2 cage traps	Varied. Most were 10 Medium Elliott and 5 pitfalls	2 trap lines of 20 Elliott, 10 pitfall, 4 funnel	none	Trap lines of 20 Elliott, 10 pitfall, 2 funnel, 2 cage traps	none	10 Elliott and 10 funnel traps (Trap lines also opened at Coodiner)	None	2 trap lines of 5 buckets, 5 pipes, 20 Elliott, 20 funnel traps and 2 cage traps.	2 trap lines of 20 Elliott, 10 pitfall, 4 funnel, 2 cage traps	Each trap site with trap lines of 10 pitfall (5 buckets and 5 pipes), 20 funnel, 20 Elliot and 2 cage traps
Trap nights	840 Elliott trap 359 Pitfalls	225 cage 450 Elliott 675 Funnel 630 pots	176 Elliott 980 pitfall 1,960 funnel 316 cage	none	700 Elliott 350 pitfall 700 funnel 70 cage	675 Elliott 175 Pitfall	620 Elliott 307 pitfall 260 funnel	none	2640 Elliott 1220 pitfall 1320 funnel 360 cage	none	30 Elliott, 30 Funnel	None	520 Elliott 260 Pitfall 216 Funnel 52 Cage	1330 Elliott 250 pitfall 322 funnel 126 cage	1680 Elliott 840 pitfall 1680 funnel 168 cage
Diurnal search (hrs)	Not specified	Not specified	60	Not specified	>900	18	15	246	59	42	35	Not specified	12	22	>500
Nocturnal search (hours)	Not specified	5 nights (hours not specified)	19	Not specified	80	Not specified	Not specified	48	19	19	12	None	5.5	18.75	80
Bird surveys (hrs)	29	19 hours	49	Not specified	9.3	9	12.3		45	19.7	34	Not specified	8	19	11
Bird Survey method	1 hour census and opportunistic	opportunistic	15 minute census	opportunistic	Four 20 min surveys at seven sites	30 minute census	20 minute census	20 minute census	20 minute census	20 minute census	Opportunistic	Opportunistic	60 minute census	20 minute 100 m radius census	Four 20 min surveys at each site
Bat	none	6	2	none	28	none	25	2	30	15	3	None	1	(By	48

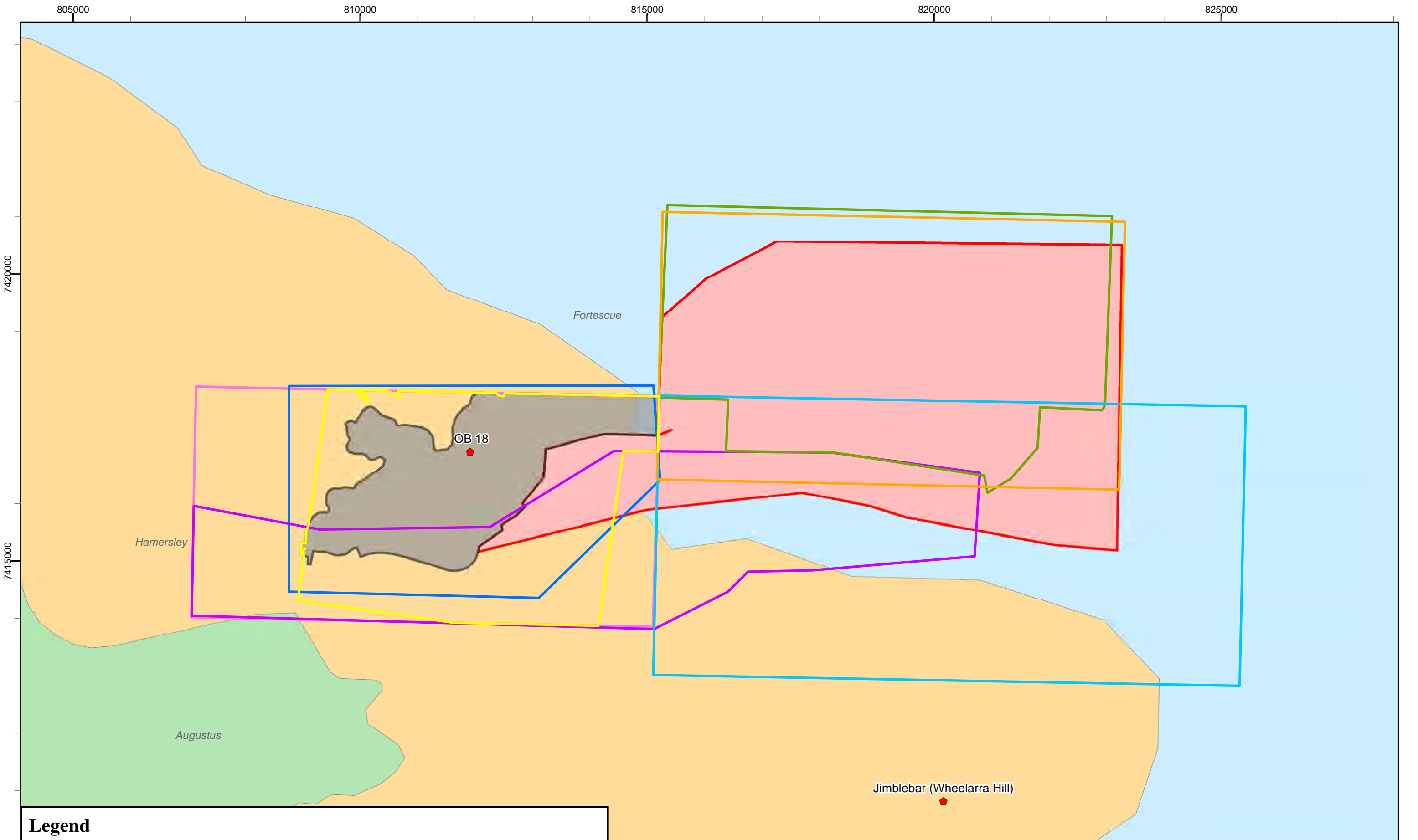




Survey	Surveys overlapping the Project Area					Surveys in the vicinity (<15 km)									
	Orebody 18 Biological Assessment Survey	Orebody 18 Fauna Assessment Phase II	Wheelarra Hill North Fauna Assessment	Orebody 31 Fauna Assessment	Orebody 31 Vertebrate Fauna Survey	Jimblebar Biological Survey	Jimblebar-Wheelarra Hill Expansion Biological Survey	Jimblebar East Exploration Project Biological Survey	Jimblebar Hashimoto Vertebrate Fauna Assessment	Jimblebar Marra Mamba Exploration Biological Survey	Jimblebar West Fauna Assessment	Mesa Gap Biological Survey	Jimblebar Wheelarra Hill Flora and Fauna Assessment	Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment	Orebody 19 Level 2 Vertebrate Fauna Survey
recording nights														Specialized Zoology)	
Bat recording hours	none	13.7	5	none	336	none	Not specified	4	Not specified	Not specified	4	None	6	none	576
Bat recording method	none	Anabat	Anabat & SM2BAT	none	SM2BAT	none	Anabat	Anabat	Anabat	Anabat	Anabat	None	Anabat	none	SM2BAT
Mammals (native)	10	12	23	5	17	6	8	8	18	6	5	4	9	10	22
Mammals (intro)	4	3		2	5	6	1	2	5	4	4	2	4	6	2
Birds	44	55	59	42	39	40	62	41	85	64	72	29	26	47	64
Reptiles	31	42	55	9	42	11	31	17	57	24	27	4	21	27	48
Amphibians	0	0	2	1	0	0	5	0	5	1	0	0	0	2	1
Conserv. Significant Spp.	none	Common Sandpiper, Bush Stone-curlew, Ramphotyp hlops ganei	Western Pebble-mound Mouse, Australian Bustard, Rainbow Bee-eater	None	Brush-tailed Mulgara, Australian Bustard, Rainbow Bee-eater	Western Pebble-mound Mouse, Australian Bustard	Bush Stone-Curlew, Rainbow Bee-eater	Australian Bustard, Rainbow Bee-eater	Australian Bustard, Rainbow Bee-eater 1	Western Pebble-mound Mouse, Australian Bustard, Rainbow Bee-eater	Australian Bustard, Rainbow Bee-eater	Western Pebble-mound Mouse	Western Pebble-mound Mouse, Rainbow Bee-eater, Ctenotus uber johnstonei2	Western Pebble-mound Mouse, Australian Bustard, Bush Stone-curlew, Rainbow Bee-eater	Brush-tailed Mulgara, Pilbara Olive Python, Western Pebble-mound Mouse, Rainbow Bee-eater, Pilbara Flat-headed Blindsnake

<sup>1</sup> Ghost Bat and Pilbara Leaf-nosed Bat were recorded, but these were considered by Specialised Zoological (2008) to be erroneous

<sup>2</sup> This subspecies of skink, first described in 1980 (Storr 1980), is listed as Priority 2 by the DPaW. Little is known of this taxon and its taxonomic status is uncertain. The type locality is Balgo Hill in the far north east of Western Australia. Specimens from the Pilbara may be grouped with *Ctenotus uber johnstonei*, or more likely it may belong to an undescribed taxon, in which case it would have no official conservation status. Within the Pilbara, the taxon is only currently known from a few localities on the western plains surrounding the Fortescue Marshes. Thus, it is considered a doubtful taxon herein and not discussed further.



**Legend**

- |  |  |
|--|--|
| ● BHP Billiton Iron Ore Mining Operations          | □ ENV 2012 Wheelarra Hill North Fauna Assessment |
| ■ OB31 Indicative Disturbance                      | □ ENV 2011 OB31 Fauna Assessment                 |
| ■ Existing OB18 Part IV area                       | □ ENV 2007a OB18 Fauna Assessment Phase II       |
| □ GHD 2008 Mesa Gap Biological Survey              | □ Ecologia 1995 OB18 Biological Assessment       |
| □ Biologic 2013a OB17-18 Vertebrate Fauna Habitats |  |
| □ Biologic 2013c OB31 Fauna Survey                 |  |

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km

N

biologic

**BHP Billiton Iron Ore Orebody 31 Project**

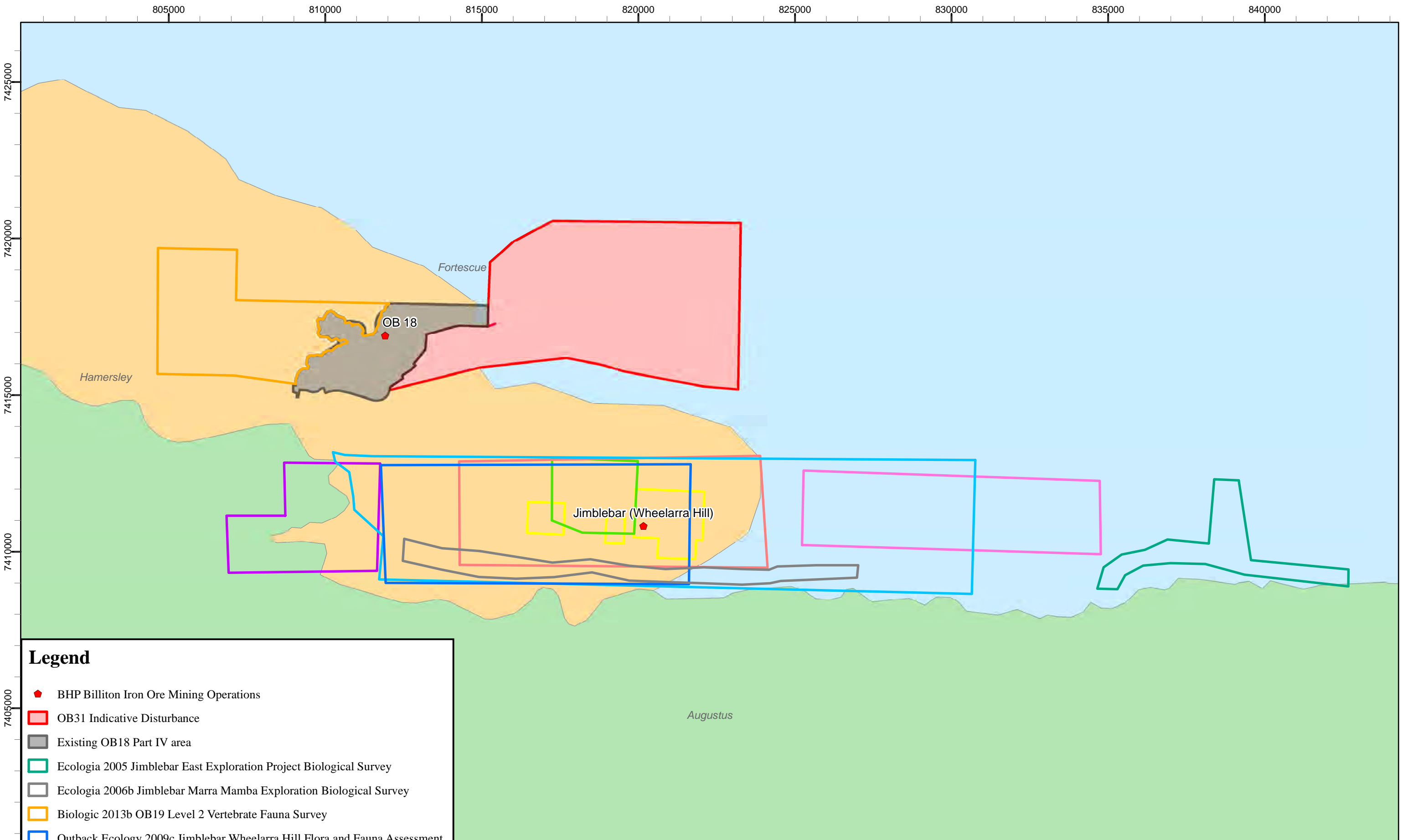
**Fig. 4.1: Previous studies within indicative disturbance area**

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994



**Legend**

- ◆ BHP Billiton Iron Ore Mining Operations
- ▭ OB31 Indicative Disturbance
- ▭ Existing OB18 Part IV area
- ▭ Ecologia 2005 Jimblebar East Exploration Project Biological Survey
- ▭ Ecologia 2006b Jimblebar Marra Mamba Exploration Biological Survey
- ▭ Biologic 2013b OB19 Level 2 Vertebrate Fauna Survey
- ▭ Outback Ecology 2009c Jimblebar Wheelarra Hill Flora and Fauna Assessment
- ▭ Outback Ecology 2009a Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna
- ▭ ENV 2007b West Jimblebar Fauna Assessment
- ▭ Ecologia 2006a Jimblebar Hashimoto Vertebrate Fauna
- ▭ Ecologia 2004 Jimblebar-Wheelarra Hill Expansion Biological Survey
- ▭ Biota 2004 Jimblebar Wheelarra Hill 3 Flora & Fauna
- ▭ BHP Billiton Iron Ore 1994 Jimblebar Mine Biological Survey

1:110,000

01246

km

N

biologic

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 4.2: Previous studies in the vicinity of OB31**

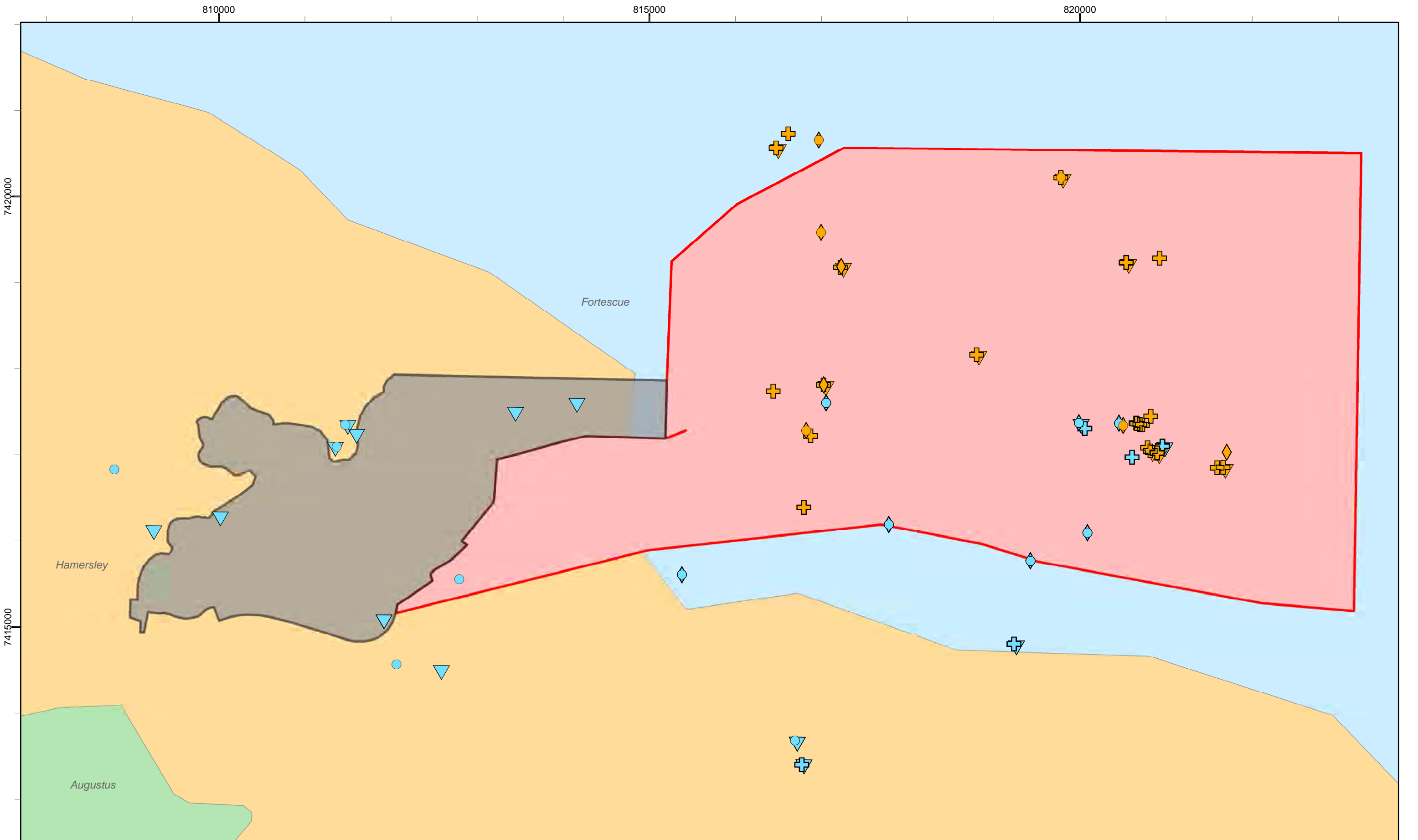
Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994





**Legend**

- |                                    |                    |                         |
|------------------------------------|--------------------|-------------------------|
| OB31 Indicative Disturbance        | Bat Detector, ENV  | Motion Camera, Biologic |
| Existing OB18 Part IV area         | Birding, Biologic  | Motion Camera, ENV      |
| <b>Sampling Method, Consultant</b> | Birding, ENV       | Trapping Site, Biologic |
| Bat Detector, Biologic             | Trapping Site, ENV |                         |

1:40,000

0 0.375 0.75 1.5 2.25 km

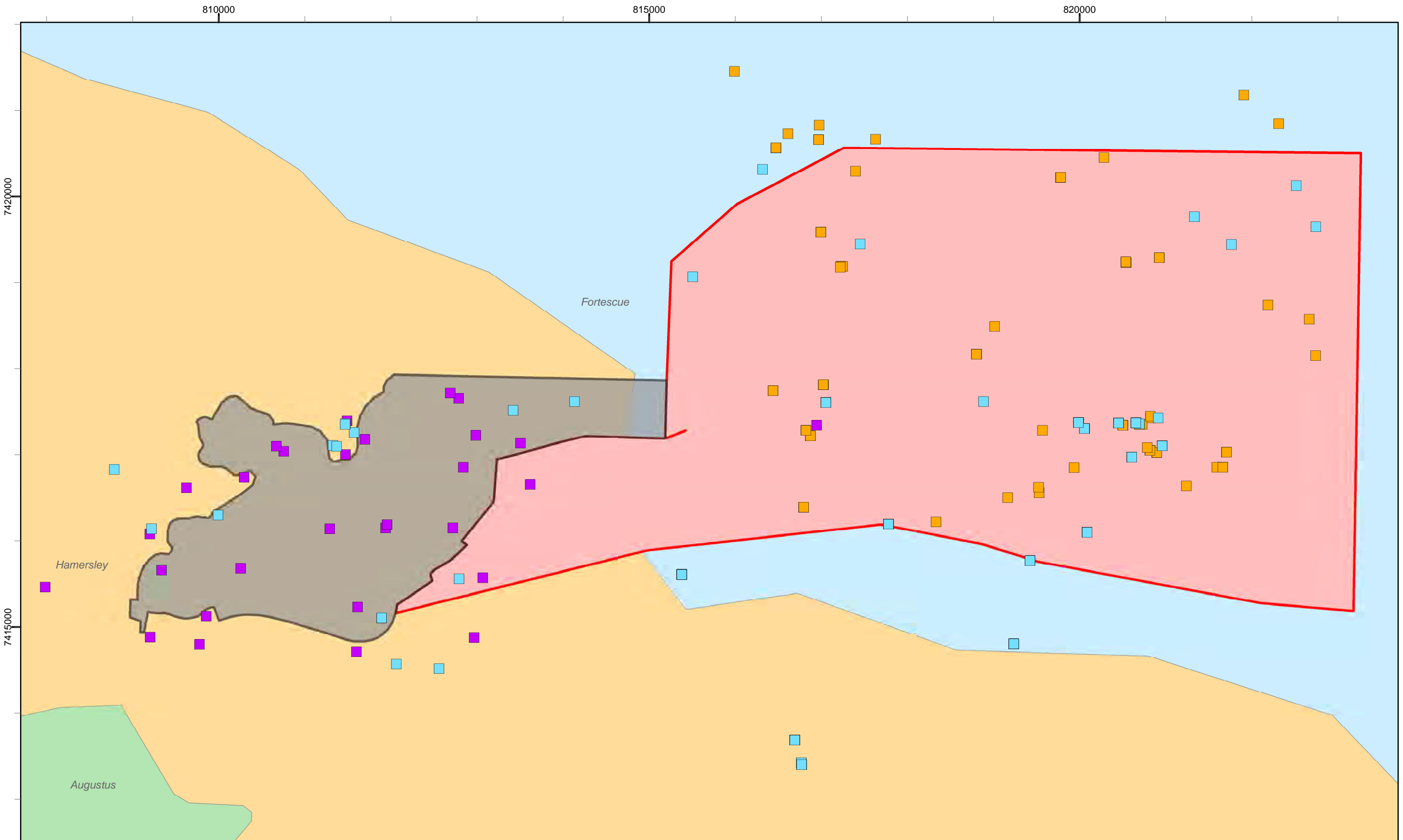
**biologic**

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 4.3 : Sampling effort for Vertebrate Fauna**

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Created 17/04/2014  
Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994



**Legend**

OB31 Indicative Disturbance

Existing OB18 Part IV area

Consultant

Biologic

ENV

ecologia

1:40,000

00.3750.751.52.25

km

N

biologic

**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 4.4: Habitat assessments for Vertebrate Fauna**

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994



#### 4.1.2 Database searches

##### 4.1.2.1 DPaW NatureMap

A NatureMap search, based on a circle of 8 km radius from the point 120°06' 30" E, 23°19' 26" S (centre of the Project Area), reported a total of 20 mammal species (including four introduced species), 64 bird species, 57 reptile species and two amphibian species, totalling 143 vertebrate species (see Appendix C). The conservation significant species identified by NatureMap comprise:

###### Mammals

- Ghost Bat *Macroderma gigas* – DPaW Priority 4;
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

###### Birds

- Australian Bustard *Ardeotis australis* – DPaW Priority 4;
- Bush Stone-Curlew *Burhinus grallarius* - DPaW Priority 4; and
- Rainbow Bee-eater *Merops ornatus* – EPBC Act Migratory, WC Act Schedule 3.

##### 4.1.2.2 EPBC Act Protected Matters Report

The EPBC Act Protected Matters database, based on a circle of 8 km radius from the point 120°06' 30" E, 23°19' 26" S, listed four threatened species and five migratory species.

###### Mammals

- Northern Quoll *Dasyurus hallucatus* – EPBC Act Endangered, WC Act Schedule 1, IUCN Endangered;
- Greater Bilby *Macrotis lagotis* – EPBC Act Endangered, WC Act Schedule 1, IUCN Vulnerable;
- Northern Marsupial Mole *Notoryctes caurinus*<sup>3</sup> – EPBC Act Endangered, WC Act Schedule 1;
- Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* – EPBC Act Vulnerable, WC Act Schedule 1;

###### Birds (Migratory species)

- Fork-tailed Swift *Apus pacificus* – EPBC Act Migratory, WC Act Schedule 3;

---

<sup>3</sup> The habitat required for this species, sand ridges and plains, does not occur within the OB31 Project Area or in the immediate vicinity, thus it is highly unlikely to be present in the area. Hence, this species is not discussed further in this report.





- Eastern Great Egret *Ardea modesta* – EPBC Act Migratory, WC Act Schedule 3;
- Cattle Egret *Bubulcus ibis* – EPBC Act Migratory, WC Act Schedule 3;
- Rainbow Bee-eater *Merops ornatus* – EPBC Act Migratory, WC Act Schedule 3; and
- Oriental Plover *Charadrius veredus* – EPBC Act Migratory, WC Act Schedule 3.

#### 4.1.2.3 DPaW Threatened Fauna Database search

A DPaW Threatened Fauna Database Search based on a circle of 30 km radius from the point 119°45'17" E, 23°18'24" S (centre of the Eastern Ophthalmia mining area), reported one mammal (a DPaW Priority 4 species) and a bird (a DPaW Priority 4 species) with conservation significance from the Project Area.

## 4.2 Overview of fauna recorded

Database searches, review of previous survey reports and results from the current survey indicated that 270 species of vertebrate fauna (excluding freshwater fish) have the potential to occur within the Project Area (Appendix C). This list comprises 34 species of native mammal, nine species of introduced mammals, 125 species of birds, 95 species of reptiles and seven species of amphibians. Of these, 194 species comprising 25 native mammal, seven species of introduced mammals, 81 species of birds, 78 species of reptiles and three species of amphibians have been recorded during the five field surveys that overlapped the Project Area.

### 4.2.1 Native mammals

Of the 34 native mammals identified in the literature and database review, 25 species from 16 families have been recorded to date within the Project Area and the vicinity. The most abundant records (including from secondary evidences such as tracks, diggings, scats, etc.) were Common Wallaroo, Gould's Wattled Bat, Little Broad-nosed Bat, Finlayson's Cave Bat, Sandy Inland Mouse and Common Rock-rat which were all recorded during four out of the seven field surveys. Seven species were recorded only once each during the seven surveys. The Common Planigale and the Ooldea Dunnart were only recorded during the surveys that overlapped the Project Area, but not others. Three species (Northern Quoll, Rory's Pseudantechinus and Greater Bilby) were identified in online databases to occur in the area but were not recorded in any of the surveys in the general area.



Given the recent taxonomic changes and existing complexity in the nomenclature, the identity of Mulgara (*Dasyercus* spp.) recorded from the Project Area remains uncertain. Some of the previous surveys have placed specimens under Crest-tailed Mulgara (*Dasyercus cristicauda*). Recent surveys and genetic work (Biologic 2013d) from South West Jimblebar (7km south of Project Area) indicate that *Dasyercus blythi* occurs in the area. Identification of captured individuals based on morphology concluded that individuals in the Project Area are highly likely to be *Dasyercus blythi*. Likewise, previous records of the Fat-Tailed Antechinus (*Pseudantechinus macdonnellensis*) have been placed under Rory's Antechinus (*Pseudantechinus roryi*), as these have been synonymised.

#### 4.2.2 Birds

One hundred and twenty five (125) species of native birds potentially occur in the general area, of which 81 species, from 46 families, have been recorded to date within the Project Area or its vicinity (during surveys that overlap the Project Area). Eighteen species of birds have been recorded during all the five field surveys that overlapped the Project Area (*i.e.* Diamond Dove, Australian Owlet-nightjar, Brown Falcon, Nankeen Kestrel, Galah, Variegated Fairy-wren, Singing Honeyeater, Black-faced Cuckoo-shrike, Rufous Whistler, Pied Butcherbird, Zebra Finch, Spinifex Pigeon, Little Button-quail, Red-backed Kingfisher, Striated Grasswren, Crested Bellbird, Little Woodswallow and Painted Finch) where as 21 species were only recorded during one survey each. The Cattle Egret, Eastern Great Egret and Oriental Plover were identified in online databases to occur in the area, but were not recorded in any of the surveys.

#### 4.2.3 Reptiles

Of the 95 reptiles that are likely to occur in the area, 78 species have been recorded to date. Five species of reptiles have been recorded during all the five surveys that overlapped the Project Area (*i.e.* *Ctenophorus caudicinctus*, *Gehyra punctata*, *Gehyra variegata*, *Ctenotus saxatilis* and *Varanus acanthurus*) whereas 24 species were only recorded during one survey each. Seven species were only recorded during the surveys that overlapped the Project Area, but not others.



#### 4.2.4 Amphibians

Seven species of amphibians were identified in the literature review as potentially occurring within the Project Area and the vicinity, of which three (*Cyclorana maini*, *Cyclorana platycephala* and *Litoria rubella*) have been recorded to date.

#### 4.2.5 Introduced fauna

Nine introduced species of mammals have been recorded from the general area and seven during surveys that overlap the Project Area. These include the Red Fox (*Vulpes vulpes*), European Rabbit (*Oryctolagus cuniculus*), Camel (*Camelus dromedaries*), Donkey (*Equus asinus*), Cattle (*Bos taurus*), Cat (*Felis catus*) and House Mouse (*Mus musculus*). Other introduced mammalian species comprise the Dog (*Canis lupus*) and the Horse (*Equus caballus*). Note that the Dingo (*Canis lupus dingo*) is regarded as a native species in some literature on the basis that its introduction predates the arrival of Europeans, and that mutual adaptation between dingoes and the surrounding ecosystems has occurred. In the Pilbara, however, there has been hybridisation between dingoes and domestic dogs.

### 4.3 Fauna habitats within the Project Area

Five major fauna habitats were identified within the Project Area during the OB17 and 18 Vertebrate Fauna Habitat Survey (Biologic 2013a) and OB31 Vertebrate Fauna Survey (Biologic 2013c), they are:






- Minor Drainage Line;
- Sand Plain;
- Crest/ Slope;
- Drainage Area; and
- Gorge/ Gully.

The 'Alluvial Plain' habitat identified by ENV (2011) was assigned to Sand Plain during the second survey season. The Low Hills in ENV (2011) largely overlaps the Crest/ Slope habitat. Habitat descriptions are presented in Table 4.2. The habitat assessments were analysed to determine the habitat's significance and the key characteristics that differentiated each habitat (Table 3.3). The extent of each fauna habitat outside of the Project Area is provided where available. The habitats are mapped in Figure 4.5.





**Table 4.2** Fauna Habitat Descriptions

Habitat	Description and habitat characteristics	Extent within the Project Area	Extent outside Project Area	Significant species associated with habitat	Photo
Crest/ Slope	The Crest/Slope habitats tend to be more open and structurally simple than other fauna habitats, and are dominated by varying species of spinifex. A common feature of these habitats is a rocky substrate, often with exposed bedrock, and skeletal red soils. Crests and slopes are dominated by sparse Eucalyptus woodlands, Acacia and Grevillea shrublands and Triodia spp. low hummock grasslands. Rocky outcrops are scattered within this habitat.	Span from north-west to the south-east of the Project Area and is the prominent habitat type in the central section of the Project Area.	Extensive areas of Crest/Slope habitat are common in the vicinity of the Project Area and throughout the Pilbara.	Crest/Slope habitat supports local populations of Western Pebble-mound Mouse which is largely restricted to this habitat type. The Pilbara Flat-headed Blindsnake and Australian Bustard may also utilize this habitat. Pilbara Olive Python may pass through this habitat during dispersal. Ghost Bats may forage in this habitat, as may Peregrine Falcons.	
Gorge/Gully	Gorges/Gullies are deeply incised rugged, steep-sided valleys cut into the surrounding landscape. Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Few separate but closely-located Gorge/ Gully habitats occur towards the south-eastern section of the Project Area. However, these are shallow gorges.	Gorges (and gullies) are a common feature of the Pilbara (especially within the Hamersley Range), but because they tend to be narrow, linear features, they represent a small proportion of the total land area.	The Gorge/Gully habitat in the Project Area could potentially provide habitat for the Ghost Bat, Pilbara Olive Python and Northern Quoll. Minor Gullies could harbour Pilbara Olive Pythons and Pilbara Flat-headed Blindsnake.	
Minor Drainage Line	Characterised by low and sparse vegetation compared to Major Drainage Lines. Located within the minor gullies and depressions through the Crest/ Slope habitat. Consisted of Acacia low woodland sometimes with scattered <i>Corymbia hamersleyana</i> .	A prominent Minor Drainage Line occurs in the north-western corner of the Project Area. Others are scattered throughout the Project Area and flow through valleys among the Crest/ Slope habitat.	A common habitat in the Hamersley Range adjacent to the Project Area.	Minor Drainage Lines provide habitat for a number of conservation significant fauna. Bush Stone-curlew may shelter during the day in areas of thicker vegetation associated with drainage areas and the Pilbara Flat-headed Blindsnake is likely to utilise this habitat type as living space.	
Sand Plains	Sand Plain habitat is characterised by relatively deep sandy soils supporting dense spinifex grasslands and sparse shrubs. This habitat transitions into patches of Acacia (sometimes Mulga) in places.	Areas of this habitat broadly occur across the northern and southern sections of the Project Area.	Large representations of this habitat are located at the border of the Hamersley and Fortescue subregions and then extensively within the Chichester subregion.	Mulgara and potentially Greater Bilby utilise finer sandy habitats for burrows and foraging. Australian Bustard is frequently encountered foraging in this habitat. The Pilbara Flat-headed Blindsnake also occurs in this habitat type.	
Drainage Area	Consisted of Acacia low woodland sometimes with scattered Eucalyptus xerothermica and Corymbia hamersleyana. The understorey generally lack density and often consists solely of sparse tussock grassland, often of Cenchrus ciliaris where it has been introduced. The substrate can be sandy in places but generally consists of a loam gravel or stone.	Drainage Areas are low lying, gently sloping areas at the base of Crest/ Slope habitats. Most patches occur along the paleodrainageline along the southern section of the Project Area.	A common habitat in the Hamersley Range adjacent to the Project Area.	Drainage Areas provide habitat for a number of conservation significant fauna. Bush Stone-curlew may shelter during the day in areas of thicker vegetation associated with drainage areas and the Pilbara Flat-headed Blindsnake are likely to utilise this habitat type.	

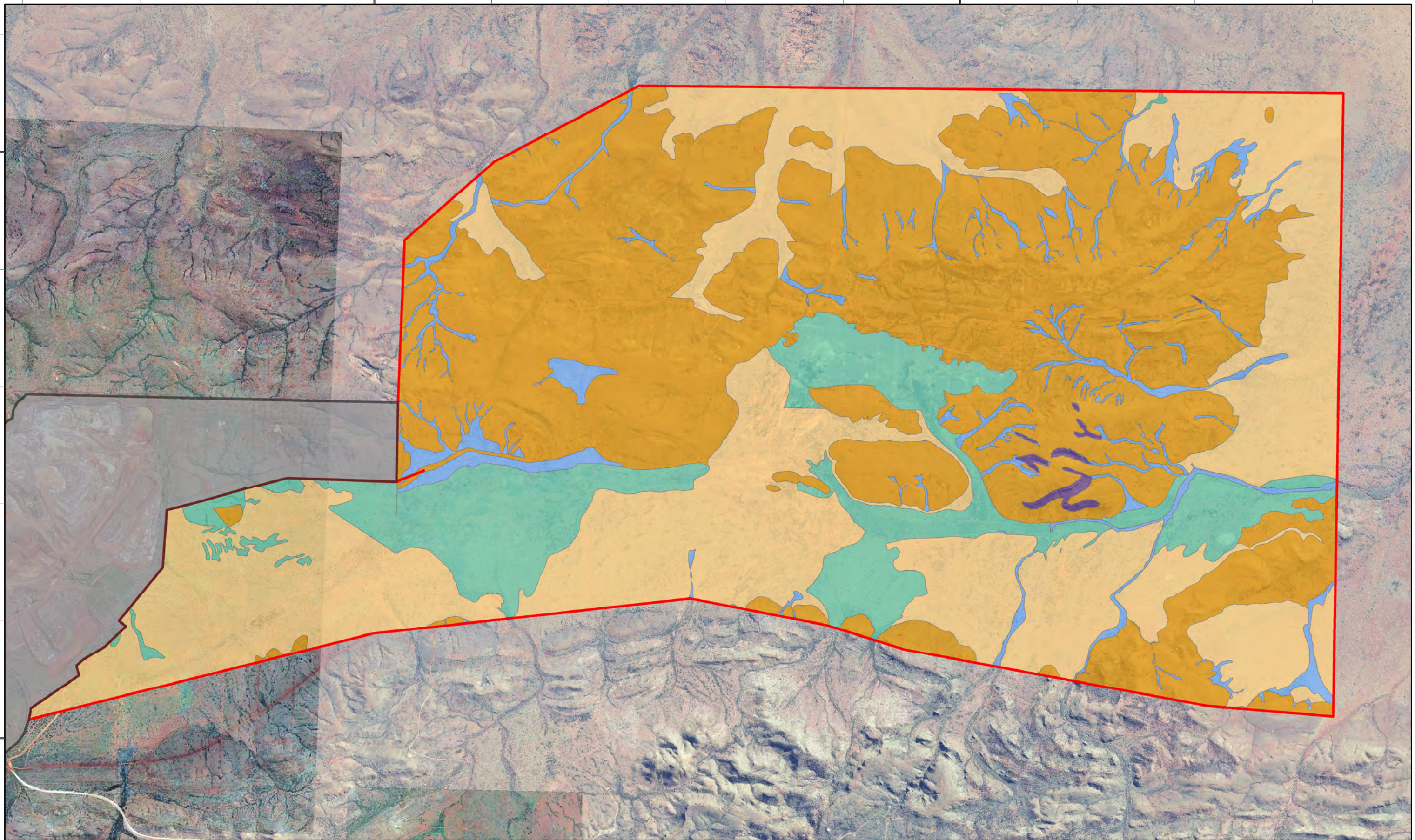


815000

820000

742000

7415000



## Legend

- |   |  |   |
|---|--|---|
| <span style="border: 2px solid red; padding: 2px;"> </span> OB31 Indicative Disturbance   | <span style="display: inline-block; width: 15px; height: 10px; background-color: orange; border: 1px solid black;"></span> Crest / Slope     | <span style="display: inline-block; width: 15px; height: 10px; background-color: lightblue; border: 1px solid black;"></span> Minor Drainage Line |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: grey; border: 1px solid black;"></span> Existing OB18 Part IV area | <span style="display: inline-block; width: 15px; height: 10px; background-color: lightgreen; border: 1px solid black;"></span> Drainage Area | <span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span> Sand Plain             |
| <b>Habitat</b>  | <span style="display: inline-block; width: 15px; height: 10px; background-color: purple; border: 1px solid black;"></span> Gorge / Gully     |   |

1:30,000

0 0.275 0.55 1.1 1.65 km

N

biologic 

## BHP Billiton Iron Ore Orebody 31 Project

### Fig. 4.5 : Vertebrate Fauna Habitats

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994





#### 4.4 Significant fauna recorded within the Project Area

Species are defined as 'Conservation Significant' if they are listed under agreements at international (e.g. IUCN, JAMBA, CAMBA, Bonn), regional (EPBC Act) or state (WC Act, Priority list of DPaW) level. Explanations of conservation status under these Acts and Agreements are provided in Table 3.4 and Appendix B.

Based on the review of regional surveys, database searches (Section 4.1), and the habitats present in the Project Area, it was determined that 17 species (six native mammals, nine birds and two reptiles) of conservation significance have the potential to occur in the Project Area. Of these species, only six have been recorded within the Project Area. These are:

##### Mammals

- Brush-tailed Mulgara *Dasycercus blythi* - DPaW Priority 4 [status under review by DoE (DSEWPaC 2012)];
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

##### Birds

- Australian Bustard *Ardeotis australis* – DPaW Priority 4;
- Bush Stone-curlew *Burhinus grallarius* – DPaW Priority 4;
- Fork-tailed Swift *Apus pacificus* – EPBC Act Migratory, WC Act Schedule 3; and
- Rainbow Bee-eater *Merops ornatus* – EPBC Act Migratory, WC Act Schedule 3.

A further 11 species were identified by database and literature searches to have the potential to occur in the Project Area. These are:

##### Mammals

- Ghost Bat *Macroderma gigas* – DPaW Priority 4;
- Northern Quoll *Dasyurus hallucatus* – EPBC Act Endangered, WC Act Schedule 1, IUCN Endangered;
- Greater Bilby *Macrotis lagotis* – EPBC Act Endangered, WC Act Schedule 1, IUCN Vulnerable;
- Pilbara Leaf-nosed Bat *Rhinonictoris aurantia* – EPBC Act Vulnerable, WC Act Schedule 1;





#### Birds

- Common Sandpiper *Actitis hypoleucos* – EPBC Act Migratory, WC Act Schedule 3;
- Eastern Great Egret *Ardea modesta* – EPBC Act Migratory, WC Act Schedule 3;
- Cattle Egret *Ardea ibis* – EPBC Act Migratory, WC Act Schedule 3;
- Oriental Plover *Charadrius veredus* – EPBC Act Migratory, WC Act Schedule 3.
- Star Finch *Neochmia ruficauda subclarescens* – DPaW Priority 4;

#### Reptile

- Pilbara Olive Python *Liasis olivaceus barroni* – EPBC Act Vulnerable, WC Act Schedule 1; and
- Pilbara Flat-headed Blind Snake *Ramphotyphlops ganei* – DPaW Priority 1.

Table 4.3 shows the conservation significant species recorded from adjacent areas and those that potentially occur within the Project Area. Locations of conservation significant fauna recorded within the Project Area are presented in Figures 4.5 and 4.6 and Appendix D.

To simplify the classification of pebble mounds, they have been characterised as active/ recently active or inactive in the text below. Active or recently active indicates that the mounds are either currently used or the mound structure is clearly evident and therefore may be used again in the future. Inactive mounds are those that are weathered, flat and appear completely abandoned.

**Table 4.3** Summary of conservation significant fauna recorded in or adjacent to the Project Area and those that may potentially occur in the Project Area.

Species	Common Name	CONSERVATION STATUS				DATABASE SEARCHES			SURVEYS														
		EPBC Act	WC Act	DPaW	IUCN	Nature Map	EPBC Act	DPaW Threat. species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<b>Mammalia</b>																							
<i>Dasyercus blythi</i>	Brush-tailed Mulgara			P4																	•	•	
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1		EN		•																
<i>Rhinonicteris aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1				•										•*						
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4		•		•		•		•	•	•			•		•	•	•		•
<i>Macroderma gigas</i>	Ghost Bat			P4		•											•*						
<i>Macrotis lagotis</i>	Greater Bilby	VU	S1		VU		•																
<b>Aves</b>																							
<i>Ardea alba</i>	Eastern Great Egret	MI	S3				•																
<i>Ardea ibis</i>	Cattle Egret	MI	S3				•																
<i>Ardeotis australis</i>	Australian Bustard			P4					•	•			•	•	•		•	•	•	•		•	
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4		•						•			•	•							
<i>Charadrius veredus</i>	Oriental Plover	MI	S3				•																
<i>Actitis hypoleucos</i>	Common Sandpiper	MI	S3			•						•											
<i>Merops ornatus</i>	Rainbow Bee-eater	MI	S3			•	•		•	•					•	•	•		•	•	•	•	
<i>Apus pacifica</i>	Fork-tailed Swift	MI	S3				•						•										
<i>Neochmia ruficauda subclaescens</i>	Star Finch (Western subspecies)			P4																•			
<b>Reptilia</b>																							
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1																		•		
<i>Ramphotylops ganei</i>	Pilbara Flat-headed Blindsnake			P1				•				•								•	•		

\* These bat records from Hashimoto may be erroneous (Specialised Zoological 2008)

#### Database Searches

DPaW Naturemap search within 8 km buffer

EPBC Act Protected Matters search with 8 km buffer

DPaW Threatened Species Database search records within the Project Area

#### Surveys

- A West Jimblebar Fauna Assessment (ENV Australia 2007)
- B Wheelarra Hill North Fauna Assessment (ENV Australia 2012)
- C Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)
- D Orebody 18 Fauna Assessment Phase II (ENV 2007a)
- E Orebody 31 Fauna Assessment (ENV 2011)
- F Jimblebar Mine Site Biological Survey (BHPB Iron Ore Pty Ltd 1994)
- G Jimblebar Iron Ore Project: Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services 2009a)
- H Jimblebar - Wheelarra Hill Biological Survey (ecologia Environmental 2004)
- I BHP Billiton Iron Ore Hashimoto Terrestrial Vertebrate Fauna Assessment (ecologia Environmental 2006a)
- J Jimblebar Marra Mamba Exploration Biological Survey (ecologia Environmental 2006b)
- K Jimblebar East Exploration Project Biological Survey (ecologia Environmental 2005)
- L Jimblebar Linear Development Terrestrial Vertebrate Assessment (Outback Ecology Services 2009b)
- M Orebody 19 Vertebrate Fauna Survey (Biologic, 2013b)
- N Orebody 31 Vertebrate Fauna Survey (Biologic, 2013c)
- O Mesa Gap Biological Survey (GHD 2008)



## 4.5 Conservation Significant Fauna Recorded from the Project Area

Six species of conservation significant fauna have been recorded in the Project Area to-date. Each of the species recorded is presented in taxonomic order and discussed in the following section. Significant fauna species localities are shown on Figures 4.5 and 4.6 and presented in Appendix D.

### 4.5.1 Mammals

#### Brush-tailed Mulgara (*Dasycercus blythi*)

Brush-tailed Mulgara (*Dasycercus blythi*) is closely associated with *Triodia* Sand Plains and swales between low dunes from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts of southern and central Northern Territory and central Western Australia, including parts of the Pilbara (DSEWPaC 2011b; Pavey et al. 2012). Brush-tailed Mulgara is currently listed as Priority 4 by the DPaW; however it is currently under consideration for listing under the EPBC Act (DSEWPaC 2012). A possible outcome of this is that both species of Mulgara (*Dasycercus blythi* and *D. cristicauda*) will have the same status of Vulnerable under the EPBC Act.

Five individuals were caught in traps at two locations in the Sand Plain habitat along the northern border of the Project Area (Biologic 2013c: Figure 4.6). These include a female with a litter of six. Secondary evidences for Mulgara (burrows, scat and diggings) were found along the Sand Plains in the northern part of the Project Area (Biologic 2013c). The Project Area contains over 1480 ha of Sand Plain habitat that is considered suitable for this species, but records were limited to the northern section (Figure 4.6). Seven burrows of the Brush-tailed Mulgara were located in Sand Plain habitat along the southern section of OB19, ~5 km west of the Project Area (Biologic 2013b) but no individuals were trapped during the survey. Mulgara were not recorded in any of the previous surveys in the immediate vicinity of the Project Area, but Biologic also recorded the species at South Jiblebar and OB24 located approximately 6 km south and 22 km west of the Project Area, respectively (Biologic 2013b,c).

#### 4.5.1.1 Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse is currently listed as Priority 4 by the DPaW. This species has experienced a significant decline in their range through the Gascoyne and Murchison, and is now considered endemic to the Pilbara (Van





Dyck & Strahan 2008). This species almost exclusively occurs on the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (Van Dyck & Strahan 2008).

ENV (2011) recorded one active mound in Crest/ Slope habitat at the western section of the Project Area and ENV (2012) recorded two mounds and caught five individuals at three locations in the southern section of the Project Area (Figure 4.6). A total of 91 mounds, of which less than a fifth of which were active, were located at OB18, of which four are located within the Project Area (ecologia 1995). However, no captures were recorded during a more recent trapping survey at OB18 (ENV 2007a). GHD (2008) recorded one inactive mound immediately south (~200 m) of the Project Area. Four active and one inactive mound were recorded and 13 individuals were caught in the traps at OB19, ~4 km west of the Project Area (Biologic, 2013b). There are several records from other areas in the vicinity of the Project Area (see Table 4.3).

#### 4.5.2 Birds

##### **Australian Bustard (*Ardeotis australis*)**

The Australian Bustard is listed as Priority 4 by the DPaW and as Least Concern by the IUCN. It occurs across most of mainland Australia, but is listed in WA primarily due to a decline in its range in the south of the state. It is a nomadic species occurring in a wide variety of habitats including Sand Plains, gravel plains, riverine habitats and open or lightly wooded grasslands (Johnstone & Storr 1998).

During the Biologic survey at OB31 (Biologic 2013c), two individuals were recorded immediately outside the Project Area and three tracks (with two located within the Project Area) were observed in the Sand Plain habitat in the northern section and the Crest/ Slope habitats in the central section of the Project Area (Figure 4.7). ENV (2011) recorded one individual flying over the north-east corner of the Project Area and ENV (2012) another one flying over the Alluvial Plains in the southern section of the Project Area. This species was recorded in numerous surveys in the vicinity of the Project Area (Table 4.3).

**Bush Stone-curlew (*Burhinus grallarius*)**

The Bush Stone-curlew is listed as Priority 4 by DPaW. It is patchily distributed across much of mainland Australia; inhabiting areas of open forest and woodland with open areas, fallen dead timber or leaf litter (del Hoyo et al. 1996). Inland, this species is associated with watercourses. Bush Stone-curlews are nocturnal and often difficult to detect, being highly cryptic.

A single individual was observed within the Project Area during a survey at OB18 (ENV 2007a: Figure 4.7). Suitable habitats in the Project Area include Drainage Areas and mixed Acacia woodland and open areas fringed by denser riparian vegetation.

**Rainbow Bee-eater (*Merops ornatus*)**

The Rainbow Bee-eater is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. This species has broad habitat preferences and lives almost anywhere suitable for hawking insects. The demographics of the species are complex, with populations in WA being resident, breeding visitors, post-nuptial nomads, passage migrants and winter visitors (Johnstone & Storr 1998). Many individuals move northwards to overwinter in Indonesia.

Three individuals were recorded by Biologic (2013c), two closer to a Minor Drainage Line and the other in Crest/ Slope habitat in the southern part of the Project Area (Figure 4.7). Ten individuals were recorded during the Wheelarra North survey, of which three records are within the Project Area (ENV, 2012). Potential nesting habitat for this ground-nesting species exists within the Minor Drainage Lines in the Project Area. However, no evidence of nesting was observed. There are several records of this species from other areas in the vicinity of the Project Area (see Table 4.3).

**Fork-tailed Swift (*Apus pacificus*)**

This species is entirely aerial within the Pilbara and thus does not utilise the terrestrial surface. It is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act, as it breeds in north-east and east Asia, wintering in Australia and southern New Guinea (Johnstone & Storr 1998).

Fifteen individuals were recorded flying overhead in the north-western section of the Project Area during a survey at OB31 (ENV 2011: Figure 4.7). This species is expected to utilise the skies above the Project Area sporadically in the summer



months, being attracted to thunderstorms and cyclonic systems (Johnstone & Storr 1998).



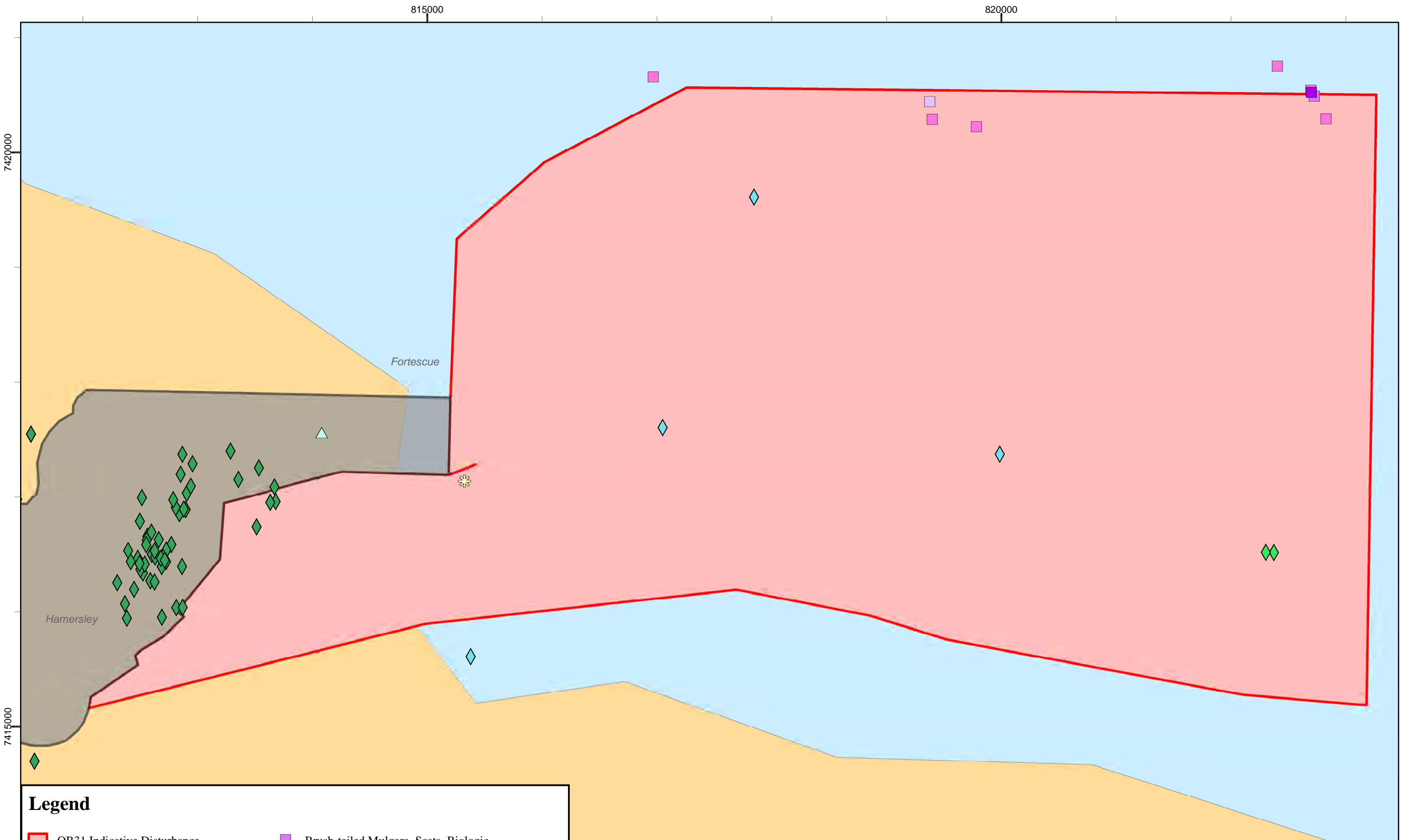


**Table 4.4** Conservation significant fauna occurring in the Project Area.

Species	Significance	Preferred habitat	Extent of the habitat in the Project Area and the region	Records
Brush-tailed Mulgara <i>Dasycercus blythi</i>	DPaW: Priority 4 (under review by DoE)	Arid, sandy areas, preferring mature spinifex on sandy soils. Brush-tailed Mulgara inhabit spinifex grasslands with medium to dense cover.	Extensive areas of Sand Plain habitat broadly occur across the northern and southern sections of the Project Area. They are also widespread in the adjoining areas.	Five individuals caught in traps at two locations along the northern border of the Project Area (Biologic 2013c). Secondary evidences (burrows, scat and diggings) found along in the same area (Biologic 2013c). Seven burrows located along the southern section of OB19, ~5 km west of the Project Area (ENV 2011). Locally common but patchy in suitable habitats throughout the Pilbara and other arid zones of Western Australia.
Western Pebble Mound Mouse <i>Pseudomys chapmani</i>	DPaW: Priority 4	Gentler slopes of rocky ranges where ground is covered with a stony mantle and vegetated by spinifex, often with sparse overstorey of eucalypts and scattered shrubs (Van Dyck and Strahan, 2008).	Span from north-west to the south-east of the Project Area. The Crest/ Slope habitat where the species occurs is also one of the most common habitat types in the surrounding areas.	One active mound in at the north-central section (ENV 2011). Two mounds and five individuals at three locations in the southern section (ENV 2012). 91 mounds, of which less than fifth of which were active, located during a previous study at OB18 of which four were located within the Project Area (ecologia 1995). Four active and one inactive mound and 13 individuals caught in the traps at OB19 (Biologic 2013b). Common to very common in suitable habitat throughout the Pilbara. Restricted to the region.
Australian Bustard <i>Ardeotis australis</i>	DPaW: Priority 4 IUCN: LC	Open or lightly wooded grasslands (Johnstone and Storr, 1998).	Extensive areas of Sand Plain habitat broadly occur horizontally across the northern and southern sections of the Project Area. They are also widespread in the	Two individuals (both outside the Project Area) and three tracks (one outside) observed in the northern and central sections (Biologic 2013c). One individual flying over south of the Project Area (ENV 2011).



Species	Significance	Preferred habitat	Extent of the habitat in the Project Area and the region	Records
			adjoining areas. This species also occurs in other habitat types including Stony Plains.	Recorded in numerous surveys in the vicinity of the Project Area. Common throughout most of mainland Australia, particularly in the arid zones.
Bush Stone-curlew <i>Burhinus grallarius</i>	DPaW: Priority 4 IUCN: Near threatened	Inhabits areas of open forest and woodland with open areas, fallen dead timber or leaf litter. Inland, it is associated with watercourses.	Suitable habitat in the Project Area includes drainage lines and open areas fringed by denser woodland, such as the grooved Mulga woodlands within the Crest/Slope habitats.	One observed within the Project Area during a survey at OB18 (ENV 2007a). Common throughout most of mainland Australia, particularly in the east coast where it is commonly seen in towns and cities.
Fork-tailed Swift <i>Apus pacificus</i>	EPBC Act: Migratory WC Act: Schedule 3	This species is entirely aerial within the Pilbara. Fork-tailed Swifts may forage above many habitat types.	It is likely that this species forages in most of the habitat types in the area. This species is expected to utilise the skies above the Project Area sporadically in the summer months, being attracted to thunderstorms and cyclonic systems (Johnstone and Storr 1998)	Fifteen individuals recorded flying overhead in the north-western section of the Study (ENV 2011). Common aerial species throughout northern Australia.
Rainbow Bee-eater <i>Merops ornatus</i>	EPBC Act: Migratory WC Act: Schedule 3	Lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998).	Suitable habitat common within the Project Area and surrounding region. Potential nesting habitat for this ground-nesting species exists in the Project Area, with this species is most likely to nest in the banks of the drainage lines.	Three individuals recorded at two locations in the southern part of the Project Area (Biologic 2013c). Ten individuals during the Wheelara North survey of which three are within the Project Area (ENV 2012). Common species in suitable habitat throughout mainland Australia.



**Legend**

OB31 Indicative Disturbance

Existing OB18 Part IV area

**NAME, TYPE, CONSULTANT**

Brush-tailed Mulgara, Burrow, Biologic

Brush-tailed Mulgara, Digging, Biologic

Brush-tailed Mulgara, Individual, Biologic

Brush-tailed Mulgara, Scats, Biologic

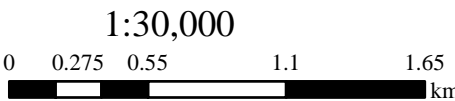
Pilbara Flat-headed Blindsnake, Individual, Biologic

Western Pebble-mound Mouse, Individual, ENV

Western Pebble-mound Mouse, Mound, ENV

Western Pebble-mound Mouse, Mound, ecologia

MAMMAL - P4 (DPaW)



**BHP Billiton Iron Ore Orebody 31 Project**

**Fig. 4.6: Conservation significant terrestrial fauna**

Created 17/04/2014  
Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994



815000

820000

7420000

7415000

Fortescue

Hamersley

Legend

OB31 Indicative Disturbance

Existing OB18 Part IV area

NAME, TYPE, CONSULTANT

Australian Bustard, Individual, Biologic

Australian Bustard, Individual, ENV

Australian Bustard, Tracks, Biologic

Bush Stone-curlew, Individual, ENV

Common Sandpiper, Individual, ENV

Fork-tailed Swift, Individual, ENV

Rainbow Bee-eater, Individual, Biologic

Rainbow Bee-eater, Individual, ENV

BIRD - P4 (DPaW)

1:30,000

0 0.275 0.55 1.1 1.65 km

N

biologic

BHP Billiton Iron Ore Orebody 31 Project

Fig. 4.7: Conservation significant avian fauna

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994



## 4.6 Conservation Significant Fauna potentially occurring in the Project Area

### 4.6.1 Mammals

#### **Northern Quoll (*Dasyurus hallucatus*)**

The Northern Quoll is listed as Endangered under the EPBC Act, on Schedule 1 under the WC Act and as Endangered by the IUCN. Northern Quolls have experienced significant declines in eastern and northern Australia, mainly due to an expansion of the Cane Toad's (*Rhinella marina*) range; these are ingested resulting in death (Tidemann et al. 1985). At present Northern Quolls are locally common in the northern part of the Pilbara region (generally within 150 km of the coast) but are uncommon in more southern areas.

Northern Quolls favour rocky areas such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, Major Drainage Lines and treed creek lines, as well as structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs (DSEWPac 2011a). Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia. Dens are made in rock crevices, tree holes or occasionally termite mounds (Oakwood 2008). In the Pilbara region, the species tends to prefer the Rocklea, Macroy and Robe Land Systems (Biota Environmental Science 2008). The Northern Quoll has also been recorded in other Land Systems which comprise sandstone and dolomite hills and ridges, shrublands, sandy plains, clay plans and tussock grasslands and coastal fringes including dunes islands and beaches.

Online databases identify the Northern Quoll to occur in the general area, but no records of this species were made in any of the surveys within or in the vicinity of the Project Area. Given the small areas of creek and rocky hill habitat, it is highly unlikely that the Project Area would contain a population. However, the DoE Species Profile and Threats Database (SPRAT) predicts their habitat to occur throughout the Project Area.

#### **Greater Bilby (*Macrotis lagotis*)**

The Greater Bilby is listed as Vulnerable under the EPBC Act, on Schedule 1 under the WC Act and as Vulnerable by the IUCN due to range reduction; it now occupies less than 20% of its original range (Southgate 1990a), inhabiting arid and semi-arid regions throughout most of the Australian mainland in disjunct populations (Johnson 2008). The Greater Bilby utilises a variety of habitats, usually on landforms with level to slow slope



topography and light to medium soils (Worthington Wilmer et al. 1999). Three major vegetation types associated with the Greater Bilby are listed by Southgate (1990b) including: open tussock grassland on uplands and hills, Mulga woodland/ scrubland on ridges and rises, and hummock grassland in plains and alluvial areas. Other habitats used by the species include stony downs, cracking clays, desert Sand Plains and dune fields, spinifex grassland, and *Acacia* spp. scrublands on red earths (Johnson, 2008). Home ranges may be temporary, and there is some suggestion that Greater Bilbies are nomadic, following food availability (Johnson, 2008).

There are no recent records in the vicinity of the Project Area and no traces were found during any of the surveys, despite suitable habitat (Sand Plain) occurring in the Project Area and the surrounds. The nearest record is from the vicinity of Jiggalong nearly 65 km to the east. Given the lack of records in the vicinity (although suitable habitats are present in the general area), it is highly unlikely that the species occurs within the Project Area.

#### **Ghost Bat (*Macroderma gigas*)**

Ghost Bats are listed as a Priority 4 species under the DPaW Priority list and Vulnerable under the IUCN Red List. They formerly occurred over a wide area of central, northern and southern Australia but have declined significantly in the southern parts of their range in the last 200 years (van Dyck and Strahan, 2008). Within W.A., Ghost Bats are now confined to the Kimberley and Pilbara regions.

The distribution of Ghost Bats is influenced by the availability of suitable caves and mine adits for roost sites. The preferred roosting habitats of Ghost Bats in the Pilbara are deep, complex caves beneath bluffs of low rounded hills composed of Marra Mamba Iron Formation, Brockman Iron Formation, granite rock piles and abandoned mines (Armstrong and Anstee, 2000). Armstrong and Anstee (2000) noted that most caves used by Ghost Bats have narrow entrances (less than 0.5 m<sup>2</sup>) that open into larger chambers. Ghost Bats move between a number of caves seasonally, or as dictated by weather changes, and roost either individually or in colonies of up to 1500 (Churchill 2008). During breeding, female Ghost Bats congregate in maternity roosts, generally selecting very warm caves during pregnancy and lactation (Hutson et al. 2001).

This species has been recorded at the nearby Hashimoto area, ~4.2 km south-east of the Project Area (ecologia 2006). Several Ghost Bats were present at the Pilbara Leaf-nosed Bat roost in the mine adit (ecologia 2006). Nevertheless, Specialised Zoological





(2008) found no evidences for the existence of this species in the adit, thus Outback Ecology (2009) mentioned that the previous record could be erroneous. No suitable roost sites occur in the Project Area or its immediate vicinity though this species may utilise a foraging home range that extends over the Project Area.

#### **Pilbara Leaf-nosed Bat (*Rhinonictoris aurantia*)**

The Pilbara Leaf-nosed Bat is classified as Vulnerable under the EPBC Act and on Schedule 1 under the WC Act. This species requires warm (28 – 32 °C) and highly humid (96 – 100%) roost sites in caves and/ or mine shafts. This is a result of their limited ability to conserve heat and water (Armstrong 2001). Such caves are relatively uncommon in the Pilbara (Armstrong & Anstee 2000; Armstrong 2001), which limits the availability of diurnal roosts for this species. The few known roosts of this species are concentrated in mine shafts in the eastern Pilbara, and at Barlee Range Nature Reserve (Department of Environment 2010) which are thought to contain most of the region's population.

This species has been recorded at the nearby Hashimoto area, ~4.2 km south-east of the Project Area (ecologia 2006). Several individuals were recorded at the mine adit which is one of the south-eastern most roosts of this species in the Pilbara (ecologia 2006). Nevertheless, Specialised Zoological (2008) found no evidences for the existence of this species in the adit, thus Outback Ecology (2009) mentioned that the previous record could be erroneous. No suitable roost sites occur in the Project Area or its immediate vicinity though this species may utilise a foraging home range that extends over the Project Area.

### **4.6.2 Birds**

#### **Cattle Egret (*Ardea ibis*)**

Cattle Egrets are listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. It is a widespread and common species according to migration movements and surveys of breeding localities. Two major distributions have been located; from north-east Western Australia to the top end of the Northern Territory and around south-east Australia. In Western Australia and the Northern Territory, the Cattle Egret is located from Wyndham to Arnhem Land. The Cattle Egret utilises a variety of natural and anthropogenic habitats and occurs in tropical and temperate grasslands, inland wetlands, wooded lands and farm lands. It has also been seen in arid and semi-arid



regions; however this is extremely rare. This species has a symbiotic relationship with grazers.

Online databases identified this species as likely to occur in the area. This species could occur within the Project Area as a foraging visitor or a temporary resident during the wet season when temporary water pools provide suitable habitat.

#### **Eastern Great Egret (*Ardea modesta*)**

The Eastern Great Egret is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. This species is described as dispersive and migratory in parts of its range (DEWHA, 2010d), with some regular seasonal movements. Non-breeding birds have been recorded across most of Australia, but avoid the driest regions of the western and central deserts (Marchant & Higgins 1993). Favoured breeding habitat relevant to the Project Area includes wooded swamps and river pools with *Eucalyptus camaldulensis* and *Melaleuca argentea* (Johnstone & Storr 1998). During the wet season and after heavy rain, however, egrets could be attracted to temporary pools throughout the Project Area, including man-made water bodies.

Online databases identified this species as likely to occur in the area. This species could occur within the Project Area as a foraging visitor or a temporary resident during the wet season when temporary water pools provide suitable habitats.

#### **Oriental Plover (*Charadrius veredus*)**

The Oriental Plover is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. It is a non-breeding visitor to Australia, where it occurs in both coastal and inland areas. Along the coast the Oriental Plover inhabits estuarine mudflats, beaches and near coastal grasslands. Inland it occurs in flat, open, semi-arid or arid grasslands (DEWHA, 2010). On migration to Northern Australia (September – November), Oriental Plovers gather in flocks on open, thinly vegetated, grassland plains (Morcombe 2004).

Online databases identified this species as likely to occur in the area. There are few records of the Oriental Plover in the Pilbara (Johnston et al. 2013) and it is possible that this species may be an infrequent transient visitor to the Project Area.

#### **Common Sandpiper (*Actitis hypoleucos*)**

The Common Sandpiper breeds across most of temperate and subtropical Europe and Asia, and migrates to Africa, southern Asia and Australia in winter. In Australia, this species is mainly found in muddy edges or rocky shores in coastal or inland wetlands. During the breeding season in the northern hemisphere, it prefers freshwater lakes and



shallow rivers. It is a gregarious bird and is usually seen in large flocks. No large water bodies are found in the vicinity of the Project Area; the nearest being the Ophthalmia Dam 14 km to the north-west. However, small water bodies may occur along Minor Drainage Lines and at overflowing bores (such as the Painkiller Bore within the Project Area).

A single individual was recorded immediately east of the Project Area at OB18 (ENV 2007a). This species is unlikely to utilise the Project Area to any great extent due to lack of suitable habitats, but may occasionally occur on a transient basis within the Project Area.

#### **Star Finch (western subspecies) (*Neochmia ruficauda subclaescens*)**

The 'western' population of the Star Finch (western subspecies) is considered by the DPaW to represent a separate subspecies (*N. r. subclaescens*), distinct from Kimberley and Northern Territory birds (*N. r. clarescens*). These birds are generally uncommon and patchily distributed in the Pilbara and are listed as Priority 4 by the DPaW and as Near Threatened by the IUCN. The Star Finch prefers areas of dense vegetation, such as reedbeds (Johnstone and Storr 2008) and woodlands near water (Armstrong & Anstee 2000).

This species was recorded near the Ophthalmia Dam (~17 km west), and in Mulga south of the Project Area (Outback Ecology Services 2009a). Suitable habitat for this species may be available at the Minor Drainage Lines in the Project Area.

### **4.6.3 Reptiles**

#### **Pilbara Olive Python (*Liasis olivaceus barroni*)**

The Pilbara Olive Python is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act. This species is primarily nocturnal and tends to shelter in small caves or under vegetation during the day, although it is occasionally active after sunrise, particularly in the warmer summer months (DSEWPaC 2011a). The Pilbara Olive Python is known from a number of sites throughout the Pilbara and is associated with drainage systems, including areas with localised drainage and semi-permanent watercourses (DSEWPaC 2011a). In the Hamersley subregion, the Pilbara Olive Python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (Pearson 1993); DSEWPaC 2011a).

This species occurs throughout the Pilbara (Bush & Maryan 2011) and was also recorded at OB19, ~8 km west of the Project Area (Biologic 2013b). At OB19, an





individual was found in a rock pool within the Gorge/ Gully habitat in the western side of the Project Area and scat of this species was observed in a cave close-by. Another individual was recorded ~500 m south from this location within the same Gorge/ Gully habitat during a field visit (Paul Taylor, pers. comm.). During night sampling at OB19 in December 2013, two individuals each were found at two water holes at Gorge/ Gully habitats in the northern section of the Project Area. It is noteworthy that these were among the only water bodies left in the area at the time of sampling. During the same period of time, nocturnal searches were done in prospective habitats at OB31 but no individuals were recorded. It is possibly due to the lack of water holes within OB31 during the peak of the dry season. It is likely that individuals (if present) either aestivate or move to other prospective areas during the dry season. However, suitable habitat for this species occurs within the Gorge/ Gully and Minor Drainage Line habitats within the Project Area and individuals may occupy these during the wet season.

#### **Pilbara Flat-headed Blindsnake (*Ramphotyphlops ganei*)**

The Pilbara Flat-headed Blindsnake *Ramphotyphlops ganei* is listed as Priority 1 by the DPaW and is endemic to the Pilbara. Given its cryptic fossorial habit, this species is rarely encountered. Little is known of this species' ecology but like most other blind snakes, it is insectivorous, feeding on termites and their eggs, and larvae and pupae of ants (Wilson & Swan 2010). *Ramphotyphlops ganei* is associated with moist gorges and gullies (Wilson & Swan 2010), and potentially with a wide range of other stony habitats.

Two individuals were caught in funnel traps within the central section of OB19, ~4.3 km west (Biologic 2013b), and rocky hilltops at OB18, ~0.5 km north-west (ENV 2007; S. Callen, pers. obs.). It has been also recorded within Alluvial Plain habitat at Jimblebar, south of the Project Area, ~3 km south (Outback Ecology 2009). Suitable habitat for this species is present in the Crest/ Slope and Gorge/ Gully habitats within the Project Area.



**Table 4.5** Conservation significant fauna potentially occurring in the Project Area.

Species	Conservation Significance	Preferred Habitat	Extent of the habitat in the Project Area	Likelihood
Northern Quoll <i>Dasyurus hallucatus</i>	EPBC Act: Endangered WC Act: Schedule 1 IUCN Endangered	Northern Quolls favour rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, Major Drainage Lines and treed creek lines, as well as structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs (DSEWPac 2011a).	The Project Area does not contain any Major Drainage Lines or substantial Gorge/ Gully habitats that would be suitable habitats for the Northern Quoll. However, the small Gorge/ Gully habitat in the south-east contain breakaways and mesas that would provide foraging and suboptimal denning habitat. The Minor Drainage Lines may provide transient habitats.	Unlikely- very little optimal habitat present and at the southern extent of the species' range.
Greater Bilby <i>Macrotis lagotis</i>	EPBC Act: Vulnerable WC Act: Schedule 1	Greater Bilbies prefer landforms with level to low slope topography and light to medium soils. Habitats include open tussock grassland on uplands and hills, Mulga woodland/ scrubland on ridges and rises and hummock grassland in plains and alluvial areas. Other habitats used by the species include stony downs, cracking clays, desert Sand Plains and dune fields, spinifex grassland and Acacia spp. scrublands on red earths (Southgate 1990a; Johnson 2008).	Sand Plains, Stony Plains and Mulga / Acacia woodlands are all potential habitat. These habitats are widespread in the region.	Unlikely- this is at the southern end of the species' range.
Pilbara Leaf-nosed Bat <i>Rhinonictis aurantius</i>	EPBC Act: Vulnerable WC Act: Schedule 1	This species requires warm (28–32 °C) and highly humid (96–100%) roost sites in caves and/or mine shafts. This is a result of their limited ability to conserve heat and water (Armstrong 2001).	No suitable roosting caves exist within the Project Area and this species has not been recorded in the immediate vicinity.	Unlikely- no known roost sites suitable for this species in the vicinity.
Ghost Bat <i>Macroderma gigas</i>	DPaW: Priority 4	Roosts in deep complex caves beneath bluffs of low rounded hills, granite rock piles and abandoned mines (Armstrong and Anstee, 2000).	No suitable roosting caves exist within the Project Area and this species has not been recorded in the immediate vicinity.	Unlikely- no known roost sites suitable for this species in the vicinity.
Cattle Egret <i>Bubulcus ibis</i>	EPBC Act: Migratory WC Act: Schedule 3	Prefers inundated grasslands and wetlands and occasionally use swamps with tall emergent vegetation, e.g. Typha sp. or wooded swamps (Johnstone & Storr 1998).	Preferred habitat of inundated grasslands and wetlands for this species are uncommon in the surrounding region. The nearest major water body is Ophthalmia Dam ~20 km west of the Project Area.	Unlikely- suitable habitat not present.
Eastern Great Egret <i>Ardea modesta</i>	EPBC Act: Migratory WC Act: Schedule 3	This species occurs in shallows of rivers and freshwater wetlands, breeding in wooded swamps and river pools with Eucalyptus camaldulensis and Melaleuca argentea (Johnstone & Storr 1998).	The drainage lines across the Project Area do not have suitable pools or wooded swamps.	Unlikely- suitable habitat not present.
Oriental Plover <i>Charadrius veredus</i>	EPBC Act: Migratory WC Act: Schedule 3	Inhabits dry grassland and thinly vegetated plains with much hard bare ground in inland. This includes areas that have been recently burnt, and areas of hard, stony, bare ground (Johnstone & Storr 1998).	The sparsely-vegetated open Stony Plains in the Project Area are marginally suitable for this species. Such habitat is widespread within the Chichester sub region.	Possible- marginally suitable habitat present, and there is a single record within 30 km in the DPaW Threatened Species Database
Common Sandpiper <i>Actitis hypoleucos</i>	EPBC Act: Migratory WC Act: Schedule 3	Mainly found in muddy edges or rocky shores in coastal or inland wetlands (Johnstone & Storr 1998).	No large water bodies are found in the vicinity of the Project Area; however small water pools may occur along drainage lines after rain.	Unlikely- suitable habitat not present. However, a single individual was recorded immediately east of the Project Area at OB18 (ENV 2007).
Star Finch (western subspecies) <i>Neochmia ruficauda subclarescens</i>	DPaW: Priority 4 IUCN: Near Threatened	Prefers areas of dense vegetation, such as reed beds and woodlands near water (Johnstone 2008).	The preferred habitat is not present within the Project Area.	Unlikely- suitable habitat not present. Recorded near Ophthalmia Dam, and in mulga to the south-west of the Project Area (Outback Ecology Services 2009a).
Pilbara Olive Python <i>Liasis olivaceus</i>	EPBC Act: Vulnerable WC Act:	Associated with drainage systems, including areas with localised drainage and semi-permanent watercourses (Bush & Maryan 2011).	Suboptimal habitat occurs within gorges and drainage lines but permanent rock pools are extremely rare or do not exist in the Project Area.	Unlikely but possible- suitable habitat very limited but suboptimal habitat present within Gorge/ Gully habitats.



Species	Conservation Significance	Preferred Habitat	Extent of the habitat in the Project Area	Likelihood
<i>barroni</i>	Schedule 1			
Pilbara Flat-headed Blindsnake <i>Ramphotyphlops</i> <i>ganei</i>	DPaW: Priority 4	Associated with moist gorges and gullies (Wilson & Swan 2010) and potentially with a wide range of other stony habitats. Recently found on an alluvial plain north of Ophthalmia dam (Outback Ecology Services 2009a) and on hillside in OB17 (Biologic unpublished).	As this species can apparently live in a range of habitats from alluvial plains to hillsides, its range may potentially include the Project Area and vicinity.	Likely- Suitable habitat occurs within the Crest/ Slope as well as Gorge/ Gully habitats.





#### 4.7 Important Fauna Habitats

The expected faunal richness in an area is proportional to the amount of habitat variation and floristic diversity, since both of these factors influence the number of different habitats available for fauna. Accordingly, an area with high variation of habitat types is likely to harbour a higher diversity of fauna and *vice versa*. The Project Area has relatively low habitat diversity with five different habitats described.

Each of the fauna habitats identified in Section 4.3 was given a significance score of High, Medium or Low based on criteria outlined in Table 3.3. Sand Plains and Gorge/Gully habitats were considered to be of High significance because they are most likely to support or provide areas of core habitat for a number of conservation significant species (Table 4.6). The important fauna habitats within the Project Area are shown on Figure 4.8.

**Table 4.6** Fauna habitats with significance scores

Fauna habitat	Score	Rationale
Sand Plain	High	Brush-tailed Mulgara was recorded in this habitat and it could provide potential habitat for the Greater Bilby. Sand Plains are also used extensively by Australian Bustard.
Crest/slope	Low	Western Pebble-mound Mouse is largely restricted to this habitat type within the Project Area. The Pilbara Flat-headed Blindsnake also could occur in this habitat type, but is not restricted to it. This habitat is common in the region.
Gorge/ Gully	High	Gorge/Gully habitat could, albeit unlikely, provide potential breeding, shelter and foraging sites for Pilbara Olive Python, Northern Quoll, and possibly Pilbara Leaf-nosed Bat. They could also provide temporary roosts, foraging habitat and transitional habitats for bats such as the Ghost Bat. Gorge/Gully areas provide habitat for the Pilbara Flat-headed Blindsnake and Rainbow Bee-eater, although neither of these species is restricted to this habitat type. Furthermore gorges and gullies could be daytime retreats for other larger mammals and reptiles.
Minor Drainage Lines	Medium	Drainage Lines have the potential to provide habitat for a number of conservation significant fauna, such as the Australian Bustard, but these species are not restricted to this habitat type. Pilbara Olive Python is likely to utilise Drainage Lines transiently, as corridors during dispersal. Drainage Lines may be used by Rainbow Bee-eater as well, but this species is widespread and not restricted to this habitat type.



Fauna habitat	Score	Rationale
Drainage Area	Medium	Drainage Areas have the potential to provide habitat for a number of conservation significant fauna, such as the Pilbara Flat-headed Blindsnake and Australian Bustard, but these species are not restricted to this habitat type. Pilbara Olive Python is likely to utilise Drainage Areas transiently, as corridors during dispersal. Drainage Areas may be used by Rainbow Bee-eater as well, but this species is widespread and not restricted to this habitat type.

#### 4.8 Threatened and Priority Ecological Communities

None of the vegetation associations present within the Project Area are considered to be Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). Possible TECs that do not meet survey criteria, or that are not adequately defined, are classified as PECs (DEC 2012). The closest PEC, Fortescue Valley Sand Dunes, is ~47 km to the north-west of the Project Area.

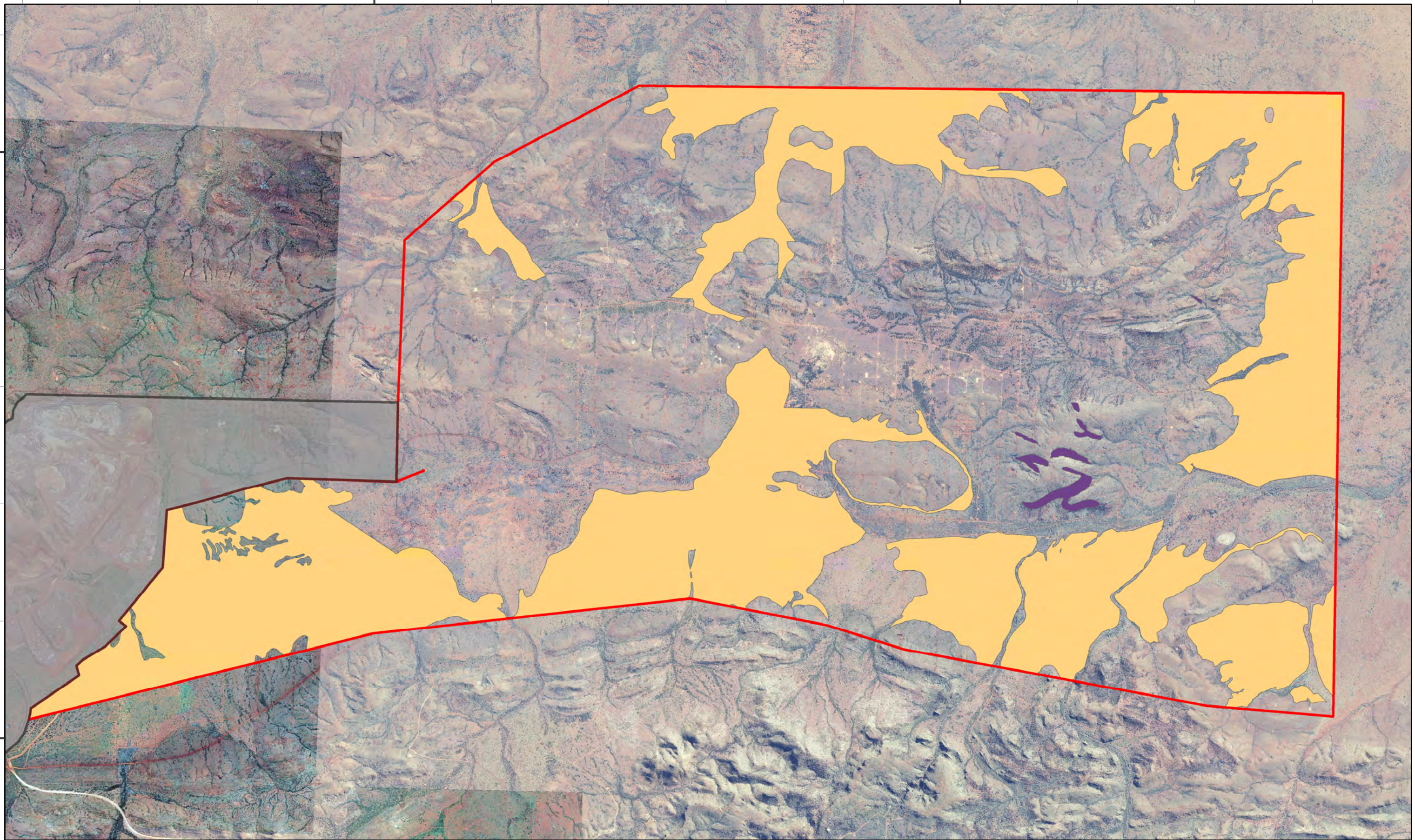


815000

820000

742000

7415000



## Legend

OB31 Indicative Disturbance

Existing OB18 Part IV area

### Habitat

Gorge / Gully

Sand Plain

1:30,000

0 0.275 0.55 1.1 1.65 km

N

biologic 

## BHP Billiton Iron Ore Orebody 31 Project

### Fig. 4.8: Conservation Significant Fauna Habitats

Created 17/04/2014

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994





## 5 EVALUATION OF POTENTIAL IMPACTS AND MITIGATION MEASURES

The EPA's Guidance Statement 56 (EPA, 2004) recommends fauna assessments report on potential impacts and options to minimize impacts. The potential impacts are discussed below, in order. The assessment of potential impacts is for the complete disturbance area as a whole, although some sections within the area may not be cleared.

### 5.1 Direct impacts

#### 5.1.1 Loss of habitat

The proposed development will result in the removal of native vegetation, rocks and soil. Vegetation clearing to accommodate development is the direct factor most likely to impact native fauna as it causes direct alteration of the land surface, rendering it unsuitable as habitat for most species. Loss of individual fauna will inevitably occur through this exposure to altered unfavourable microclimatic conditions. Vegetation clearing may destroy nests and burrows that are currently in use, and also reduce the foraging areas available to animals, potentially forcing them into adjacent areas. This flux of excess animals may push densities over the carrying capacity in adjoining areas, creating higher competition for resources which may result in territorial stress in some species. Loss of habitat may also result indirectly by a reduction in habitat quality arising from habitat fragmentation, edge effects and facilitation of weed and feral predator invasions.

The maximum disturbance boundary of the development is 4054.64 ha. Relative to the total areas of the IBRA subregions in the Pilbara, this area amounts to less than 0.2 % of the area of each subregion (Table 5.1).

**Table 5.1** The areas of the disturbance in the two IBRA sub-regions.

IBRA Sub-region	Total extent (ha)	Area within the disturbances (ha)			
		Indicative Infrastructure Corridor Area		Indicative Mine Disturbance Area	
		ha	%	ha	%
PIL02, Fortescue	1,953,621.04	479.94	0.024	3300.32	0.17
PIL03, Hamersley	1,861,724.88	274.58	0.015	0	0

The area to be cleared for the project is located on four land systems (van Vreeswyk et al. 2004). Table 5.2 shows the area and percentage of each land system that will be impacted by clearing.



**Table 5.2** The areas of the disturbance within the four land systems.

Land System	Total extent in Pilbara (ha)	Area within the disturbances			
		Indicative Infrastructure Corridor Area		Indicative Mine Disturbance Area	
		ha	%	ha	%
BGD, Boolgeeda	826,416.12	541.44	0.066	1144.41	0.138
NEW, Newman	1,458,027.91	8.86	0.001	1982.75	0.136
WSP, Washplain	91,700.00	187.86	0.205	154.37	0.168
MCK, McKay	420,494.15	16.17	0.004	18.78	0.004

The maximum disturbance area contains less than 0.4 % of any one land system's total extent in the Pilbara. In terms of overall area, no land systems are being heavily impacted by the proposed disturbance. Land systems are defined in terms of recurring patterns of component parts in geographical, geological, botanical and ecological terms. Fauna habitats are therefore related to the land system classification, albeit not exactly. As such, the analysis of the land systems affected by the proposed project does allow the impacts on fauna habitat to be placed in the overall context of the Pilbara region.

Some habitats that are of high importance (due to their limited availability (e.g. Gorge/ Gully) or their ability to support a higher diversity of species, including those with conservation significance (e.g. Sand Plains, Crest/ Slope)) will be disturbed during the proposed development. However, none of these habitats are restricted to the Project Area or its vicinity and are widespread in the region (Gorge/ Gully and Crest/ Slope) or the desert areas of central Australia (Sand Plains). . The total area of each fauna habitat type within Project Area is given in Table 5.3.

**Table 5.3** The extent of fauna habitats within the Project Area

Fauna habitat	Indicative Infrastructure Corridor Area (ha)	Indicative Mine Disturbance Area (ha)
Crest/Slope	21.13	1889.88
Sand Plain	514.70	967.28
Minor Drainage Line	16.18	156.95
Drainage Area	202.55	273.63
Gorge/ Gully	0	13.88

Up to 1481 ha of Sand Plains (high importance), that is known habitat of Mulgara and potential habitat of Greater Bilby, is potentially subject to clearing. There is a high possibility of direct mortality of Mulgara where individuals may be killed during clearing as they will remain in their burrows (see 4.2.2). However, due to the



relatively small size of the Project Area (in a regional context), this will only have a minor direct impact on Mulgara and (potentially) Greater Bilby and this can be reduced further through mitigation measures. Any Mulgara displaced during clearing are likely to move into the continuous stretches of Sand Plain in the surrounding areas. Habitat fragmentation and barriers to movement are discussed in Section 5.2.1.

Crest/ Slope and Drainage Areas (both habitats considered as potential habitat for conservation significant species such as Western Pebble-mound Mouse, Australian Bustard and Pilbara Flat-headed Blindsnake etc.) also comprise substantial extents within the Project Area (1910 ha and 475 ha, respectively) and anticipated to be subject to clearing. The rock outcrops scattered among the Crest/ Slope habitats could be important from a fauna perspective as they could potentially provide denning and foraging habitat for species such as the Northern Quoll, although this species is unlikely to actually occur in the Project Area. However, Rock Outcrops are not extensively located within the Project Area and resident animals (if any) could move to adjoining areas.

Gorge/ Gully and Minor Drainage Line habitats provide important nesting and foraging as well as transitional habitats for fauna. Given the linear nature of these habitats, the spatial coverage is comparatively small. Pilbara Olive Pythons are likely to use these habitats but no records of this species have been made within the Project Area despite extensive nocturnal searches. Pilbara Olive Pythons use similar habitats to the Northern Quoll so will benefit from management measures implemented for this species.

No roosts of Pilbara Leaf-nosed Bats or Ghost Bats have been located in the Project to date; however, both species may forage within the area. The loss of foraging habitats will be relatively small, and therefore bats will not need to travel much further to compensate for this loss of resource.

The impact of the proposed development on significant species through habitat loss is low and localised, and is not expected to alter the conservation status of any species. Habitats of high and medium value that are planned to be cleared are also present outside of the Project Area and are reasonably widespread in the general area and in the region.





### **5.1.2 Direct mortality during clearing**

Direct mortality of the larger mobile and diurnal species is likely to be minimal as they are able to move away from disturbances. Nesting birds and their young and small mammals, reptiles and frogs are the exception. Mobile species will be forced into surrounding areas which will then impact on resident species due to direct competition for resources (shelter and food).

Fossorial species, smaller less mobile species and nocturnal species that are in refuges during the day time (and hence will be inactive when most of the land clearing and construction work is taking place) are highly likely to be directly impacted during clearing, either by being buried alive, squashed or injured in their burrows, or killed or injured when attempting to escape.

### **5.1.3 Fauna entrapment**

Trenches, drains, borrow pits, turkey nests and storage containers have the potential to trap animals, particularly if they are steep-sided and contain water. This is a significant issue where trenching (or any form of digging that creates a hole) is being undertaken. Fauna of all sizes can become trapped in construction of trenches and significant effort is required in managing the trenching operations. Provided management measures are in place, such as physical barriers and egress points (e.g. open-ended drains), the potential impact to fauna is considered to be minimal.

Species such as Northern Quolls are able to climb in to rubbish bins or water tanks and become trapped. Measures must be undertaken to prevent access.

### **5.1.4 Vehicle strike**

Roadkill on access tracks has the potential to decrease the abundance of vertebrate fauna species at a local level, including conservation significant fauna species such as the Australian Bustard and Bush Stone Curlew. Road mortality is of particular concern for nocturnal species foraging or travelling near roads at night and species that tend to be active on roads (e.g. basking, foraging) during daytime. Roadkill also attracts scavengers, including birds of prey, which may themselves become victims of vehicle accidents. As most of the vertebrate fauna potentially affected by vehicle movement are well represented throughout the surrounding area and Pilbara region, the loss of individuals due to increased vehicle activity is expected to have a minimal impact on the abundance and conservation status of most local fauna populations. Management of vehicles within habitat for conservation significant fauna, or where



conservation significant species have been recorded needs to be implemented as vehicle strike mortality can have significant impacts on these species at a local scale.



## 5.2 Indirect impacts

### 5.2.1 Habitat fragmentation and barriers to movement

BHP Billiton Iron Ore operates several other mine sites around the Project Area including Newman orebodies in the west and Jimblebar operation in the south. The current project adds another disturbance to an already highly disturbed area in a local context. This may cause further local disruption of movement patterns or division of populations. This applies mainly to the ground-dwelling fauna but may also impact upon bat species if they are unwilling to fly across large cleared areas while foraging. Inevitably, there would be some level of habitat isolation which could reduce gene flow between populations and sub-populations. Populations in fragmented habitats are expected to become differentiated due to founder effects, genetic drift and increased inbreeding. A reduction in population size due to habitat fragmentation may result in loss of allelic richness, gene diversity and exacerbate local extinctions (Lande 1999).

Species most likely to experience such isolation would be those inhabiting continuous stretches of habitat such as Sand Plains and Crest/ Slope. Those in patchy habitats such as Minor Drainage Lines would only be impacted if clearing traverses the particular habitat patch. The risk of roadkill, with many kilometers of tracks and supporting infrastructure, could be substantial and is not limited to wildlife but also to livestock.

Clearing for infrastructure could increase edge effects on the adjacent vegetation, such as weed invasion and decline in health from dust deposition. While this could negatively affect some species, others such as introduced predators could benefit from increased habitat edges (Goosem 2000). An increase in habitat edges can cause altered levels of predation, restricting or increasing fauna movements and altering assemblage structure (Goosem 2001), resulting in an impact area larger than the actual cleared footprint.

The Mulgara and Western Pebble-Mound Mice are the two conservation significant species that are likely to be impacted by habitat fragmentation. In a regional context, there may be local disruption of movement patterns, however it is unlikely to affect the conservation status of any species as these species are widespread and suitable patches of habitats are still available in the adjoining areas. Thus it is considered to be a minor impact to vertebrate fauna.





### 5.2.2 Habitat degradation

**Fire:** Fire is a natural process in the Pilbara that commonly arises through lightning strike, but human activities have the potential to increase the frequency of fires. An increase in vehicle traffic, machinery use and site-based personnel activity (e.g. track grinding) increases the risk of fire. This could impact terrestrial fauna directly through injury or death, or indirectly through loss of fauna habitats. Linear clearings such as roads and rail lines provide barriers to naturally occurring fires and may alter the natural fire regimes that the fauna have evolved to accommodate.

Certain habitats such as deeply incised Drainage Lines and Gorge/ Gully habitats as well as Rock Outcrops provide refuges from fire. Removal and structural changes to such habitat within the proposed development may remove a portion of the refuges available for the protection of fauna from fire. However, Drainage Lines are widespread locally, thus mobile fauna could seek refuge in new locations. The likelihood that vertebrate fauna will be impacted by increased frequency of fires is considered to be low-medium, provided that management measures to reduce the likelihood of project related fires are implemented.

**Dust:** Vegetation clearing and vehicle movements will result in an increase in airborne particulate matter. Dust can indirectly affect fauna by altering the structure and composition of native vegetation. Dust interferes with photosynthesis, respiration and transpiration and allows penetration of gaseous pollutants (Farmer 1993). Most plant communities can be adversely affected by dust deposition, resulting in alteration of plant community structure (Prajapati 2012). A decline in vegetation quality impacts faunal assemblages by reducing both food and habitat resources.

**Introduced species:** The introduction and spread of feral animals and weeds through increased human activity and disturbances could result in changes to the structure, species composition, fire frequency and abundance of native communities.

Introduced flora (weed) species may be spread as a result of ground disturbance, construction and ongoing activities in the proposed development. Weeds such as Buffel Grass (*Cenchrus ciliaris*) are established in some parts of the proposed development as a result of pastoral land uses and these weeds have replaced spinifex hummock grasslands in several parts of the Pilbara. While the impact of weeds on fauna has generally been neglected (Adair 1995), they can significantly alter the vegetation of a fauna habitat where infestations occur, resulting in significant



declines to species richness or diversity of local fauna (Adair and Groves 1998). Mosaic habitats such as Drainage Lines are particularly susceptible to weed invasion.

Introduced species may impact native fauna through a range of factors including predation, competition for food and shelter, habitat destruction and the spread of diseases. Because of the pastoral history of the proposed development and surroundings, European Cattle (*\*Bos taurus*) are prevalent and have caused habitat degradation in some areas of the Project Area. The presence of cats may cause significant impacts to small and moderately-sized mammals and reptiles (Dickman 1996), while feral dogs also contribute to predation pressure on native animals within the proposed development. The House Mouse (*\*Mus musculus*) may compete with local species for food. Cane Toads (*\*Rhinella marina*) are not yet known from the Pilbara but may eventually reach the region through natural migration.

**Alteration of hydrology:** Interruptions of hydro-ecological processes can have significant effects because they underpin primary production in ecosystems and there are specific habitats that are hydrology-dependent. The creeks in the Project Area are dry outside of seasonal rainfall events. Assuming a final pit depth of about 351 m RL, then a significant portion (~80%) of the orebody is below the water table, thus significant amount of de-watering would be carried out. If the surplus water will be discharged at the surface, it could have significant impacts on nearby minor drainage lines and creeks. Changes to hydrology affects surface water-dependent vegetation communities (e.g. Mulga) and ephemeral pools (increasing water levels and duration of inundation).

Drainage lines provide potential habitat to several conservation significant species in the Pilbara (as foraging areas, nesting areas and temporary refuges) and the proposed development will potentially alter surface water flow in drainage lines by physically disrupting runoff volumes and quality.

The proposed project will include mining below the groundwater table, which will require pit dewatering. Groundwater would be drawn down at the point of extraction and the impact on the groundwater would radiate out from the source of the drawdown, forming a cone of depression. This may reduce water availability to vegetation dependent on groundwater and result in degradation of fauna habitat. The extent to which vegetation degradation may occur is dependent on the reliance of the plant species on water sources from the groundwater table. Onshore (2014)



only identified a Drainage Line in the south-east sector of the Project Area that supports a ground-water dependant Coolibah vegetation community to have a medium risk of impact from the Project. However, no faunal taxa are exclusively reliant on this habitat patch and none of the fauna habitats within the Project Area rely specifically on groundwater. There is therefore a low risk of impacts arising from alteration of hydrology.

Contamination of water by chemicals or hydrocarbons resulting from increasing usage of machinery or vehicles within the area has the potential to harm or kill fauna, and degrade fauna habitat. Additional sediment load of water runoff, caused by exposed soil, would also affect aquatic habitats.

### 5.2.3 Behavioural impacts

**Noise and vibrations:** Noise and vibration pollution associated with construction (e.g. blasting) and ongoing activity in the proposed development may result in local disturbance to fauna occupying adjacent areas. Responses to noise and variation vary between species and individuals according to characteristics of the noise and its duration, the life history characteristics of the species, habitat type, season, activity at the time of exposure, sex and age of the individual, level of previous exposure and whether other stresses are present at the time of exposure (Busnel and Fletcher 1978).

Impacts on fauna from noise and vibration associated with the proposed development are likely to be temporary during construction, but regular during operation. It is likely that initially fauna may move away from the area but, over time, some may become more accustomed to noise levels and relocate back to the area. No known bat roosts occur in the vicinity of the proposed development.

**Light:** Artificial light could disrupt navigation, cause barriers to movement, impact foraging activity, cause abandoning of roosts and nests and expose nocturnal animals to nocturnal predators (Rich and Longcore 2006). Light can also attract feral predators such as cats and dogs to areas, as they associate human activity with food resources. Conversely, it could increase foraging benefits to insectivorous reptiles and microbats by attracting insects and other nocturnal predators by exposing their prey. The lighting in the proposed development is unlikely to have significant effects on the fauna if lighting is directed away from any areas where conservation significant species are known to occur.





**Food and water:** Edible garbage and artificial water points around human habitations could attract both native and introduced animals. Apart from the physical threats (entangling in packing material, bottles and cans), animals could also be subjected to higher vulnerability to introduced predators (e.g. dingoes that are regularly commensal) and road accidents within human habitats. Conservation significant species such as Northern Quolls and Pilbara Olive Pythons could be victims of such threats if proper waste and water disposal measure are not implemented.



## **6 ASSESSMENT OF IMPACTS ON CONSERVATION SIGNIFICANT SPECIES**

For each of the significant species identified during biological surveys, potential impacting processes and outcomes (where applicable) are summarised in Table 6.1 and are discussed in terms of their local (Project Area) and regional (wider area) scale.



**Table 6.1** Impacts to conservation-significant fauna

Species and status	Potential impacting processes	Potential outcomes
<b>Species recorded in the Project Area</b>		
Western Pebble-mound Mouse <i>Pseudomys chapmani</i> DPaW Priority 4	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Competition from introduced grazers</li> <li>• Predation by introduced predators</li> <li>• Light and noise</li> <li>• Entrapment</li> </ul>	<ul style="list-style-type: none"> <li>• Pebble-mound Mice are common within suitable habitat (Crest/ Slope), and this habitat is widespread and common within the Pilbara region. Clearing of habitat may remove local populations but this is unlikely to have an impact on this species as a whole. Clearing for roads is unlikely to cause a barrier to movement. Small rodents are known to use culverts, so it is possible that these will mitigate these impacts.</li> <li>• Feral animals may increase with an increased availability of food (i.e. putrescible waste) and water resources. These will then place increased predation and competition pressure on the mice.</li> <li>• Noise and light may impact animals residing close to disturbance areas, although active mounds have been observed adjacent to exploration camps (M. O'Connell, pers. obs.) so it is likely that these impacts are low to negligible.</li> </ul>
Mulgara <i>Dasycercus</i> sp. EPBC Act: Vulnerable WC Act: Schedule 1	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Predation by introduced predators</li> <li>• Vehicle strike</li> <li>• Light and noise</li> <li>• Entrapment</li> </ul>	<ul style="list-style-type: none"> <li>• The Sand Plain areas provide suitable habitat for Mulgara. At a regional level, Sand Plains are widespread and continuous, extending extensively into the desert regions east of the Pilbara. It is considered therefore that at a regional level, any impacts to this species are likely to be low.</li> <li>• Where Mulgara occur in the Project Area they can be locally very common, and therefore clearing in these areas can have a significant impact at a local level. Populations within the Project Area are scattered with clusters occurring in suitable habitat. Isolation of populations, with potential barriers to gene flow, is a potential threat to this species arising from linear projects, although Mulgara are known to cross roads and use culverts (Biologic 2012).</li> <li>• Although the proposed project is unlikely to introduce any new species of predator, predator numbers may increase in areas surrounding camps or infrastructure where increased food and water resources are available. Degradation of habitat from fire or dust may make Mulgara more vulnerable to predation, or force them to move to new areas if it impacts on their prey species.</li> </ul>
Australian Bustard <i>Ardeotis australis</i> DPaW Priority 4 IUCN: Near Threatened	<ul style="list-style-type: none"> <li>• Clearing of habitat</li> <li>• Predation by introduced predators</li> <li>• Vehicle strike</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable habitat for the Australian Bustard is widespread and common within the Project Area and regionally. This species is highly mobile and can easily move away from disturbances.</li> <li>• This species may be subject to additional predation if predator numbers increase. Bustards feed on roads and are often killed by vehicle strike.</li> </ul>





Species and status	Potential impacting processes	Potential outcomes
Bush Stone-curlew <i>Burhinus grallarius</i> DPaW Priority 4 IUCN: Near Threatened	<ul style="list-style-type: none"> <li>• Clearing of habitat</li> <li>• Predation by introduced predators</li> <li>• Vehicle strike</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable habitat for Bush Stone-curlews is present within the Project Area but is also very common in surrounding areas and the region. It is also a highly mobile species that can easily move away from disturbances. This species may be subject to additional predation if predator numbers increase. Bush Stone-curlews can be attracted to roads and may be killed by vehicle strike.</li> </ul>
Rainbow Bee-eater <i>Merops ornatus</i> EPBC Act: Migratory	<ul style="list-style-type: none"> <li>• Clearing of habitat</li> <li>• Predation by introduced predators</li> </ul>	<ul style="list-style-type: none"> <li>• Rainbow Bee-eaters may utilise all habitats within the proposed development and surroundings and are widespread and common in the region (Birds Australia, 2011). They are a highly mobile species that can easily move away from disturbances, although nesting habitat may be cleared in riparian areas. This species may be subject to additional predation if predator numbers increase.</li> </ul>
Fork-tailed Swift <i>Apus pacificus</i> EPBC Act: Migratory WC Act Schedule 3	<ul style="list-style-type: none"> <li>• None anticipated</li> </ul>	<ul style="list-style-type: none"> <li>• Fork-tailed Swifts will not be affected from the proposed disturbance areas as they are entirely aerial summer visitors to the region.</li> </ul>
<b>Species recorded in the vicinity and those that potentially occur in the area</b>		
Ghost Bat <i>Macroderma gigas</i> DPaW Priority 4	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Light</li> <li>• Vehicle strike</li> <li>• Entrapment</li> </ul>	<ul style="list-style-type: none"> <li>• The proposed development does not contain any known Ghost Bat roosts; however they may roost in Rock Outcrops within Crest/ Slope habitats. It is also possible that the area is used for foraging. Clearing of habitat may reduce the area available for foraging; however as Ghost bats forage over a large area (&gt;60 ha each night: Tidemann et al. 1985) this is unlikely to have a local impact on this species.</li> <li>• Little is known about the impact of lights on Ghost Bats. They are likely to forage around light sources as they attract potential prey which may benefit the bats, but very strong light sources may confuse or blind them. Ghost Bats are known to get entangled in barbed wire due to the low elevation flying pattern (Armstrong and Anstee 2000).</li> </ul>



Species and status	Potential impacting processes	Potential outcomes
Northern Quoll <i>Dasyurus hallucatus</i> EPBC Act: Endangered WC Act: Schedule 1 IUCN: Endangered	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Competition with and predation by introduced predators</li> <li>• Vehicle strike</li> <li>• Entrapment</li> </ul>	<ul style="list-style-type: none"> <li>• Denning habitat could occur within Gorge/ Gully and Rock Outcrops within the Crest/ Slope habitats. Clearing of these habitats may remove denning and foraging habitat.</li> <li>• Areas of very rocky habitat with little vegetation cover is likely to be resilient to fire and dust impacts; however these can reduce the availability of foraging habitat forcing quolls to increase their home range (and possibly overlapping with other animals) or move to new areas (where they will compete with or displace resident animals).</li> <li>• Feral animals may increase with an increased availability of food (i.e. putrescible waste) and water resources. These will then place increased pressure on resident quolls (if any).</li> <li>• Northern Quolls are known to cross roads and rail lines and this can lead to vehicle strike and mortality.</li> <li>• Northern Quolls are curious and are known to scavenge around camps and other areas of human activity. They can become trapped in rubbish containers or water tanks where they will perish.</li> </ul>
Greater Bilby <i>Macrotis lagotis</i> EPBC Act: Vulnerable WC Act: Schedule 1	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Competition from introduced grazers</li> <li>• Predation by introduced predators</li> <li>• Entrapment</li> <li>• Vehicle strike</li> </ul>	<ul style="list-style-type: none"> <li>• The Sand Plain areas could provide suitable habitat for the Greater Bilby, but there are no recent records in the vicinity of the Project Area. The nearest record is from the vicinity of Jiggalong nearly 65 km to the east. Given the lack of records in the vicinity (although suitable habitats are present in the general area), it is highly unlikely that the species occurs within the Project Area, thus be impacted.</li> </ul>
Pilbara Leaf-nosed Bat <i>Rhinioncteris aurantia</i>	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Light</li> <li>• Vehicle strike</li> </ul>	<ul style="list-style-type: none"> <li>• No roosts have been recorded within the Project Area and it is unlikely to roost in any of the habitats within the Project Area. However, they may forage within the area, especially when surface water is available. Loss or changes to surface water could impact their behaviour in the area resulting in a decline of local populations.</li> <li>• Little is known about the impact of lights on the Pilbara Leaf-nosed Bat; however as they are insectivorous they may possibly forage around light sources which could increase their susceptibility to predation by nocturnal birds (owls).</li> <li>• Pilbara Leaf-nosed Bats can be struck and killed by vehicles.</li> </ul>
Migratory and Marine waders	<ul style="list-style-type: none"> <li>• None anticipated</li> </ul>	<ul style="list-style-type: none"> <li>• These species generally don't occur within the habitats present within the Project Area. Some species may use the area occasionally, but are unlikely to be impacted by the project.</li> </ul>



Species and status	Potential impacting processes	Potential outcomes
Star Finch (western ssp.) <i>Neochmia ruficauda subclarescens</i> DPaW: Priority 4	<ul style="list-style-type: none"> <li>• Clearing of habitat</li> <li>• Altered surface hydrology affecting breeding habitat</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable habitat for this species may be available at the Minor Drainage Lines in the Project Area. However no permanent water pools were recorded within the Project Area, thus it is unlikely that this species would utilize the Project Area on a permanent basis. Hence, there are minimal impacts on the species anticipated from the development.</li> </ul>
Pilbara Olive Python <i>Liasis olivaceus barroni</i> EPBC Act: Vulnerable WC Act: Schedule 1	<ul style="list-style-type: none"> <li>• Vegetation clearing</li> <li>• Alteration of habitat by fire, dust or weeds</li> <li>• Competition with and predation by introduced species</li> <li>• Vehicle strike</li> <li>• Entrapment</li> </ul>	<ul style="list-style-type: none"> <li>• It is considered unlikely, but possible, that Pilbara Olive Pythons may occur in the Project Area. Any individuals present will preferentially use the Drainage Line habitats which are likely to be impacted, and rock pools, which are used for shelter and hunting, may be lost. As no permanent water pools were recorded during the surveys the impact on this species through habitat destruction is considered to be minimal.</li> <li>• Pilbara Olive Pythons may disperse across roads but drains and pits will represent barriers to movement. There is also a high likelihood of roadkill.</li> </ul>
Pilbara Flat-headed Blindsnake <i>Ramphotyphlops ganei</i> DPaW Priority 1	<ul style="list-style-type: none"> <li>• Loss of individuals through clearing</li> <li>• Habitat change through weeds, fire, altered surface hydrology and dust deposition</li> <li>• Barriers to dispersal</li> </ul>	<ul style="list-style-type: none"> <li>• This species is likely to occur in the Project Area and individuals are likely to be impacted by clearing activities within the proposed disturbance areas. Additional possible impacts may occur if the fauna habitats in which the species occurs (e.g. Drainage Areas) are altered through the processes of weed introduction, fire, altered surface hydrology or dust deposition. Any diggings (trenches, pits etc.) are likely to provide barriers for movement for this fossorial species. It is, however, known to be widespread in the surrounding region (Department of Environment and Conservation and the Western Australian Museum 2013), and given that there are extensive areas of suitable habitat surrounding the Project Area, impacts to the species are considered to be minor.</li> </ul>





## 7 CONCLUSION

Based on results from the surveys undertaken in areas overlapping the Project Area and records available through online databases, 270 vertebrate fauna species are potentially occurring in the Project Area. This total comprises 34 native and nine introduced mammal species, 125 bird species, 95 reptile species and seven amphibian species. A total of 194 species, comprising 25 native and seven introduced mammal species, 81 bird species, 78 reptile species and three amphibian species were recorded during surveys that overlapped the Project Area. Six vertebrate fauna species of conservation significance, comprising two native mammals and four birds have been recorded from the Project Area to-date. These include two species listed under the EPBC Act 1999 and the WC Act 1950, and four listed in the Priority list of DPaW.

Based on records contained within online databases and studies conducted in adjacent areas, a further 11 conservation significant species are considered to potentially occur within the Project Area. Five of these species are birds and are unlikely to use the Project Area on a permanent basis. Preferred habitats for the Northern Quoll and roosting habitats for another two (Ghost Bat and Pilbara Leaf-nosed Bat) are not well represented within the Project Area. Hence, these species are unlikely to occur within the Project Area.

Of the five broad fauna habitats identified within the Project Area, two habitats; *i.e.* Sand Plain and Gorge/ Gully, were considered important, based on their ability to support conservation significant species.

The maximum disturbance area within the Project Area is estimated to be 4054.64 ha, of which 3300.32 ha comprises the 'Indicative Mine Disturbance Area' and 754.32 ha comprise the 'Indicative Infrastructure Corridor Area'. Relative to the total area of the IBRA subregions in the Pilbara, this disturbance amounts to less than 0.2 % of each subregion and no more than 0.4 % of any one land system's total extent in the Pilbara occurring within it. All habitat types identified within the Project Area are well represented outside the Project Area and in the region in general.

Loss and fragmentation of fauna habitat, direct mortality during land clearing, fauna entrapment, collision with vehicles, habitat barriers to movement, habitat degradation due to fire, dust, introduced species and altered hydrology, and behavioural impacts



due to noise, vibrations and light were identified as potential impacts to fauna arising from the proposed construction and operation of the rail line.

Management recommendations aimed at maintaining the representation, diversity, viability, and ecological function of vertebrate fauna at the species, population and assemblage levels have been suggested separately.



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## Appendix A Survey methods used during surveys overlapping the Project Area

Location		Methodology	Consultant
-23.31859	120.09977	Bat Detector	Biologic, 2013
-23.31506	120.11703	Bat Detector	Biologic, 2013
-23.30617	120.10145	Bat Detector	Biologic, 2013
-23.30511	120.13380	Bat Detector	Biologic, 2013
-23.29634	120.12615	Bat Detector	Biologic, 2013
-23.29388	120.09378	Bat Detector	Biologic, 2013
-23.32634	120.14527	Bat Detector	Biologic, 2013
-23.32497	120.13775	Bat Detector	Biologic, 2013
-23.32475	120.13697	Bat Detector	Biologic, 2013
-23.30617	120.10145	Birding	Biologic, 2013
-23.31859	120.09977	Birding	Biologic, 2013
-23.32474	120.14565	Birding	Biologic, 2013
-23.29296	120.09862	Birding	Biologic, 2013
-23.32342	120.09789	Birding	Biologic, 2013
-23.32217	120.13382	Birding	Biologic, 2013
-23.30263	120.09910	Birding	Biologic, 2013
-23.32115	120.13693	Motion Camera	Biologic, 2013
-23.31935	120.09406	Motion Camera	Biologic, 2013
-23.31859	120.09975	Motion Camera	Biologic, 2013
-23.31508	120.11704	Motion Camera	Biologic, 2013
-23.30625	120.10139	Motion Camera	Biologic, 2013
-23.30511	120.13379	Motion Camera	Biologic, 2013
-23.30507	120.13377	Motion Camera	Biologic, 2013
-23.30454	120.13754	Motion Camera	Biologic, 2013
-23.29633	120.12615	Motion Camera	Biologic, 2013
-23.29388	120.09378	Motion Camera	Biologic, 2013
-23.29238	120.09512	Motion Camera	Biologic, 2013
-23.32634	120.14527	Motion Camera	Biologic, 2013
-23.32497	120.13775	Motion Camera	Biologic, 2013
-23.32475	120.13697	Motion Camera	Biologic, 2013
-23.32444	120.13665	Motion Camera	Biologic, 2013
-23.32496	120.13774	Motion Camera	Biologic, 2013
-23.32192	120.13538	Motion Camera	Biologic, 2013
-23.32205	120.13600	Motion Camera	Biologic, 2013
-23.32204	120.13571	Motion Camera	Biologic, 2013
-23.32638	120.14458	Motion Camera	Biologic, 2013
-23.33148	120.09781	Motion Camera	Biologic, 2013
-23.32398	120.0984	Motion Camera	Biologic, 2013
-23.33148	120.09781	Motion Camera	Biologic, 2013
-23.29633	120.12618	Trapping Site	Biologic, 2013
-23.29296	120.09862	Trapping Site	Biologic, 2013



Location		Methodology	Consultant
-23.32342	120.09789	Trapping Site	Biologic, 2013
-23.32217	120.13382	Trapping Site	Biologic, 2013
-23.30263	120.09910	Trapping Site	Biologic, 2013
-23.32887	120.12441	Habitat Assessment	Biologic, 2013
-23.32670	120.12840	Habitat Assessment	Biologic, 2013
-23.32476	120.14567	Habitat Assessment	Biologic, 2013
-23.32291	120.12473	Habitat Assessment	Biologic, 2013
-23.32134	120.13695	Habitat Assessment	Biologic, 2013
-23.31933	120.09406	Habitat Assessment	Biologic, 2013
-23.31861	120.09975	Habitat Assessment	Biologic, 2013
-23.31508	120.11710	Habitat Assessment	Biologic, 2013
-23.31445	120.15553	Habitat Assessment	Biologic, 2013
-23.31210	120.11903	Habitat Assessment	Biologic, 2013
-23.31064	120.15470	Habitat Assessment	Biologic, 2013
-23.30923	120.14999	Habitat Assessment	Biologic, 2013
-23.30617	120.10163	Habitat Assessment	Biologic, 2013
-23.30505	120.13376	Habitat Assessment	Biologic, 2013
-23.30455	120.13754	Habitat Assessment	Biologic, 2013
-23.29388	120.09380	Habitat Assessment	Biologic, 2013
-23.29633	120.12618	Habitat Assessment	Biologic, 2013
-23.33274	120.11287	Habitat Assessment	Biologic, 2013
-23.28599	120.08890	Habitat Assessment	Biologic, 2013
-23.32474	120.13700	Habitat Assessment	Biologic, 2013
-23.33148	120.09781	Habitat Assessment	Biologic, 2013
-23.33000	120.12095	Habitat Assessment	Biologic, 2013
-23.29277	120.10508	Habitat Assessment	Biologic, 2013
-23.29144	120.09866	Habitat Assessment	Biologic, 2013
-23.32398	120.0984	Habitat Assessment	Biologic, 2013
-23.32838	120.14118	Habitat Assessment	Biologic, 2013
-23.29296	120.09862	Habitat Assessment	Biologic, 2013
-23.32342	120.09789	Habitat Assessment	Biologic, 2013
-23.32217	120.13382	Habitat Assessment	Biologic, 2013
-23.30263	120.09910	Habitat Assessment	Biologic, 2013
-23.30380932	120.1035934	Habitat Assessment	ENV, 2011
-23.3075828	120.0846722	Habitat Assessment	ENV, 2011
-23.29620927	120.0923361	Habitat Assessment	ENV, 2011
-23.32002176	120.1179592	Habitat Assessment	ENV, 2011
-23.33206287	120.7528196	Habitat Assessment	ENV, 2011
-23.32131545	120.1378089	Habitat Assessment	ENV, 2011
-23.32199896	120.1357029	Habitat Assessment	ENV, 2011
-23.30019912	120.1414271	Habitat Assessment	ENV, 2011
-23.29669883	120.1529144	Habitat Assessment	ENV, 2011



Location		Methodology	Consultant
-23.30097375	120.1552271	Habitat Assessment	ENV, 2011
-23.30299393	120.1457156	Habitat Assessment	ENV, 2011
-23.33307748	120.1074837	Trapping Site	ENV, 2012
-23.33655214	120.1236425	Trapping Site	ENV, 2012
-23.32194686	120.1333488	Trapping Site	ENV, 2012
-23.32199877	120.1287935	Trapping Site	ENV, 2012
-23.33350158	120.1300317	Trapping Site	ENV, 2012
-23.33879951	120.0841469	Trapping Site	ENV, 2012
-23.32048578	120.1000753	Trapping Site	ENV, 2012
-23.32549555	120.1349242	Motion Camera	ENV, 2012
-23.35844662	120.0982042	Motion Camera	ENV, 2012
-23.32188337	120.1353047	Motion Camera	ENV, 2012
-23.32424957	120.1383519	Motion Camera	ENV, 2012
-23.34532127	120.1219873	Motion Camera	ENV, 2012
-23.32258923	120.1294943	Motion Camera	ENV, 2012
-23.35591315	120.0973698	Trapping Site	ENV, 2012
-23.32424957	120.1383519	Bat Detector	ENV, 2012
-23.32199877	120.1287935	Bat Detector	ENV, 2012
-23.34532127	120.1219873	Bat Detector	ENV, 2012
-23.35827467	120.0981786	Bat Detector	ENV, 2012
-23.35591315	120.0973698	Bat Detector	ENV, 2012
-23.33307748	120.1074837	Habitat Assessment	ENV, 2012
-23.33655214	120.1236425	Habitat Assessment	ENV, 2012
-23.32194686	120.1333488	Habitat Assessment	ENV, 2012
-23.32199877	120.1287935	Habitat Assessment	ENV, 2012
-23.33350158	120.1300317	Habitat Assessment	ENV, 2012
-23.33879951	120.0841469	Habitat Assessment	ENV, 2012
-23.32048578	120.1000753	Habitat Assessment	ENV, 2012
-23.294182	120.131035	Habitat Assessment	Biologic, 2013
-23.296171	120.102867	Habitat Assessment	Biologic, 2013
-23.329418	120.124496	Habitat Assessment	Biologic, 2013
-23.287333	120.146744	Habitat Assessment	Biologic, 2013
-23.290215	120.150764	Habitat Assessment	Biologic, 2013
-23.34291667	120.0474444	Habitat Assessment	ecologia 1995
-23.33480556	120.0441111	Habitat Assessment	ecologia 1995
-23.32286111	120.0990833	Habitat Assessment	ecologia 1995
-23.32344444	120.0458056	Habitat Assessment	ecologia 1995
-23.33952778	120.0251111	Habitat Assessment	ecologia 1995
-23.33575	120.0236944	Habitat Assessment	ecologia 1995
-23.33913889	120.0340833	Habitat Assessment	ecologia 1995
-23.33425	120.0505833	Habitat Assessment	ecologia 1995
-23.33458333	120.0504167	Habitat Assessment	ecologia 1995





Location		Methodology	Consultant
-23.32083333	120.0584167	Habitat Assessment	ecologia 1995
-23.33080556	120.0277222	Habitat Assessment	ecologia 1995
-23.32958333	120.03425	Habitat Assessment	ecologia 1995
-23.32805556	120.0591111	Habitat Assessment	ecologia 1995
-23.32466667	120.0604444	Habitat Assessment	ecologia 1995
-23.32625	120.0378333	Habitat Assessment	ecologia 1995
-23.32680556	120.0386944	Habitat Assessment	ecologia 1995
-23.32533333	120.0478611	Habitat Assessment	ecologia 1995
-23.33441667	120.0580556	Habitat Assessment	ecologia 1995
-23.34655556	120.0239722	Habitat Assessment	ecologia 1995
-23.34422222	120.0302778	Habitat Assessment	ecologia 1995
-23.34716667	120.0295833	Habitat Assessment	ecologia 1995
-23.33958333	120.0615833	Habitat Assessment	ecologia 1995
-23.34588889	120.06075	Habitat Assessment	ecologia 1995
-23.34761111	120.0474167	Habitat Assessment	ecologia 1995
-23.32030556	120.0574444	Habitat Assessment	ecologia 1995
-23.32969444	120.0667222	Habitat Assessment	ecologia 1995
-23.32541667	120.0655278	Habitat Assessment	ecologia 1995
-23.327	120.0456944	Habitat Assessment	ecologia 1995
-23.34152778	120.0119444	Habitat Assessment	ecologia 1995
-23.34883697	120.0519752	Trapping Site	ENV 2007
-23.3397526	120.0588807	Trapping Site	ENV 2007
-23.32614658	120.0446878	Trapping Site	ENV 2007
-23.32382618	120.0455893	Trapping Site	ENV 2007
-23.32903522	120.0194983	Trapping Site	ENV 2007
-23.32199087	120.0646077	Bat recorder	ENV 2007
-23.32373671	120.0456304	Bat recorder	ENV 2007
-23.32604844	120.0442697	Bat recorder	ENV 2007
-23.33360184	120.031378	Bat recorder	ENV 2007
-23.34921708	120.0568246	Bat recorder	ENV 2007
-23.3440293	120.0501951	Bat recorder	ENV 2007
-23.32464012	120.0466365	Bat recorder	ENV 2007
-23.32092056	120.07155	Bat recorder	ENV 2007
-23.3440293	120.0501951	Bat recorder	ENV 2007
-23.33520093	120.023866	Bat recorder	ENV 2007
-23.33307748	120.1074837	Trapping Site	ENV, 2011
-23.33655214	120.1236425	Trapping Site	ENV, 2011
-23.32194686	120.1333488	Trapping Site	ENV, 2011
-23.32199877	120.1287935	Trapping Site	ENV, 2011
-23.33350158	120.1300317	Trapping Site	ENV, 2011
-23.33879951	120.0841469	Trapping Site	ENV, 2011
-23.32048578	120.1000753	Trapping Site	ENV, 2011



Location		Methodology	Consultant
-23.35591315	120.0973698	Trapping Site	ENV, 2011
-23.32549555	120.1349242	Remote Camera	ENV, 2011
-23.35844662	120.0982042	Remote Camera	ENV, 2011
-23.32188337	120.1353047	Remote Camera	ENV, 2011
-23.32424957	120.1383519	Remote Camera	ENV, 2011
-23.34532127	120.1219873	Remote Camera	ENV, 2011
-23.32258923	120.1294943	Remote Camera	ENV, 2011
-23.32424957	120.1383519	Bat recorder	ENV, 2011
-23.32199877	120.1287935	Bat recorder	ENV, 2011
-23.34532127	120.1219873	Bat recorder	ENV, 2011
-23.35827467	120.0981786	Bat recorder	ENV, 2011
-23.35591315	120.0973698	Bat recorder	ENV, 2011



## Appendix B Conservation status codes

### *International Union for Conservation of Nature*

Category	Definition
<b>Extinct (EX)</b>	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
<b>Extinct in the Wild (EW)</b>	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
<b>Critically Endangered (CE)</b>	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
<b>Endangered (EN)</b>	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
<b>Vulnerable (VU)</b>	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
<b>Near Threatened (NT)</b>	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future



Category	Definition
<b>Data Deficient (DD)</b>	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

### ***Environment Protection and Biodiversity Conservation Act 1999***

Category	Definition
<b>Extinct (EX)</b>	Taxa not definitely located in the wild during the past 50 years.
<b>Extinct in the Wild (EW)</b>	Taxa known to survive only in captivity.
<b>Critically Endangered (CE)</b>	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
<b>Endangered (EN)</b>	Taxa facing a very high risk of extinction in the wild in the near future.
<b>Vulnerable (VU)</b>	Taxa facing a high risk of extinction in the wild in the medium-term future.
<b>Migratory (MG)</b>	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA) China-Australia Migratory Bird Agreement (CAMBA) Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

### ***Wildlife Conservation Act 1950***

Category	Definition
<b>Schedule 1 (S1)</b>	Rare and Likely to become Extinct.
<b>Schedule 2 (S2)</b>	Extinct.
<b>Schedule 3 (S3)</b>	Migratory species listed under international treaties.
<b>Schedule 4 (S4)</b>	Other Specially Protected Fauna.

### **Department of Environment and Conservation Priority codes**

Category	Definition
<b>Priority 1 (P1)</b>	Taxa with few, poorly known populations on threatened lands.





Category	Definition
<b>Priority 2 (P2)</b>	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
<b>Priority 3 (P3)</b>	Taxa with several, poorly known populations, some on conservation lands.
<b>Priority 4 (P4)</b>	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
<b>Priority 5 (P5)</b>	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

**Appendix C** Fauna recorded in the Project Area and region

EPBC Act Protected Matters search with 8 km buffer

DPaW Threatened Species Database search within 8 km buffer

**Surveys**

- A West Jimblebar Fauna Assessment (ENV Australia 2007)  
B Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)  
C Orebody 18 Fauna Assessment Phase II (ENV Australia 2007)  
D Orebody 31 Fauna Assessment (ENV Australia 2011)  
E Jimblebar Mine Site Biological Survey (BHP Iron Ore Pty Ltd 1994)  
F Wheelara Hill Iron Ore Mine Modification: Fauna and Flora Assessment (Outback Ecology Services 2009b)  
G Jimblebar Iron Ore Project: Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services 2009a)  
H Jimblebar - Wheelara Hill Biological Survey (ecologia Environmental 2004)  
I BHP Billiton Iron Ore Hashimoto Terrestrial Vertebrate Fauna Assessment (ecologia Environmental 2006a)  
J Jimblebar Marra Mamba Exploration Biological Survey (ecologia Environmental 2006b)  
K East Jimblebar Exploration Project Biological Survey (ecologia Environmental 2005)  
L Orebody 19 Vertebrate Fauna Survey (Biologic 2013a)  
M Orebody 31 Vertebrate Fauna Survey (Biologic 2013c)  
N Wheelarra Hill North Fauna Assessment (ENV Australia 2012)  
O Mesa Gap Biological Survey (GHD 2008)

**Mammals**

Family and Species	Common Name	EPBC Act	WC Act	DPaW	IUCN	DPaW Nature Map	EPBC Act Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<b>TACHYGLOSSIDAE</b>																						
<i>Tachyglossus aculeatus</i>	Echidna													•					•			
<b>DASYURIDAE</b>																						
<i>Dascycercus blythi</i>	Brush-tailed Mulgara					•						•	•	•	•	•			•	•		
<i>Dasykaluta rosamondae</i>	Little Red Kaluta					•						•	•	•	•	•			•		•	
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1		EN		•															
<i>Ningauai timealeyi</i>	Pilbara Ningauai								•						•	•			•			
<i>Planigale maculata</i>	Common Planigale								•													
<i>Pseudantechinus roryi</i>	Rory's Pseudantechinus					•																
<i>Pseudantechinus macdonnellensis</i>	Fat-tailed Antechinus								•			•										
<i>Pseudantechinus woolleyae</i>	Woolley's Pseudantechinus																		•			
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart												•	•		•			•			
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart												•	•		•			•			
<i>Sminthopsis ooldea</i>	Ooldea Dunnart																			•		
<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart					•							•	•					•	•	•	



<b>THYLACOMYIDAE</b>																					
<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	S1		VU		•														
<b>MACROPODIDAE</b>																					
<i>Macropus robustus</i>	Common Wallaroo					•		•	•	•		•	•	•	•	•	•	•	•	•	
<i>Macropus rufus</i>	Red Kangaroo, Marlu					•		•			•		•	•		•	•	•		•	•
<i>Petrogale rothschildi</i>	Rothschild's Rock-wallaby					•			•	•								•			
<b>MEGADERMATIDAE</b>																					
<i>Macroderma gigas</i>	Ghost Bat			P4	VU	•										•					
<b>HIPPOSIDERIDAE</b>																					
<i>Rhinonicteris aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1				•									•					
<b>EMBALLONURIDAE</b>																					
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat															•		•		•	•
<i>Taphozous georgianus</i>	Common Sheathtail-bat									•						•			•	•	•
<i>Taphozous hilli</i>	Hill's Sheathtail-bat																		•	•	•
<b>MOLOSSIDAE</b>																					
<i>Chaerephon jobensis</i>	Northern Freetail-bat					•												•	•	•	•
<i>Mormopterus beccarii</i>	Beccari's Freetail-bat					•				•						•				•	•
<b>VESPERTILIONIDAE</b>																					
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat					•				•	•					•	•	•	•	•	•
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat					•				•						•		•		•	•
<i>Scotorepens greyii</i>	Little Broad-nosed Bat					•				•	•					•	•	•	•	•	•
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat					•		•		•	•		•			•	•	•	•	•	•
<b>MURIDAE</b>																					
<i>*Mus musculus</i>	House Mouse					•	•	•	•	•		•	•	•	•	•				•	
<i>Notomys alexis</i>	Spinifex Hopping-mouse									•						•			•		
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4		•					•	•	•	•	•		•		•		•
<i>Pseudomys desertor</i>	Desert Mouse									•					•	•			•	•	
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse					•			•	•		•	•	•	•	•			•	•	•
<i>Zyzomys argurus</i>	Common Rock-rat					•		•	•	•		•		•	•	•			•	•	•
<b>BOVIDAE</b>																					
<i>*Bos taurus</i>	European Cattle							•			•		•	•		•	•				•
<b>CANIDAE</b>																					
<i>Canis lupus dingo</i>	Dingo											•	•	•		•	•	•	•	•	•
<i>*Canis lupus</i>	Dog					•	•	•													
<i>*Vulpes vulpes</i>	Red Fox						•			•											
<b>CAMELIDAE</b>																					
<i>*Camelus dromedarius</i>	Dromedary, Camel					•	•	•									•			•	•
<b>EQUIDAE</b>																					
<i>*Equus asinus</i>	Donkey						•				•			•		•				•	
<i>*Equus caballus</i>	Horse						•	•				•		•							
<b>FELIDAE</b>																					



* <i>Felis catus</i>	Cat					•	•			•			•	•		•	•	•	•	•	•	•
<b>LEPORIDAE</b>																						
* <i>Oryctolagus cuniculus</i>	Rabbit						•					•								•		

**Birds**

Family and Species	Common Name	EPBC Act	WC Act	DPaW	IUCN	DPaW Nature Map	Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<b>CASUARIIDAE</b>																						
<i>Dromaius novaehollandiae</i>	Emu					•		•	•	•		•										
<b>PHASIANIDAE</b>																						
<i>Coturnix pectoralis</i>	Stubble Quail					•												•			•	
<i>Coturnix ypsilophora</i>	Brown Quail															•						
<b>ANATIDAE</b>																						
<i>Chenonetta jubata</i>	Australian Wood Duck															•						
<i>Cygnus atratus</i>	Black Swan														•							
<i>Tadorna tadornoides</i>	Australian Shelduck															•						
<b>RALLIDAE</b>																						
<i>Gallinula ventralis</i>	Black-tailed Native-hen															•						
<b>COLUMBIDAE</b>																						
<i>Geophaps plumifera</i>	Spinifex Pigeon					•		•	•	•	•	•	•	•	•	•	•		•	•	•	•
<i>Geopelia cuneata</i>	Diamond Dove					•		•	•	•	•	•			•	•	•	•	•	•	•	
<i>Geopelia striata</i>	Peaceful Dove															•						•
<i>Ocyphaps lophotes</i>	Crested Pigeon					•		•		•	•	•		•	•	•	•	•	•	•	•	•
<i>Phaps chalcoptera</i>	Common Bronzewing					•		•		•	•	•			•	•		•	•	•	•	
<b>PODARGIDAE</b>																						
<i>Podargus strigoides</i>	Tawny Frogmouth					•				•					•	•		•			•	
<b>EUROSTOPODIDAE</b>																						
<i>Eurostopodus argus</i>	Spotted Nightjar					•		•	•	•	•					•	•	•			•	
<b>AEGOTHELIDAE</b>																						
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar					•			•	•	•	•				•		•	•	•	•	
<b>APODIDAE</b>																						
<i>Apus pacificus</i>	Fork-tailed Swift	MG	S3				•				•											
<b>PHALACROCORACIDAE</b>																						
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant															•						
<b>ARDEIDAE</b>																						
<i>Ardea ibis</i>	Cattle Egret	MG	S3				•															





<i>Ardea modesta</i>	Eastern Great Egret	MG	S3				•															
<i>Ardea pacifica</i>	White-necked Heron															•						
<i>Egretta novaehollandiae</i>	White-faced Heron													•	•							
<b>ACCIPITRIDAE</b>																						
<i>Aquila audax</i>	Wedge-tailed Eagle					•		•		•	•		•	•	•	•	•		•		•	•
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk							•											•			
<i>Accipiter fasciatus</i>	Brown Goshawk							•						•	•	•			•			•
<i>Circus assimilis</i>	Spotted Harrier					•			•							•	•		•		•	
<i>Elanus axillaris</i>	Black-shouldered Kite							•	•	•							•		•	•		
<i>Haliastur sphenurus</i>	Whistling Kite					•		•	•	•				•		•	•		•	•	•	•
<i>Milvus migrans</i>	Black Kite					•				•				•			•		•			
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard					•				•				•		•	•	•	•	•		
<i>Hieraaetus morphnoides</i>	Little Eagle							•						•		•		•				
<b>FALCONIDAE</b>																						
<i>Falco berigora</i>	Brown Falcon					•		•	•	•	•		•	•	•	•	•	•	•	•	•	•
<i>Falco cenchroides</i>	Nankeen Kestrel					•		•	•	•	•	•		•	•	•	•	•	•	•	•	•
<i>Falco longipennis</i>	Australian Hobby					•									•	•		•	•		•	
<i>Falco peregrinus</i>	Peregrine Falcon		S4					•														
<b>OTIDIDAE</b>																						
<i>Ardeotis australis</i>	Australian Bustard			P4	NT	•		•	•		•			•		•	•	•		•	•	
<b>BURHINIDAE</b>																						
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4	NT	•				•				•	•							
<b>CHARADRIIDAE</b>																						
<i>Charadrius veredus</i>	Oriental Plover	MG	S3				•															
<i>Euseyonis melanops</i>	Black-fronted Dotterel															•						
<b>SCOLOPACIDAE</b>																						
<i>Actitis hypoleucos</i>	Common Sandpiper	MG	S3			•				•												
<b>TURNICIDAE</b>																						
<i>Turnix velox</i>	Little Button-quail					•		•	•	•	•					•	•		•	•	•	
<b>CACATUIDAE</b>																						
<i>Eolophus roseicapillus</i>	Galah					•		•	•	•	•	•			•	•	•	•	•	•	•	•
<i>Cacatua sanguinea</i>	Little Corella							•	•					•	•	•						
<i>Nymphicus hollandicus</i>	Cockatiel					•		•		•	•					•	•				•	
<b>PSITTACIDAE</b>																						
<i>Barnardius zonarius</i>	Australian Ringneck					•		•	•					•	•	•	•	•	•	•	•	
<i>Psephotus varius</i>	Mulga Parrot							•												•		
<i>Melopsittacus undulatus</i>	Budgerigar					•		•	•	•	•	•		•		•	•	•	•		•	
<i>Neopsephotus bourkii</i>	Bourke's Parrot							•								•						
<b>CUCULIDAE</b>																						
<i>Centropus phasianinus</i>	Pheasant Coucal															•						
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo							•	•		•		•		•	•	•					



<i>Chalcites osculans</i>	Black-eared Cuckoo						•										•					•	
<i>Cacomantis pallidus</i>	Pallid Cuckoo						•		•	•	•	•					•	•				•	
<b>STRIGIDAE</b>																							
<i>Ninox connivens</i>	Barking Owl																			•			
<i>Ninox novaeseelandiae</i>	Southern Boobook						•		•				•		•		•				•	•	
<b>TYTONIDAE</b>																							
<i>Tyto alba</i>	Barn Owl													•	•					•			
<b>HALCYONIDAE</b>																							
<i>Dacelo leachii</i>	Blue-winged Kookaburra																•						
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher						•		•	•	•	•		•	•		•	•		•	•	•	
<i>Todiramphus sanctus</i>	Sacred Kingfisher																•		•				
<b>MEROPIIDAE</b>																							
<i>Merops ornatus</i>	Rainbow Bee-eater	MG	S3					•	•					•	•	•	•	•	•	•	•	•	
<b>CLIMACTERIDAE</b>																							
<i>Climacteris melanura</i>	Black-tailed Treecreeper																•						
<b>PTILINORHYNCHIDAE</b>																							
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird						•		•						•	•				•	•	•	
<b>MALURIDAE</b>																							
<i>Amytornis striatus whitei</i>	Striated Grasswren						•			•	•	•	•		•	•	•			•	•	•	•
<i>Malurus lamberti</i>	Variegated Fairy-wren						•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Malurus leucopterus</i>	White-winged Fairy-wren						•		•					•	•	•	•	•	•	•		•	
<i>Malurus splendens</i>	Splendid Fairy-wren							•															
<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren																•						
<b>ACANTHIZIDAE</b>																							
<i>Pyrrholaemus brunneus</i>	Redthroat								•												•		
<i>Smicronis brevirostris</i>	Weebill						•		•		•	•	•	•	•	•	•	•		•	•	•	
<i>Gerygone fusca</i>	Western Gerygone						•		•		•			•	•			•		•			
<i>Acanthiza apicalis</i>	Inland Thornbill						•		•				•	•				•	•		•	•	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill								•								•	•					•
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill								•								•				•		
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill								•			•			•	•	•				•		
<i>Aphelocephala leucopsis</i>	Southern Whiteface								•														
<b>PARDALOTIDAE</b>																							
<i>Pardalotus rubricatus</i>	Red-browed Pardalote						•				•				•	•	•			•	•	•	
<i>Pardalotus striatus</i>	Striated Pardalote									•					•					•			
<b>MELIPHAGIDAE</b>																							
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater						•		•		•	•	•	•		•	•	•	•	•		•	
<i>Certhionyx niger</i>	Black Honeyeater								•	•							•					•	
<i>Certhionyx variegatus</i>	Pied Honeyeater						•		•	•							•	•					
<i>Conopophila whitei</i>	Grey Honeyeater								•														
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater								•	•	•		•		•	•		•		•		•	



<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater								•		•		•		•	•	•	•	•	•		•	
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater												•										
<i>Lichenostomus virescens</i>	Singing Honeyeater								•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Lichmera indistincta</i>	Brown Honeyeater					•			•	•	•	•	•			•	•	•	•	•		•	•
<i>Melithreptus gularis</i>	Black-chinned Honeyeater															•				•			
<i>Purnella albifrons</i>	White-fronted Honeyeater								•	•			•										
<i>Sugomel niger</i>	Black Honeyeater																	•					
<i>Manorina flavigula</i>	Yellow-throated Miner					•			•		•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Epthianura tricolor</i>	Crimson Chat					•			•	•	•					•	•		•				
<b>POMATOSTOMIDAE</b>																							
<i>Pomatostomus superciliosus</i>	White-browed Babbler								•								•						
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler					•			•		•	•		•	•	•	•	•		•	•	•	•
<b>CINCLOSOMATIDAE</b>																							
<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush																	•					
<i>Psophodes occidentalis</i>	Chiming Wedgebill																	•					
<b>CAMPEPHAGIDAE</b>																							
<i>Coracina maxima</i>	Ground Cuckoo-shrike															•	•						
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike					•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Lalage leucomela</i>	Varied Triller																		•				
<i>Lalage tricolor</i>	White-winged Triller					•			•	•	•	•				•	•	•		•		•	
<b>PACHYCEPHALIDAE</b>																							
<i>Pachycephala rufiventris</i>	Rufous Whistler					•			•	•	•	•			•	•	•	•	•	•	•	•	•
<i>Colluricincla harmonica</i>	Grey Shrike-thrush					•			•	•	•	•	•	•	•	•	•	•	•	•		•	•
<i>Oreoica gutturalis</i>	Crested Bellbird					•			•	•	•	•	•	•		•	•	•		•	•	•	
<b>ARTAMIDAE</b>																							
<i>Artamus cinereus</i>	Black-faced Woodswallow					•			•		•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Artamus minor</i>	Little Woodswallow					•			•	•	•	•	•			•	•			•	•	•	
<i>Artamus personatus</i>	Masked Woodswallow												•	•			•		•				
<i>Cracticus nigrogularis</i>	Pied Butcherbird					•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Cracticus tibicen</i>	Australian Magpie					•			•		•	•	•	•	•	•		•		•		•	
<i>Cracticus torquatus</i>	Grey Butcherbird					•			•		•	•				•	•	•	•			•	•
<b>RHIPIDURIDAE</b>																							
<i>Rhipidura albiscapa</i>	Grey Fantail					•			•														
<i>Rhipidura leucophrys</i>	Willie Wagtail					•			•	•	•		•	•	•	•	•	•	•	•	•	•	•
<b>CORVIDAE</b>																							
<i>Corvus bennetti</i>	Little Crow															•							
<i>Corvus coronoides</i>	Australian Raven																	•					
<i>Corvus orru</i>	Torresian Crow					•			•		•		•	•	•	•	•	•	•	•	•	•	
<b>MONARCHIDAE</b>																							
<i>Grallina cyanoleuca</i>	Magpie-lark					•			•		•			•	•	•	•	•	•	•			•
<b>PETROICIDAE</b>																							



<i>Petroica goodenovii</i>	Red-capped Robin							•					•	•	•	•	•	•				
<i>Melanodryas cucullata</i>	Hooded Robin					•		•	•	•	•		•	•	•	•		•			•	
ALAUDIDAE																						
<i>Mirafrja javanica</i>	Horsfield's Bushlark							•					•	•		•						
MEGALURIDAE																						
<i>Cincloramphus cruralis</i>	Brown Songlark							•			•				•							•
<i>Cincloramphus mathewsi</i>	Rufous Songlark					•		•		•	•				•	•	•		•		•	
<i>Eremiornis carteri</i>	Spinifexbird					•		•	•	•		•		•	•		•		•		•	
HIRUNDINIDAE																						
<i>Cheramoeca leucosterna</i>	White-backed Swallow										•		•	•	•	•						
<i>Petrochelidon ariel</i>	Fairy Martin								•									•				
NECTARINIIDAE																						
<i>Dicaeum hirundinaceum</i>	Mistletoebird								•						•	•	•		•			
ESTRILDIDAE																						
<i>Emblema pictum</i>	Painted Finch					•		•	•	•	•				•	•	•		•	•	•	•
<i>Neochmia ruficauda subclarescens</i>	Star Finch (western subspecies)			P4																		
<i>Taeniopygia guttata</i>	Zebra Finch					•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
MOTACILLIDAE																						
<i>Anthus australis</i>	Australasian Pipit					•											•		•		•	•
<i>Anthus novaeseelandiae</i>	Richard's Pipit							•	•	•		•		•	•	•						

## Reptiles

Family and Species	Common Name	EPBC Act	WC Act	DPaW	IUCN	DPaW Nature Map	EPBC Act Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<b>CHELUIDAE</b>																						
<i>Chelodina steindachneri</i>	Flat-shelled Turtle														•	•						
<b>AGAMIDAE</b>																						
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon					•		•	•	•	•		•	•	•	•	•	•	•	•	•	•
<i>Ctenophorus isolepis</i>	Crested Dragon					•			•		•						•	•		•	•	•
<i>Ctenophorus nuchalis</i>	Central Netted Dragon							•	•				•	•		•						
<i>Ctenophorus reticulatus</i>	Western Netted Dragon					•				•							•				•	
<i>Diporiphora valens</i>						•				•											•	
<i>Lophognathus longirostris</i>	Long-nosed Dragon					•		•							•	•	•	•		•	•	
<i>Moloch horridus</i>	Thorney Devil																			•		
<i>Pogona minor</i>						•		•	•	•						•	•		•	•	•	





<b>DIPLODACTYLIDAE</b>																					
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko					•			•				•	•		•		•	•	•	•
<i>Diplodactylus savagei</i>	Yellow-spotted Pilbara Gecko								•									•			
<i>Lucasium stenodactylum</i>	Pale-snouted Ground Gecko					•		•		•			•	•	•	•		•	•	•	•
<i>Lucasium wombeyi</i>						•		•		•				•	•			•	•	•	
<i>Oedura marmorata</i>	Marbled Velvet Gecko					•		•		•								•	•	•	
<i>Rhynchoedura ornata</i>	Beaked Gecko					•			•	•					•		•			•	
<i>Strophurus ciliaris</i>																	•				
<i>Strophurus elderi</i>						•				•					•		•			•	
<i>Strophurus jeanae</i>						•											•		•	•	
<i>Strophurus wellingtonae</i>						•		•		•					•		•	•	•	•	
<b>CARPHODACTYLIDAE</b>																					
<i>Nephrurus wheeleri</i>																	•				
<b>GEKKONIDAE</b>																					
<i>Gehyra pilbara</i>						•		•	•											•	
<i>Gehyra punctata</i>	Spotted Rock Dtella					•		•	•	•	•			•		•	•		•	•	•
<i>Gehyra purpurascens</i>															•						
<i>Gehyra variegata</i>	Tree Dtella					•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Heteronotia binoei</i>	Bynoe's Gecko					•		•	•	•	•			•	•	•	•		•		
<i>Heteronotia spelea</i>	Desert Cave Gecko					•				•	•				•	•			•	•	
<b>PYGOPODIDAE</b>																					
<i>Delma butleri</i>	Unbanded Delma									•									•		
<i>Delma elegans</i>	Pilbara Delma					•									•				•		•
<i>Delma haroldi</i>						•									•					•	
<i>Delma nasuta</i>						•			•	•					•				•		•
<i>Delma pax</i>						•		•	•	•			•	•	•	•	•		•	•	
<i>Delma tinctoria</i>						•								•						•	
<i>Lialis burtonis</i>	Burton's legless lizard							•						•	•	•	•				
<i>Pygopus nigriceps</i>	Hooded Scaly foot												•			•					
<b>SCINCIDAE</b>																					
<i>Carlia munda</i>																•	•			•	
<i>Carlia triacantha</i>	Desert Rainbow Skink					•				•			•		•				•	•	
<i>Cryptoblepharus carnabyi</i>										•											
<i>Cryptoblepharus plagiocephalus</i>	Fence Skink								•	•											
<i>Cryptoblepharus ustulatus</i>																			•		
<i>Ctenotus ariadnae</i>						•				•									•		
<i>Ctenotus duricola</i>						•				•			•	•	•	•			•	•	•
<i>Ctenotus grandis</i>						•				•			•	•		•				•	
<i>Ctenotus helenae</i>						•		•	•	•			•	•	•	•			•	•	•
<i>Ctenotus leonhardii</i>									•	•		•			•			•			



<i>Ctenotus pantherinus</i>	Leopard Ctenotus					•				•	•			•	•	•	•	•		•	•	•	
<i>Ctenotus quattuordecimlineatus</i>	Fourteen-lined Ctenotus									•													
<i>Ctenotus rubicundus</i>																				•			
<i>Ctenotus rutilans</i>	Pilbara Rusty Ctenotus					•											•			•		•	
<i>Ctenotus saxatilis</i>	Rock Ctenotus					•		•	•	•	•		•	•	•	•	•		•	•	•		
<i>Ctenotus schomburgkii</i>	Barred wedge-tailed Ctenotus					•										•						•	
<i>Ctenotus serventyi</i>								•															
<i>Ctenotus uber</i>						•							•	•			•				•	•	
<i>Cyclodomorphus branchialis</i>	Gunther's Skink								•			•											
<i>Cyclodomorphus melanops</i>	Slender Blue-tongue					•											•	•		•	•	•	
<i>Egernia cygnitos</i>	Pygmy Spiny-tailed Skink (western)																			•	•		
<i>Egernia depressa</i>	Pygmy Spiny-tailed Skink												•				•						
<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer															•	•		•				
<i>Lerista bipes</i>									•												•		
<i>Lerista chalybura</i>										•													
<i>Lerista flammicauda</i>						•																•	
<i>Lerista muelleri</i>						•		•	•	•			•	•			•	•		•		•	
<i>Lerista neander</i>						•			•	•				•	•		•	•		•	•	•	
<i>Lerista timida</i>																					•	•	
<i>Lerista zietzi</i>						•				•						•	•			•		•	
<i>Menetia greyii</i>	Dwarf Skink					•			•	•				•			•	•		•	•	•	
<i>Morethia ruficauda</i>	Fire-tailed Skink					•		•	•	•		•				•	•			•	•		
<i>Tiliqua multifasciata</i>	Central Blue-tongue					•				•			•	•	•	•	•	•	•	•	•	•	
<b>VARANIDAE</b>																							
<i>Varanus acanthurus</i>	Spiny-tailed Monitor					•		•	•	•	•			•	•	•	•		•	•	•		
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor					•																•	
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor							•					•	•			•					•	
<i>Varanus eremius</i>	Desert Pygmy Monitor					•		•		•										•	•		
<i>Varanus giganteus</i>	Perentie					•			•								•			•		•	
<i>Varanus gouldii</i>	Bungarra or Sand Monitor					•		•		•				•			•				•	•	
<i>Varanus panoptes</i>	Yellow-spotted Monitor					•		•								•	•		•		•	•	
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor								•										•				
<i>Varanus tristis</i>	Black-headed Monitor								•	•		•	•	•	•	•	•		•	•			
<b>TYPHLOPIDAE</b>																							
<i>Ramphotyphlops ammodytes</i>								•														•	
<i>Ramphotyphlops ganeii</i>	Pilbara Flat-headed Blindsnake				P1					•									•				
<i>Ramphotyphlops grypus</i>						•			•	•						•	•			•		•	
<i>Ramphotyphlops hamatus</i>													•	•			•			•	•		
<i>Ramphotyphlops waitii</i>																			•				



<b>PYTHONIDAE</b>																						
<i>Antaresia perthensis</i>	Pygmy Python					•			•						•	•					•	
<i>Antaresia stimsoni</i>	Stimson's Python														•			•				
<i>Aspidites melanocephalus</i>	Black-headed Python															•						
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1																•			
<b>ELAPIDAE</b>																						
<i>Brachyuophis approximans</i>						•			•						•					•	•	
<i>Demansia psammophis</i>	Yellow-faced Whipsnake					•		•	•							•	•	•	•	•	•	
<i>Demansia rufescens</i>	Rufous Whipsnake								•										•			
<i>Furina ornata</i>	Moon Snake							•											•			
<i>Pseudechis australis</i>	Mulga Snake					•								•	•	•	•		•			
<i>Pseudonaja modesta</i>	Ringed Brown Snake															•			•	•		
<i>Pseudonaja mengdeni</i>						•						•	•			•		•	•	•	•	
<i>Suta fasciata</i>	Rosen's Snake					•															•	
<i>Suta punctata</i>	Spotted Snake																•			•		
<i>Vermicella snelli</i>																					•	

**Amphibians**

Family and Species	Common Name	EPBC Act	WC Act	DPaW	IUCN	DPaW Nature Map	EPBC Act Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
<b>HYLIDAE</b>																						
<i>Cyclorana maini</i>	Main's Frog					•										•		•			•	
<i>Cyclorana platycephala</i>	Water-Holding Frog					•										•					•	
<i>Litoria rubella</i>	Desert Tree Frog										•			•	•	•	•	•				
<b>MYOBATRACHIDAE</b>																						
<i>Uperoleia russelli</i>	Russell's Toadlet													•	•	•		•				
<b>LIMNODYNASTIDAE</b>																						
<i>Neobatrachus centralis</i>	Desert Trilling Frog														•							
<i>Notaden nichollsi</i>	Desert Spadefoot														•							
<i>Platypsectrum spenceri</i>	Centralian Burrowing Frog														•	•		•				



**Appendix D** Conservation significant fauna recorded during surveys that overlapped the Project Area

Location		Species	Record type	Consultant
-23.2978	120.1537	Australian Bustard	Individual	ENV
-23.3342	120.1292	Australian Bustard	Individual	ENV
-23.3163	120.1247	Australian Bustard	Tracks	Biologic
-23.3062	120.0991	Australian Bustard	Tracks	Biologic
-23.2963	120.1262	Brush-tailed Mulgara	Burrow	Biologic
-23.2958	120.1224	Brush-tailed Mulgara	Burrow	Biologic
-23.2951	120.1559	Brush-tailed Mulgara	Burrow	Biologic
-23.2944	120.1222	Brush-tailed Mulgara	Digging	Biologic
-23.2933	120.1549	Brush-tailed Mulgara	Scats	Biologic
-23.3279	120.0713	Bush Stone-curlew	Individual	ENV
-23.3007	120.094	Fork-tailed Swift	Individual	ENV
-23.3256	120.1363	Rainbow Bee-eater	Individual	Biologic
-23.3234	120.0979	Rainbow Bee-eater	Individual	Biologic
-23.3342	120.1292	Rainbow Bee-eater	Individual	ENV
-23.322	120.1288	Rainbow Bee-eater	Individual	ENV
-23.3293	120.1523	Western Pebble-mound Mouse	Mound	ENV
-23.3293	120.1516	Western Pebble-mound Mouse	Mound	ENV
-23.3354	120.0596	Western Pebble-mound Mouse	Mound	ecologia
-23.329	120.0657	Western Pebble-mound Mouse	Mound	ecologia
-23.3269	120.0673	Western Pebble-mound Mouse	Mound	ecologia
-23.327	120.0668	Western Pebble-mound Mouse	Mound	ecologia
-23.322	120.1288	Western Pebble-mound Mouse	Individual	ENV
-23.3205	120.1001	Western Pebble-mound Mouse	Individual	ENV
-23.3022	120.1074	Western Pebble-mound Mouse	Individual	ENV
-23.325	120.0833	MAMMAL - P4		DPaW
-23.3291	120.1522	BIRD - P4		DPaW