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ecologia
ENVIRONMENT

FORTESCUE METALS GROUP LIMITED
ADDITIONAL RAIL INFRASTRUCTURE PROJECT
CONSERVATION SIGNIFICANT FAUNA MONITORING PROGRAM

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ACRONYMS

BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
JAMBA	Japan-Australian Migratory Bird Agreement
NHMRC	National Health and Medical Research Centre
SAC	Species Accumulation Curve
SM2BAT	Wildlife Acoustic Song Meter SM2BAT+ platforms
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

Fortescue is expanding its current operations in the Pilbara by developing the Additional Rail Infrastructure Project (the Project), which includes sections of rail duplication and additional sidings along its current rail infrastructure (Mainline), between Herb Elliott Port and the Cloudbreak Mine site. Fortescue has prepared the *Additional Rail Infrastructure: EPBC Fauna Management Plan* (R-PL-EN-0019) (fauna management plan) and is now proposing to implement the fauna management plan with the goal of ongoing monitoring and long-term protection and management of conservation significant fauna associated with the Project.

As per the fauna management plan, two species are targeted for detailed population-based (systematic) monitoring; Mulgara (*Dasycercus cristicauda* / *Dasycercus blythii*) (EPBC Act Vulnerable), and Greater Bilby (*Macrotis lagotis*) (EPBC Act Vulnerable). Four species are targeted for "hot spot" monitoring: Night Parrot (*Pezoporus occidentalis*) (EPBC Act Endangered), Northern Quoll (*Dasyurus hallucatus*) (EPBC Act Endangered), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (EPBC Act Vulnerable); and Pilbara Olive Python (*Liasis olivaceus barroni*) (EPBC Act Vulnerable). This document compiles the results of the detailed population based monitoring and "hot spot" monitoring programs conducted between August 2012 and May 2013 for the previously identified EPBC Act listed fauna species.

General survey methods adopted by *ecologia* are in accordance with the EPA Guidance Statement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002), *Technical Guide – Terrestrial Vertebrate Fauna surveys for Environmental impact Assessment* (EPA and DEC 2010) and the fauna management plan. Monitoring was conducted between August 2012 and May 2013, appropriate survey timing and species specific survey methodology for each EPBC listed species was determined as per relevant guidelines (DSEWPaC 2010, 2011b, c, d; EPA 2004; EPA and DEC 2010).

Impact and control sites were established in suitable and representative habitat for Northern Quoll, Pilbara Olive Python and Greater Bilby. Suitable control sites have been selected for Mulgara and Pilbara Leaf-nosed Bat and will be established in the next phase of monitoring.

Northern Quoll

Two individual male Northern Quolls were captured within the impact zone of the Mainline. Records were made from an additional nine locations within the impact zone from secondary evidence (camera trap, tracks). One individual male Northern Quoll was captured at control site 2, with no records at other control sites. Habitats targeted for Northern Quoll included granite outcrop and boulder piles, and constructed rocky arms at bridges of major river crossings. Locations of secondary evidence records will be targeted for trapping in future monitoring.

Night Parrot

No Night Parrots or secondary evidence of Night Parrots were recorded during this initial phase of monitoring. The recording of 62 bird species from waterhole observations (a primary survey method) suggests the effectiveness of techniques used in recording avifauna at the time of monitoring.

Pilbara Olive Python

No Pilbara Olive Pythons or secondary evidence of this species was recorded during this initial phase of monitoring. Impact route 1 and 2 and control route 2 represent suitable habitat for this species. It is recommended that control route 1 be changed for future monitoring due to habitat unsuitability.

Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bats were recorded from two locations within the impact zone. These records intersect the two known populations at Wodjina (Atlas Iron) and North Star (Fortescue), and

continued monitoring will give an indication as to the potential movements between these two known populations. Future monitoring should also establish control sites within this vicinity, in areas of suitable habitat outside the impact zone of Mainline.

Mulgara

Mulgara were recorded from seven locations during this initial phase of annual monitoring. These records comprise eight individuals from two sites captured using Elliot traps and detection of presence through secondary evidence and camera trapping at a further five locations. Based on the outcomes of this phase of monitoring, a total of twelve detailed population monitoring sites (six impact and six control) have been selected and will be completed in future monitoring.

Greater Bilby

A total of four Greater Bilby populations were recorded from separate locations. Populations were located through the recording of signs of activity (burrows, diggings, tracks and scats), with images of Greater Bilby individuals captured on camera traps at two of these sites. Two sites were recorded in close proximity to the Mainline (within 1 km) as impact sites (ML B2 and ML B3). Sites ML B1 and ML B4 were recorded further then 1 km from the Mainline and are control sites.

Non-targeted Fauna

A combined total of 27 mammals, 93 birds, 31 reptiles and six amphibian species were recorded during this current monitoring program, indicating that survey methods are suitable for detecting a variety of fauna species. An additional eight non-targeted conservation significant fauna species were recorded while conducting the targeted species monitoring: Eastern Great Egret, Rainbow Bee-eater, Common Sandpiper, Common Greenshank, Grey Falcon, Australian Bustard, Bush Stone-curlew and Star Finch (western).

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group Limited (Fortescue) has expanded its current operations in the Pilbara by developing the Additional Rail Infrastructure Project (the Project), which includes sections of rail duplication and additional sidings along its current rail infrastructure (Mainline) between Herb Elliott Port and the Cloudbreak Mine site (Figure 1.1).

In accordance with the requirements of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval (EPBC 2010/5513 and EPBC 2012/6314), Fortescue has prepared the *Additional Rail Infrastructure: EPBC Fauna Management Plan* - R-PL-EN-0019 (fauna management plan), and is now proposing to implement the fauna management plan with the goal of ongoing monitoring and long-term protection and management of conservation significant fauna (i.e. *Wildlife Conservation Act 1950* (WC Act) and EPBC Act listed species) associated with the Project. The fauna management plan requires that annual monitoring be conducted, targeting EPBC listed conservation significant fauna that may potentially be affected by the Project.

Four species were determined to not have sufficient records to allow for detailed population-based monitoring programs, and as such have been targeted using "hot spot" monitoring. These species are:

- Northern Quoll (*Dasyurus hallucatus*) (EPBC Act Endangered);
- Night Parrot (*Pezoporus occidentalis*) (EPBC Act Endangered);
- Pilbara Olive Python (*Liasis olivaceus barroni*) (EPBC Act Vulnerable); and
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (EPBC Act Vulnerable).

The species targeted for detailed population based annual monitoring include:

- Mulgara (*Dasycercus cristicauda* / *Dasycercus blythii*) (EPBC Act Vulnerable); and
- Greater Bilby (*Macrotis lagotis*) (EPBC Act Vulnerable).

This document compiles the results of the first year of detailed population-based and "hot spot" monitoring programs conducted between August 2012 and May 2013 for the previously identified EPBC Act listed fauna species.

1.2 SURVEY OBJECTIVES

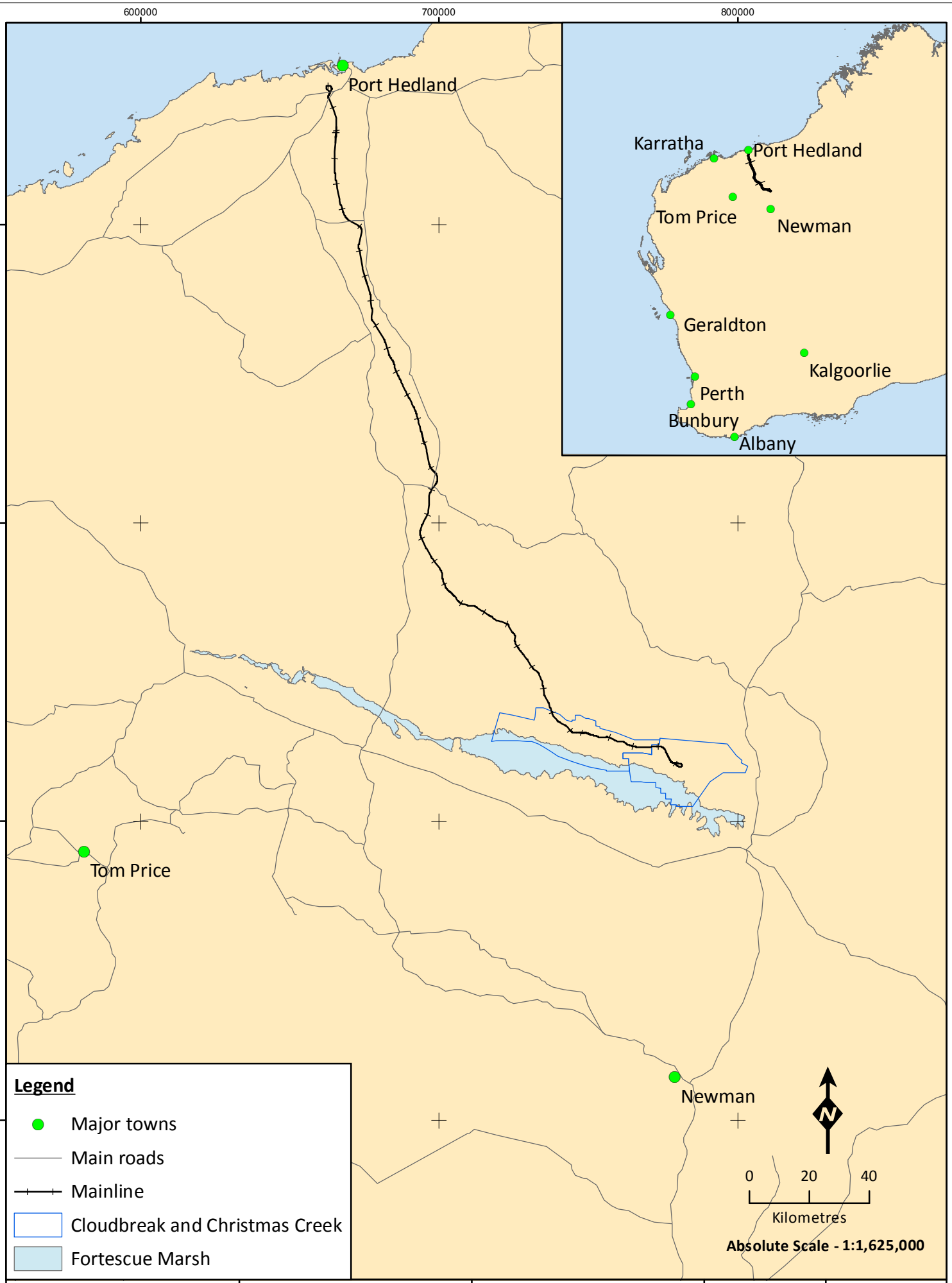
The scope of work is to undertake a highly consultative process with the Department of Environment and Conservation (DEC) (now Department of Parks and Wildlife (DPaW)) to design and conduct annual monitoring programs for the EPBC listed threatened fauna species. The programs were undertaken in accordance with the objectives and methodology outlined in the Fauna Monitoring Guidelines as described in the fauna management plan, as well as in accordance with the EPA Guidance Statement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002), *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010) and species specific survey methodology (Section 2) and monitoring guideline documents (DEC 2009; Oakley *et al.* 2003)

Fauna monitoring conducted in this program will assist in identifying potential direct and indirect impacts associated with the construction and operation of this Project on conservation significant fauna species. It allows for the development of management measures that maximize the protection and long-term conservation of the species adjacent to the Mainline.

In accordance with the above listed guidelines, the monitoring program was conducted to:

- Measure the impacts of the Project over time by undertaking ongoing annual monitoring of EPBC Act listed threatened fauna species.
- Measure the success of management measures to inform an adaptive management approach that may be implemented during construction of the remaining sections of the line.
- Determine the usage and success of culverts in areas of habitat for EPBC Act listed threatened fauna species over the duration of the fauna monitoring program.

The fauna management plan requires “detailed population monitoring” using systematic monitoring sites to be conducted for the Mulgara and the Greater Bilby along the Mainline, as well as “hot spot” monitoring sites for other EPBC Act listed species which may occur in the area, but in numbers considered to be insufficient for meaningful population monitoring. These other species include the Night Parrot, Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat.



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FMG Fortescue The New Force in Iron Ore

Mainline location map

Figure: 1.1	**Drawn: BG**
Project ID: 1463	**Date: 8/2/13**

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

Unique Map ID: BG274

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2 SURVEY METHODS

Survey methods adopted by *ecologia* Environment (*ecologia*) are in accordance with EPA Guidance Statement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002), *Technical Guide – Terrestrial Vertebrate Fauna surveys for Environmental impact Assessment* (EPA and DEC 2010) and the fauna management plan.

Species specific survey methodology used for the Northern Quoll, Greater Bilby and Mulgara were in accordance with survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011c). The Northern Quoll methodology also aligns with EPBC Act Referral Guidelines for the Endangered Northern Quoll (*Dasyurus hallucatus*) (DSEWPaC 2011a). Pilbara Leaf-nosed Bat survey methodology aligns with survey Guidelines for Australia's Threatened Bats (DSEWPaC 2011b). Pilbara Olive Python survey methodology aligns with Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011d). Night Parrot survey methodology aligns with Guidelines for Australia's Threatened Birds (DSEWPaC 2010), ongoing Night Parrot monitoring from Bamford Consulting Ecologists at Cloudbreak (Bamford 2012), as well as consultation with DPaW.

Monitoring surveys were conducted between August 2012 and May 2013, in seasons appropriate to maximise the likelihood of recording each EPBC listed species, determined as per relevant guidelines (DSEWPaC 2010, 2011b, c, d; EPA 2004; EPA and DEC 2010). Survey timing and duration for all monitoring surveys is summarised in Table 2.1

Table 2.1 – Summary of survey timing and duration for each monitoring survey

Survey	Survey Dates	Duration (days)	Person Days
Northern Quoll	2nd Aug – 10th Aug 2012; and 15th Aug – 23rd Aug 2012	18	36
Night Parrot	13th Nov – 21st Nov 2012	9	18
Pilbara Olive Python/Pilbara Leaf-nosed Bat	17th Jan – 23rd Jan 2013	7	14
Greater Bilby/Mulgara	19th May – 27th May 2013	13	104
Total		**60**	**172**

This initial phase of monitoring consisted of a variety of sampling sites:

- Detailed population based monitoring sites (Greater Bilby and Mulgara);
- "Hot spot" monitoring sites (Northern Quoll, Night Parrot, Pilbara Olive Python and Pilbara Leaf-nosed Bat); and
- Opportunistic sampling (all species).

Detailed population based monitoring sites were established as repeatable, permanent locations, where sampling of the majority of potential habitat can be conducted. Data collected from these sites is sampled methodically over a fixed time period in a discrete habitat type, using an equal or standardised sampling effort. The resulting information can be analysed statistically.

"Hot spot" monitoring refers to systematic sampling which is focused on selected locations of potential habitat and does not sample all accessible potential habitat within the impact zone. The "hot spot" monitoring may be repeated and sites may be setup on a permanent basis. However, data collected from "hot spot" monitoring sites is less comprehensive than the data collected from systematic monitoring sites. Results may not be adequate for statistical analsysis.

Opportunistic sampling includes data collected non-systematically from within and outside fixed monitoring sites. This sampling technique is not repeatable and collected data is not suitable for statistical analysis. It includes data such as secondary evidence and allows new populations to be detected and further information to be collected from known populations.

The survey effort was split for each species, where applicable, between impact and control sites. Control sites chosen are located further than 1 km from the Mainline (impact zone), as individuals that occur in these areas are not expected to be impacted by the project.

2.1 HOT SPOT MONITORING

2.1.1 Northern Quoll

2.1.1.1 Timing

The Northern Quoll "hot spot" monitoring was conducted from 2nd to 10th August 2012 and from 15th to 23rd August 2012, which represents the initial periods of the mating season and their highest activity period, in particular for the male Northern Quoll.

2.1.1.2 Monitoring site selection

Northern Quoll trap sites ("hot spot" monitoring sites) were established within both the impact zone and at control sites located within potential habitat at least 4 km from the Mainline. Previous surveys have shown that male Northern Quolls can travel up to 2.8 km during one night and home ranges of up to 4 km (linear distance) during breeding season in the Pilbara are recognised (*ecologia* 2011a, pers. comm. A. Cooke; King 1989; Oakwood 2000). Due to the mobility of the Northern Quoll, establishing control sites greater than the defined impact zone of 1 km from the Mainline ensures that any individuals captured at control sites should have no interaction with and impact from the rail.

Site locations were determined by the presence of suitable habitat identified during a reconnaissance survey, review of aerial photography and literature, ground truthing and the accessibility during monitoring. All trapping sites were required to be accessible on a daily basis to perform trap check within three hours of sunrise. Areas of potential habitat not sampled through the use of systematic monitoring sites were sampled using camera traps (motion cameras).

Some impact sites (ML NQI4 and ML NQI5) were sub-divided into separate sites. This was due to these sites consisting of small isolated patches of habitat. Locations of monitoring sites and camera trap sites are shown in Figure 2.3 and Table 2.2. Site descriptions for all "hot spot" monitoring sites are listed in Appendix A.

Table 2.2 – Location of Northern Quoll "hot spot" monitoring sites

"Hot spot" monitoring site	Location	
	Easting	Northing
Impact Site NQ 1 (ML NQI1)	674207	7686668
Impact Site NQ 2 (ML NQI2)	687443	7647611
Impact Site NQ 3 (ML NQI3)	692463	7635255
Impact Site NQ 4(ML NQI4A)	696759	7589543
Impact Site NQ 4B (ML NQI4B)	697320	7588236
Impact Site NQ 4C (ML NQI4C)	700813	7583899
Impact Site NQ 5A (ML NQI5A)	696647	7607408
Impact Site NQ 5B (ML NQI5B)	696597	7605324
Impact Site NQ 5C (ML NQI5C)	693971	7595229
Control Site NQ 1 (ML NQC1)	674338	7643620
Control Site NQ 2 (ML NQC2)	676947	7636586
Control Site NQ 3 (ML NQC3)	691657	7613294

Datum: GDA 94
Zone: 50K

2.1.1.3 Sampling methods

The Northern Quoll monitoring was undertaken using "hot spot" monitoring and opportunistic sampling techniques. "Hot spot" monitoring sites did not cover all areas of potential habitat present along the Mainline. Opportunistic sampling includes data collected non-systematically from within and outside fixed monitoring sites.

A total of nine impact sites consisting of 122 traps, and three control sites comprising 61 traps were established. The traps consisted of extra-large Elliott box traps which were setup within potential Northern Quoll habitat such as granite outcrops and boulders. Traps were left open for seven consecutive nights, which resulted in a total of 854 trap nights at impact sites and 427 trap nights at control sites.

In addition to trapping, camera trapping sites using four motion cameras were established inside and outside the impact zone of the Mainline at systematic and opportunistic sites, to increase the likelihood to detect Northern Quolls. Camera traps were deployed for a total of 576 hrs to determine the absence or presence of Northern Quolls.

The following morphological parameters were recorded for each captured Northern Quoll: weight, sex, head and short pes length, reproductive condition and health condition noted (ascertained from thickness of tail and general appearance: 1 = Poor, 3 = Average, 5 = Good). In addition, the reproduction state was noted for females (development of pouch/presence of pouch young). Tissue samples were taken from animals and lodged with the WA Museum.

2.1.2 Night Parrot

2.1.2.1 Timing

The monitoring was conducted from 13th to 21st November 2012. Survey timing was determined to coincide with the hottest time of year (Appendix B) prior to any significant rainfall, to enhance the likelihood of observing the Night Parrot at waterholes (current primary detection method).

2.1.2.2 Monitoring site selection

The survey methods for this phase of the monitoring consisted of "hot spot" monitoring sites at waterholes, camera trapping, and the establishment of three permanent feeding stations. All current water points along the Mainline were documented on the first day of monitoring by driving the length of the Mainline.

In 2005, the Night Parrot was recorded at Minga Well by waterhole observation (Bamford 2005). Feeding stations were therefore positioned within rocky ranges, with two stations in close proximity to drainage lines which link up to the drainage system entering in to the Fortescue Marsh, near Minga Well. These locations were selected by assessing aerial photography prior to mobilisation.

Night Parrot "hot spot" monitoring sites and opportunistic sites are described in detail below and their locations are shown in Figure 2.4, with water point and feeding site descriptions outlined in greater detail in Appendix A.

2.1.2.3 Sampling methods

Monitoring was undertaken using a variety of sampling techniques. The primary survey methods for this phase of the monitoring were, as discussed, opportunistic searches at waterholes and camera trapping, with an added method of establishing permanent feeding stations. Details of these sampling methods are described below. The survey effort for the current phase of the monitoring program was:

- 15 hours of water point surveys;
- 15 hours of listening surveys;
- 51.1 hours nocturnal road spotting;
- opportunistic searching for secondary evidence;
- 381.5 hours of camera trapping;
- establishment of three permanent feeding stations; and
- 168 hours of SM2Bat acoustic recordings.

2.1.2.4 Water point surveys

Stationary opportunistic observations were conducted at water sources prior to sunset and until visible observations were no longer possible due to darkness. A spotlight was then used to scan the edge of the water. The primary focus was to visually observe birds that visited the water to drink. A total of 15 hours were invested in water point surveys. Table 2.3 lists the locations of all water points and observation survey effort. Due to the length of the rail, water observations were focussed on the most suitable and accessible locations.

Table 2.3 – Location of water points and observation survey effort

Location	Easting	Northing	Survey Effort (min)
Chainage 37	665935	7711813	0
Chainage 54	674098	7697778	0
Chainage 77	677181	7674961	120
Chainage 137	697340	7614183	0
Chainage 151	696756	7606350	154
Chainage 170	697185	7589111	0
Chainage 190	707122	7573469	210
Chainage 214	725640	7559718	0
Chainage 227	733666	7550184	0
Chainage 229	734143	7548070	286
Chainage 231	734800	7546231	130
Chainage 242	738422	7535414	0
Total			900

Datum: GDA 94
Zone: 50K

2.1.2.5 Listening surveys

Listening surveys were conducted in conjunction with waterhole surveys. During waterhole surveys, observers were positioned in strategic locations to listen for birds calling while flying in to water points. Survey effort was equivalent to that at water point surveys, with a total of 15 hours invested.

2.1.2.6 Spotlighting

Visual searches using spotlights from a vehicle were conducted in an attempt to observe foraging individuals. Survey effort totalled 10.9 hours for road spotting during the Night Parrot monitoring and an additional 40.2 hours during the Pilbara Olive Python monitoring, which is considered also relevant survey effort for the Night Parrot.

2.1.2.7 Opportunistic searches

Throughout the monitoring, any signs of foraging individuals (e.g. tracks, snipped stems of spinifex and feathers) plus evidence of nesting or roosting (holes leading under spinifex clumps) were recorded if observed.

2.1.2.8 Camera trapping

Motion sensitive cameras were deployed at water points to attempt to document Night Parrots coming in to drink. The setup used during monitoring is shown in Figure 2.1. Motion cameras were deployed for a total of 381.5 hours, with camera trap locations and survey effort shown in Table 2.4 and Figure 2.4.

Table 2.4 – Location of camera traps and survey effort

Location	Easting	Northing	Survey Effort (hours)
Chainage 54	674098	7697778	88.75
Chainage 77	677181	7674961	34.5
Chainage 137	697340	7614183	15
Chainage 190	707122	7573469	40.5
Chainage 229	734143	7548070	111.75
Chainage 242	738422	7535414	91
Total			**381.5**

Datum: GDA 94
Zone: 50K

Figure 2.1 – Motion camera setup at water point chainage 54

2.1.2.9 Feeding stations

Three artificial feeding stations were installed in areas suitable for roosting or foraging Night Parrots (Table 2.5, Figure 2.4), to attract individuals which may occur locally. It is anticipated that local birds will become familiar with these stations and regularly utilise them as a food source. Feeding stations consist of a rectangular grain feeder, each filled with 40 kg of Chicken Starter Pellets. Each feeding station is currently monitored by a motion sensitive camera (Reconyx HC500) to record activity. This setup was installed for permanent and ongoing recording and will be checked during future monitoring.

Motion cameras were setup to record all fauna visiting the feeding station. Vegetation in the immediate vicinity of the feeders was cleared to eliminate the potential for the motion camera to false trigger. Motion cameras were secured to a star picket, with wire tie downs attached to eliminate all movement and prevent false triggers. Feeding stations were established during the Night Parrot phase of this monitoring (14th November 2013), with images recorded from cameras downloaded and analysed during the Greater Bilby/Mulgara phase of this monitoring (24th May 2013). This totals 192 days of monitoring for each feeding station. A photograph of Feeding Station 3 and motion camera setup is shown in Figure 2.2.

Table 2.5 – Feeding station locations

Feeding Station	Easting	Northing
Feeding station 1	725917	7561680
Feeding station 2	734252	7548100
Feeding station 3	738451	7535503

Datum: GDA 94
Zone: 50K

Figure 2.2 – Image showing feeding station 3 and motion camera setup

2.1.2.10 Sound recording devices

Wildlife Acoustic Song Meter SM2BAT+ platforms (SM2BAT) equipped with acoustic microphones were deployed in potential roosting or foraging habitat for Night Parrots. Each device was setup to record between the hours of sunset and sunrise. Recorded audio files were analysed to identify frequencies and patterns of calls that could potentially match the call of the Night Parrot, based on descriptions of their call in literature and the elimination of by-catch species.

A total of 168 hours of recordings were made and subsequently analysed. Details of SM2BAT locations are listed in Table 2.6.

Table 2.6 – Night Parrot SM2BAT locations

Site	Easting	Northing	Recording Length (hours)
ML NP SM2-1	695889	7624745	12
ML NP SM2-2	695889	7624745	12
ML NP SM2-3	736015	7541476	12
ML NP SM2-4	736015	7541476	12
ML NP SM2-5	738558	7535383	12
ML NP SM2-6	750178	7529593	12
ML NP SM2-7	750178	7529593	12
ML NP SM2-8	734164	7548083	12
ML NP SM2-9	675355	7682126	12
ML NP SM2-10	675355	7682126	12
ML NP SM2-11	744341	7530305	12
ML NP SM2-12	744341	7530305	12
ML NP SM2-13	734490	7547266	12
ML NP SM2-14	718335	7568137	12
Total			**168**

Datum: GDA 94
Zone: 50K

In addition, an Olympus hand held digital audio recorder was positioned to record bird calls during surveys at the waterhole.

2.1.3 Pilbara Olive Python

2.1.3.1 Timing

The Pilbara Olive Python monitoring was conducted from 17th to 23rd January, 2013, during hot, humid and wet conditions, representing a period of high activity for the Pilbara Olive Python.

2.1.3.2 Monitoring site selection

"Hot spot" monitoring sites in the form of pre-determined, repeated road spotting transects were selected through an assessment of aerial photography and available access tracks. Nocturnal road spotting routes are shown in Figure 2.5.

2.1.3.3 Sampling methods

The monitoring was undertaken by completing repeated nocturnal road spotting transects, and nocturnal active searches at known water points. Survey effort conducted during the current phase of the monitoring program consisted of:

- 51.1 person hours of nocturnal road spotting; and
- 15 hours of active searches at water points.

2.1.3.4 Nocturnal road spotting

Nocturnal road spotting was conducted along pre-determined transects. The vehicle was driven at a slow pace (approximately 40 km/hour). Vertebrate fauna was identified from the vehicle while driving, or otherwise once an animal was observed, the vehicle stopped and the animal identified. Areas of potential interest such as pools of water and rocky areas were investigated on foot and

searched with a head torch. Table 2.7 shows the nocturnal road spotting transects conducted, along with survey effort for this phase of the monitoring program.

Table 2.7 – Locations of nocturnal road spotting transect routes

Transect Name	Distance (km)	Person hours
Impact Route 1	70	16.3
Impact Route 2	98	14.2
Control Route 1	68	3
Control Route 2	63	6.7
Total		**40.2**

Datum: GDA 94
Zone: 50K

2.1.4 Pilbara Leaf-nosed Bat

2.1.4.1 Timing

Bat echolocation call recordings were carried out during two separate monitoring phases. The first was conducted in conjunction with the Pilbara Olive Python phase from 17th to 23rd January 2013, during hot, humid and wet conditions. The second was during the Greater Bilby/Mulgara survey, 17th to 29th May 2013, in cooler conditions.

2.1.4.2 Monitoring site selection

"Hot spot" survey locations were focussed within two areas, the rocky areas of the Chichester Ranges, and the granite boulder and outcrop habitat within the Abydos Plain. Both habitats represent the most suitable habitat for this species along the Mainline. "Hot spot" survey locations are shown in Figure 2.6 and Table 2.8.

2.1.4.3 Sampling methods

The Pilbara Leaf-nosed Bat was targeted using SM2BAT devices equipped with ultrasonic microphones. Survey effort included:

- 144 hours of SM2BAT recordings analysed.

2.1.4.4 Sound recording devices

Ultrasonic microphones were attached to SM2BAT recorders and used to record bat calls along the Mainline. Each device was setup to record between the hours of sunset and sunrise. Recorded audio files were analysed to determine the presence or absence of the Pilbara Leaf-nosed Bat.

Details of SM2BAT recording locations are shown in Table 2.8 and Figure 2.6.

Table 2.8 – Pilbara Leaf-nosed Bat SM2BAT locations along the Mainline

Site	Easting	Northing	Recording Length (hours)
SM2 4683 18/1	727363	7556992	12
SM2 4683 19/1	730033	7553660	12
SM2 4683 20/1	717360	7568862	12
SM2 4683 22/1	693932	7595344	12
SM2 4679 18/1	725568	7562050	12
SM2 4679 19/1	735449	7543459	12
SM2 4679 20/1	743051	7531669	12
SM2 4679 22/1	704603	7576210	12
SM2 6035 18/1	734171	7548089	12
SM2 6035 19/1	738425	7535420	12
SM2 6035 20/1	750234	7529574	12
SM2 6035 22/1	696681	7605354	12
SM2 4683 21/5	683546	7656800	24
SM2 4683 23/5	677536	7669985	24
SM2 4699 21/5	685224	7652369	72
SM2 4699 23/5	687260	7647572	72
Total			**144**

Datum: GDA 94
Zone: 50K

2.2 DETAILED POPULATION BASED MONITORING

2.2.1 Mulgara

2.2.1.1 Timing

Mulgara monitoring was conducted from the 17th to 29th May 2013. Survey timing was completed in accordance with relevant guidelines to not interfere with the Mulgara breeding season (October-November, DSEWPaC 2011c).

2.2.1.2 Monitoring site selection

The monitoring program consists of the establishment of 12 long term systematic monitoring sites, comprising six impact sites and six control sites. To ensure suitable systematic monitoring sites are established, the focus of this phase of monitoring was to determine as many potential monitoring sites as possible (based on detecting presence of Mulgara or determining areas of suitable habitat). Since the conclusion of the initial phase of monitoring, an assessment has been made to determine the most suitable locations for the establishment of systematic monitoring sites, based on the presence of Mulgara or suitable habitat.

Table 2.9 displays the locations of proposed systematic impact and control monitoring sites. These locations, along with all other sampling sites are mapped in Figure 2.7.

Prior to this monitoring phase, all previous records of Mulgara along the Mainline (ATA 2007, NatureMap 2013; Bamford 2010; Biota 2004) were reviewed. The locations of previous records were then targeted during the sampling and complimented with previously unsurveyed areas representing suitable habitat. All monitoring and opportunistic sampling sites are displayed in Table 2.10. Due to

the similar habitat requirements for Greater Bilby and Mulgara, all sampling sites were searched for evidence of both species. The area between chainage 155 and chainage 225 was observed from vehicles and assessed for habitat suitability due to previous records in this area. No suitable habitat was identified in this area (excluding the small area covered by Solomon Rail Mulgara monitoring (*ecologia* 2013b), hence no opportunistic surveying was conducted here.

Table 2.9 – Mulgara systematic monitoring sites

Site	Easting	Northing
Proposed impact sites		
Mainline Mulgara Impact Site 1(ML MI1)	664430	7739888
ML MI3	668366	7703776
ML MI2	665548	7725510
ML MI4	697318	7609625
ML MI5	699109	7615700
ML MI6	693303	7635131
Proposed control site		
Mainline Mulgara Control Site 1 (ML MC1)	660015	7734573
ML MC2	668029	7700850
ML MC3	673043	7685019
ML MC4	704734	7609671
ML MC5	699989	7610712
ML MC6	690925	7613088

Datum: GDA 94
Zone: 50K

Table 2.10 – Mulgara and Greater Bilby opportunistic sites

Site	Easting	Northing
Bilb/Mul Opp 1	697555	7609744
Bilb/Mul Opp 2	699926	7615883
Bilb/Mul Opp 3	695183	7612661
Bilb/Mul Opp 4	692479	7612353
Bilb/Mul Opp 5	682559	7659700
Bilb/Mul Opp 6	687508	7648032
Bilb/Mul Opp 7	690876	7641373
Bilb/Mul Opp 8	693888	7637935
Bilb/Mul Opp 9	695930	7628790
Bilb/Mul Opp 10	697853	7618839
Bilb/Mul Opp 11	697617	7615404
Bilb/Mul Opp 12	700841	7614075
Bilb/Mul Opp 13	702667	7614334
Bilb/Mul Opp 14	698666	7613677
Bilb/Mul Opp 15	699109	7615700
Bilb/Mul Opp 16	696750	7606754
Bilb/Mul Opp 17	697318	7609625
Bilb/Mul Opp 18	693723	7634951
Bilb/Mul Opp 19	696907	7619135
Bilb/Mul Opp 20	695280	7626225
Bilb/Mul Opp 21	694514	7628846
Bilb/Mul Opp 22	697356	7617868
Bilb/Mul Opp 23	698161	7618035
Bilb/Mul Opp 24	677414	7668492
Bilb/Mul Opp 25	681500	7663010
Bilb/Mul Opp 26	710923	7602459
Bilb/Mul Opp 27	693595	7632409
Bilb/Mul Opp 28	697329	7618309
Bilb/Mul Opp 29	698105	7616643
Bilb/Mul Opp 30	702389	7608770
Bilb/Mul Opp 31	705246	7604690
Bilb/Mul Opp 32	703120	7606185
Bilb/Mul Opp 33	704734	7609671
Bilb/Mul Opp 34	707309	7609079
Bilb/Mul Opp 35	685718	7650591
Bilb/Mul Opp 36	684096	7655188
Bilb/Mul Opp 37	699989	7610712
Bilb/Mul Opp 38	693303	7635131
Bilb/Mul Opp 39	688463	7613122
Bilb/Mul Opp 40	690925	7613088
Bilb/Mul Opp 41	663690	7745761
Bilb/Mul Opp 42	662977	7745201
Bilb/Mul Opp 43	663767	7745144
Bilb/Mul Opp 44	663412	7744619
Bilb/Mul Opp 45	660015	7734573
Bilb/Mul Opp 46	664430	7739888
Bilb/Mul Opp 47	666347	7734588
Bilb/Mul Opp 48	666810	7730820
Bilb/Mul Opp 49	665548	7725510
Bilb/Mul Opp 50	665390	7723623
Bilb/Mul Opp 51	665965	7722045
Bilb/Mul Opp 52	666046	7718319
Bilb/Mul Opp 53	665616	7716344
Bilb/Mul Opp 54	667841	7712406
Bilb/Mul Opp 55	665507	7710852
Bilb/Mul Opp 56	667268	7709432
Bilb/Mul Opp 57	664832	7708098
Bilb/Mul Opp 58	667824	7705996
Bilb/Mul Opp 59	668500	7703855
Bilb/Mul Opp 60	670146	7701847
Bilb/Mul Opp 61	666997	7701044
Bilb/Mul Opp 62	668018	7700656
Bilb/Mul Opp 63	671681	7700887
Bilb/Mul Opp 64	673074	7700203
Bilb/Mul Opp 65	674366	7697175
Bilb/Mul Opp 66	673493	7693365
Bilb/Mul Opp 67	674103	7689987
Bilb/Mul Opp 68	674419	7685993
Bilb/Mul Opp 69	673043	7685019
Bilb/Mul Opp 70	675349	7682544
Bilb/Mul Opp 71	676816	7678008
Bilb/Mul Opp 72	674990	7676183
Bilb/Mul Opp 73	677299	7675935

Datum: GDA 94
Zone: 50K

2.2.1.3 Sampling methods

The locations of previous records were the primary focus of the monitoring, followed by areas of potential habitat. Opportunistic sites consisted of conducting walking transects and searches of recent evidence and activity such as burrows, tracks and scats. Where evidence was noted, opportunistic camera trapping and baited Elliott trapping was conducted to attempt to confirm the presence or absence of Mulgara. At each search site shown in Table 2.10, a minimum 500 m transect was completed searching for evidence. A total of 73 sites were surveyed utilising four staff, resulting in 146 km of transects completed during this phase of monitoring.

Future monitoring will consist of 50 medium sized Elliot traps, five lines (50 m apart) of 10 traps spaced 20 meters apart. This method is consistent with systematic monitoring site setup for the concurrent Solomon Rail Monitoring (*ecologia* 2013b). Each trap point is marked with a metal fence dropper. Each monitoring site will have traps opened for seven nights.

The following morphological parameters were recorded for each captured Mulgara: weight, sex, head and short pes length, reproductive condition and health condition noted (ascertained from thickness of tail and general appearance: 1 = Poor, 3 = Average, 5 = Good). In addition, the reproduction state was noted for females (development of pouch/presence of pouch young). Tissue samples were taken from animals and lodged with the WA Museum.

2.2.2 Greater Bilby

2.2.2.1 Timing

Monitoring was conducted from the 17th to 29th May 2013. There is no specific recommendation on the survey timing for Greater Bilbies. However, hot summer temperatures should be avoided to reduce heat related issues (DSEWPaC 2011c).

2.2.2.2 Monitoring site selection

Prior to this monitoring phase, all previous records of Greater Bilby along the Mainline were reviewed. These areas were ground truthed with a focus on areas representing potential habitat. Due to the similar habitat requirements for Greater Bilby and Mulgara, all sampling sites were searched for evidence of both species. These sites are displayed in Table 2.10. The area between chainage 155 and chainage 225 was driven and ground truthed due to some previous records in this area. No suitable habitat was recorded in this area (excluding the small area covered by the Solomon Rail Monitoring (*ecologia* 2013b), hence no opportunistic surveying was conducted within this area.

Due to confirmation of Greater Bilby activity during opportunistic searches, four sites (two impact and two control) were subsequently established as systematic monitoring sites for the next phase of monitoring. During the current monitoring, cage trapping was established at one impact site where habitat was highly suitable for the Greater Bilby (as per the Fauna Management Plan). Greater Bilby monitoring site locations are shown in Table 2.11. Opportunistic sites and monitoring sites for Greater Bilbies are mapped in Figure 2.8.

Table 2.11 – Systematic monitoring sites for Greater Bilbies

Site	Easting	Northing	Datum	Zone
Impact				
ML B2	693303	7635131	GDA 94	50K
ML B3	697356	7617868	GDA 94	50K
Control				
ML B1	693888	7637935	GDA 94	50K
ML B4	700841	7614075	GDA 94	50K

2.2.2.3 Sampling methods

The selection of site locations was based on previous records and areas of suitable habitat. Opportunistic searches consisting of walking transects and searches for evidence (primarily being old burrows and diggings) were completed at the survey sites. Where secondary evidence was discovered, more intensive searching was conducted in the area to search for fresher activity, such as diggings and tracks. Where fresh diggings were recorded, indicating an active individual being present, searches were conducted to try to locate the active burrows for the individual.

Once an active burrow was recorded, searches were expanded to locate further burrows. Active burrows then had camera traps placed at the entrance of the burrow. This attempted to confirm the current Greater Bilby activity for the burrow.

Due to obvious active signs (i.e. burrows) of the Greater Bilby and easy accessibility at monitoring site ML B4, cage traps were established at a trapping rate of 1 trap per 100 linear metres (as per the Fauna Management Plan) in an attempt to trap individuals. A total of 14 cage traps from 20th to 26th May 2013, resulting in 42 trap nights of survey effort was completed. Due to the apparent ineffectiveness of cage traps capturing Greater Bilbies, and logistical constraints in checking traps (distance from road significantly increasing time to check traps, putting captured individuals at risk of injury), this method was not employed at the remaining monitoring sites during the current monitoring phase.

2.3 CULVERT MONITORING

Culverts have been constructed under the rail of Mainline to allow surface water flows to be maintained. It is known that fauna utilise culverts to move across their range (Clevenger *et al.* 2001), with utilisation of culverts reducing the risk of mortality by train collision. Consistent with the FMP, the monitoring program aims to determine the usage and success of culverts in areas of habitat for EPBC Act listed threatened fauna species.

Methods used for culvert monitoring as required within the FMP include:

- recording of secondary evidence (tracks and scats) of fauna species using sand pans;
- recording sightings of fauna utilising culverts; and
- recording fauna using motion cameras.

This initial year of monitoring included recording fauna species utilising culverts through secondary evidence and direct sightings only. Sand pans were not required within the culvert, as soil texture is naturally sandy allowing for clear fauna tracks to be identified. As required within the FMP, culvert monitoring should be completed in areas of habitat and populations of the targeted EPBC listed conservation significant species. It was assessed that following the results of this initial year of monitoring, culverts will be monitored via motion cameras strategically selected in areas where habitats for EPBC Act listed have now been identified or confirmed. Motion cameras will be established on these culverts in the next phase of annual monitoring, with locations and survey effort repeated annually.

2.4 TAXONOMY AND NOMENCLATURE

Nomenclature for mammals, reptiles and amphibians within this report is as per *Western Australian Museum Checklist of the Vertebrates of Western Australia*, birds according to Christidis and Boles (2008). References used for fauna identification are listed in Table 2.12.

Table 2.12 – References used for identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (1998), Menkhorst and Knight (2011)
Birds	Simpson and Day (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr *et al*. (1990), Wilson and Swan (2010)
Skinks	Storr *et al*. (1999), Wilson and Swan (2010)
Dragons	Storr *et al*. (1983), Wilson and Swan (2010)
Varanids	Storr *et al*. (1983), Wilson and Swan (2010)
Legless Lizards	Storr *et al*. (1990), Wilson and Swan (2010)
Snakes	Storr *et al*. (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)

2.5 ANIMAL ETHICS

Surveying was conducted as per *ecologia*'s Animal Ethics Code of Practice, which conforms to Section 5 of the *Australian code of practice for the care and use of animals for scientific purposes* (NHMRC 2004).

In all cases, fauna were identified in the field and released at the point of capture. A single specimen of Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) was vouchered due to a request from the WA Museum who is currently conducting genetic analysis of this genus (Voucher number WAMTS196).

2.6 SURVEY TEAM AND LICENCES

Field survey team members are listed in Table 2.13 and external consultants listed in Table 2.14. The monitoring phases were conducted under DEC Regulation 17 Licence SF008957, SF009266 and SF008763.

Table 2.13 – Field survey personnel

Survey Member	Expertise	Qualification	Experience
Northern Quoll			
Nigel Jackett	Ornithology	B.Sc. (Hons)	8 years
Bruce Greatwich	Ornithology	B.Sc.	5 years
Hannah Pusey	Mammalogy	B.Sc. (Hons)	3 years
Night Parrot			
Nigel Jackett	Ornithology	B.Sc. (Hons)	8 years
Bruce Greatwich	Ornithology	B.Sc.	5 years
Pilbara Olive Python/Pilbara Leaf-nosed Bat			
Bruce Greatwich	Ornithology	B.Sc.	5 years
Leigh Smith	Herpetology	-	4 years
Greater Bilby/Mulgara			
Bruce Greatwich	Ornithology	B.Sc.	5 years
John Graff	Ornithology	B. Sc.	5 years
Farhan Bokhari	Zoology	B. Sc. (Hons)	5 years
Jordan DeJong	Zoology	B. Sc. (Hons)	5 years
Louisa Robertson	Mammalogy	M. Sc.	4 years
Adam Young	Zoology	B. Sc.	3 years
Jesse Forbes-Harper	Zoology	B.A., B.Sc. (Hons)	3 years
Anna Nowicki	Zoology	B.Sc. (Hons)	3 years

Table 2.14 – External consultant

External Consultant	Institution	Relevant Experience
Bob Bullen	Bat Call WA	15 years – bat call IDs

650000
700000
750000
800000
7750000
7700000
7650000
7600000
7550000
7500000

GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
INDEE ROAD
PIPPINGARRA ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Impact Site 1
Impact Site 2
Impact Site 3
Control Site 1
Control Site 2
Control Site 3
Impact Site 5A
Impact Site 5B
Impact Site 5C
Impact Site 4A
Impact Site 4B
Impact Site 4C

Legend

- Control site
- Impact site
- Camera trap
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 20 40
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Northern Quoll monitoring sites

Figure: 2.3
Project ID: 1463

Drawn: BG
Date: 4/2/13

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

Unique Map ID: BG272

A3

650000
700000
750000
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7750000
7700000
7650000
7600000
7550000
7500000

GOLDSWORTHY SHAY GAP ROAD
PIPPINGARRA ROAD
NORTH WEST COASTAL HIGHWAY
INDEE ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
WNEY DOWNS HILLSIDE ROAD
ITTENOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Ch 37 water point
Ch 54 water point
Ch 77 water point
Ch 137 water point
Ch 151 water point
Ch 170 water point
Ch 190 water point
Feeding station 1
Ch 214 water point
Ch 227 water point
Feeding station 2
Ch 229 water point
Ch 231 water point
Ch 242 water point
Feeding station 3

Feeding station 2
Ch 229 water point
Ch 231 water point

Feeding station 3
Ch 242 water point

Legend

- Camera trap
- Feeding station
- SM2 recording
- Water point
- Water point survey
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Night Parrot monitoring sites

Figure: 2.4
Project ID: 1463

Drawn: BG
Date: 3/1/13

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

Unique Map ID: BG266

A3

650000
700000
750000
800000
7750000
7700000
7650000
7600000
7550000
7500000

Ch 0
0km
Ch 25
Ch 50
Ch 75
Ch 100
Ch 125
Ch 150
Ch 175
Ch 200
Ch 225
Ch 250
Ch 275

NORTH WEST COASTAL HIGHWAY
GOLDSWORTHY SHAY GAP ROAD
PIPPINGARRA ROAD
INDEE ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
WITTENOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

- Impact route 1
- Impact route 2
- Control route 1
- Control route 2
- Rail Camp 195
- Mainline
- Railway Chainage
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Pilbara Olive Python monitoring routes

Figure: 2.5
Project ID: 1463

Drawn: BG
Date: 14/1/13

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

Unique Map ID: BG268

A3

650000
700000
750000
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7750000
7700000
7650000
7600000
7550000
7500000
Ch 0
0km
Ch 25
Ch 50
Ch 75
Ch 100
Ch 125
Ch 150
Ch 175
Ch 200
Ch 225
Ch 250
Ch 275
NORTH WEST COASTAL HIGHWAY
PIPPINGARRA ROAD
INDEE ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
GOLDSWORTHY SHAY GAP ROAD
MARBLE BAR ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD
N
0 10 20
Kilometres
Absolute Scale - 1:750,000

Legend

- SM2BAT locations
- Rail Camp 195
- Mainline
- Impact zone
- Railway Chainage
- Cloudbreak and Christmas Creek
- Fortescue Marsh

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Pilbara Leaf-nosed Bat SM2Bat locations

Figure: 2.6
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG269

A3

650000
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7750000
7700000
7650000
7600000
7550000
7500000

Ch 0
ML MI1
ML MC1
ML MC Option
ML MI2
Ch 25
ML MC Option
ML MI3 (proposed)
ML MC2
Ch 50
ML MC Option
ML MC3
Ch 75
Ch 100
ML MC Option
ML MI6
Ch 125
ML MI5
ML MC6
ML MC6
ML MC5
ML MI4
ML MC4
Ch 150
Ch 175
Ch 200
Ch 225
Ch 250
Ch 275

GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
NOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

- Mulgara survey sites
- Proposed control monitoring site
- Proposed impact monitoring site
- Railway Chainage
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Mulgara survey sites and proposed monitoring sites

Figure: 2.7
Project ID: 1463
Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG291

A3

650000
700000
750000
800000
7750000
7700000
7650000
7600000
7550000
7500000

Ch 0
Ch 25
Ch 50
Ch 75
Ch 100
ML B1
ML B2
Ch 125
ML B3
ML B4
Ch 150
Ch 175
Ch 200
Ch 225
Ch 250
Ch 275

GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
PIPPINGARRA ROAD
INDEE ROAD
PORT HEDLAND WITTENOOM ROAD
GREAT NORTHERN HIGHWAY
MARBLE BAR ROAD
HILLSIDE MARBLE BAR ROAD
HILLSIDE WOODSTOCK ROAD
BONNEY DOWNS HILLSIDE ROAD
WITTENOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

- Monitoring sites
- Opportunistic sites
- Railway Chainage
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Greater Bilby survey sites and monitoring sites

Figure: 2.8
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG292

A3

3 RESULTS

3.1 HOT SPOT MONITORING

3.1.1 Northern Quoll

Two individual male Northern Quolls were captured at impact site 5B (individual I20 shown in Figure 3.1). Additional Northern Quoll individuals were recorded from six locations from within the impact zone using camera traps (Figure 3.2). Northern Quoll records from this monitoring phase are mapped in Figure 3.15 and summarised in Table 3.1. Additional records were made during the targeted Night Parrot and Greater Bilby/Mulgara monitoring, where a single individual was captured from a camera trap drinking from a water point, and tracks recorded in two separate creeklines. Morphological data of the captured individuals are listed in Table 3.2.

Table 3.1 – Summary of Northern Quolls recorded from the impact zone

Site	Easting	Northing	Notes
NQ Impact 5B	696624	7605329	Individual ID I10 captured from trap point 4
NQ Impact 5B	696610	7605140	Individual ID I20 captured from trap point 8
Opportunistic camera trap	677268	7674893	-
Opportunistic camera trap	677140	7674954	-
Opportunistic camera trap	675916	7680865	-
Opportunistic camera trap	677554	7674763	-
Opportunistic camera trap	677149	7675051	-
Opportunistic camera trap	675951	7680739	-
Opportunistic camera trap	674098	7697778	Camera trap – Night Parrot monitoring
Opportunistic	692952	7634867	Tracks in creekline – Greater Bilby/Mulgara monitoring
Opportunistic	671697	7700806	Tracks in creekline – Greater Bilby/Mulgara monitoring

Datum: GDA 94
Zone: 50K

Table 3.2 – Morphological details of Northern Quolls captured at impact sites

Quoll ID	Sex	Date of Capture	Trap No.	Easting	Northing	Weight (g)	Short Pes (mm)	Head (mm)	Caudal Width (mm)	Reproduction Status	Condition
I10	M	17/08/12	I5B E4	696624	7605329	865	40	79	21	Sternal gland present indicating male territory marking	2 / 5
I20	M	20/08/12	I5B E8	696610	7605140	755	41	76.5	24.5	Evidence of fighting	4 / 5

Datum: GDA 94
Zone: 50K

Figure 3.1 – Northern Quoll individual I10 captured at impact site 5B

Figure 3.2 – Image of Northern Quoll recorded by motion camera (MC I 8/8)

One male Northern Quoll individual was captured at control site 2 (Figure 3.3). The location of the captured individual is shown in Figure 3.15 and in Table 3.3 with morphological data shown in Table 3.4.

Table 3.3 – Summary of Northern Quolls recorded from the control sites

Site	Easting	Northing	Notes
NQ C2 E24	676699	7635757	Individual ID C10 captured from trap point 8

Datum: GDA 94
Zone: 50K

Table 3.4 – Morphological details of Northern Quoll captured at control sites

Quoll ID	Sex	Date of Capture	Trap No.	Easting	Northing	Weight (g)	Short Pes (mm)	Head (mm)	Caudal Width (mm)	Reproduction Status	Condition
Control sites											
C10	M	7/8/12	C2 E24	676699	7635757	755	38	76	-	Sternal gland present	4.5 / 5

Datum: GDA 94
Zone: 50K

Figure 3.3 – Northern Quoll (M10) captured at control site 2

3.1.2 Night Parrot

No Night Parrots or secondary evidence of Night Parrots was recorded during this initial phase of monitoring.

A total of 62 other bird species were recorded during water point surveys (Appendix E), with 37 of these species recorded from camera trapping.

Fauna captured by motion cameras at the established feeding stations are shown in Appendix F and included a total of four mammal species, 11 bird species and two reptile species.

3.1.3 Pilbara Olive Python

No Pilbara Olive Pythons or secondary evidence of this species was recorded during this initial phase of monitoring.

The nocturnal road spotting and active searches conducted during the Pilbara Olive Python monitoring resulted in seven gecko species, one pygopod, two skinks and eight species of snakes (one blind snake, two pythons and five elapids) being recorded (Appendix G).

3.1.4 Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bats were recorded from two locations. All records were made during the second period of monitoring for this species which was conducted in late autumn (17th to 29th May 2013). The recordings were made within the granite boulder and outcrop habitat. No records were made further south during the first period of monitoring (17th to 23rd January 2013) within the the rocky areas of the Chichester Range. Records are summarised in Table 3.5 and mapped in Figure 3.16.

A total of 10 bat species were recorded (Appendix E).

Table 3.5 – Summary of Pilbara Leaf-nosed Bat records

Site	Date	Easting	Northing	Notes
SM2 4683 23/5	23/5/13	677536	7669985	Three calls recorded, middle of the night
SM2 4683 23/5	24/5/13	677536	7669985	Single call recorded, middle of the night
SM2 4683 23/5	26/5/13	677536	7669985	Single call recorded, middle of the night
SM2 4699 21/5	22/5/13	685224	7652369	Two calls recorded, one call at 1912

Datum: GDA 94
Zone: 50K

3.2 DETAILED POPULATION BASED MONITORING

3.2.1 Mulgara

Mulgara were recorded from seven locations during this initial phase of annual monitoring. These records comprise eight individuals from two sites captured using Elliot traps (Figure 3.4) and detection of presence through secondary evidence and camera trapping (Figure 3.5 and Figure 3.6) at a further five locations. Mulgara locations recorded from this phase of monitoring are summarised in Table 3.6 and mapped in Figure 3.17. Morphological data of individuals captured are shown in Table 3.7.

Table 3.6 – Summary of Mulgara records

Site	Area	Easting	Northing	Survey Technique	Notes
ML MI6	Impact	693105	7635050	Trap capture	Total of seven individuals captured plus camera trap records.
ML MI4	Impact	697318	7609625	Trap capture	Single individual captured
Bilb/Mul Opp 8	Control	693888	7637935	Camera trap	Recorded utilising active burrow
Bilb/Mul Opp 22	Impact	697356	7617868	Camera trap	Recorded on three occasions including a daytime (5:30 pm) record
ML MC2	Control	668029	7700850	Camera trap	Recorded on six occasions
ML MI3	Impact	668366	7703776	Camera trap	Recorded on 13 occasions
Bilb/Mul Opp 12	Control	701991	7614228	Scat	Unconfirmed scat of typical Mulgara size and shape, containing reptile scales

Datum: GDA 94
Zone: 50K

Table 3.7 – Morphological details of Mulgara captured

ID	Site	Sex	Date of Capture	Weight (g)	Short Pes (mm)	Head (mm)	Reproduction Status	Condition (out of 5)
M1	ML MI4	M	18/5/13	102	21.5	44.2	None evident	5
M1	ML MI6	M	24/5/13	85	21.2	49.8	None evident	5
F2	ML MI6	F	24/5/13	70	17.9	40.0	Undeveloped pouch and nipples	5
M3	ML MI6	M	25/5/13	120	23.4	41.0	None evident	5
F4	ML MI6	F	25/5/13	71	20.5	44.7	Undeveloped pouch and nipples	5
M5	ML MI6	M	26/5/13	86	21.6	40.3	None evident	5
M6	ML MI6	M	27/5/13	68	21.9	40.3	None evident	5
F7	ML MI6	F	27/5/13	72	21.2	43.3	Undeveloped pouch and nipples	5

Figure 3.4 – Mulgara captured at site ML MI6

Figure 3.5 – Mulgara captured by camera trap at site Bilb/Mul Opp 22

Figure 3.6 – Mulgara captured by camera trap at site ML MC2

3.2.2 Greater Bilby

Active Greater Bilby populations were recorded from four separate locations, with images of Greater Bilby individuals captured on camera traps at two of these sites. Due to the difficulty in trapping this species, detection of burrows is the primary method for determining presence of this species (DSEWPaC 2011c). An example of an active burrow, diggings and tracks recorded during this monitoring are shown in Figure 3.7, Figure 3.8 and Figure 3.9 respectively. Two sites were recorded in close proximity to the Mainline, within 1 km, are therefore considered within the impact zone (ML B2 and ML B3). Sites ML B1 and ML B4 were recorded further than 1 km from the Mainline and are therefore considered control sites.

In addition to the four active populations recorded, inactive burrows were recorded from a number of other sites, indicating Greater Bilby presence in these locations in the past. The status of Greater Bilby burrows were assessed against the categories in Table 3.8. Greater Bilby burrow information recorded at the four monitoring sites is shown in Table 3.9. Photos of all active Greater Bilby burrows can be seen in Appendix C. The location of all further inactive burrows can be seen in Appendix D. All burrows (inactive and active burrows) are mapped in Figure 3.18. Detailed mapping of Greater Bilby burrows and records at monitoring sites BL B1-4 are shown in Figure 3.19 to Figure 3.22 respectively. Aerial photography for mapping is not available for this location, due to the distance of this population to the Mainline impact zone.

Table 3.8 – Greater Bilby burrow categories

Status	Description
Active	Open entrance to burrow, fresh and lose dirt within entrance. Entrance can contain spider-webs and some plant material if not currently occupied. Other evidence such as recent diggings, tracks or scats present in the vicinity.
Inactive, recently active	Open entrance to burrow. No fresh signs of activity within burrow, soil old and compacted. Spiderwebs and plant material present within burrow. No recent evidence such as fresh diggings, tracks or scats present within the vicinity.
Inactive, old	Burrow that has filled in inside the entrance or completely caved in.

Table 3.9 – Summary of Greater Bilby burrow locations

Burrow	Easting	Northing	Activity status	Camera trap records
ML B1				
BB7	693803	7637975	Inactive, old	-
BB8	693934	7637958	Inactive, old	-
BB9	693927	7638054	Active	-
BB10	693905	7638082	Inactive, old	-
BB11	693876	7638067	Active	-
BB12	693484	7638104	Inactive, recently active	-
BB46	693959	7637911	Inactive, old	-
ML B2				
BB19	693154	7634998	Inactive, recently active	-
BB20	693394	7635205	Active	-
BB21	693303	7635131	Active	Individual recorded on camera trap
BB22	693298	7635073	Active	-
BB23	693175	7635014	Active	Individual recorded on camera trap
BB29	693445	7635204	Active	-
BB30	693374	7635265	Active	-
BB31	693352	7634971	Active	-
BB32	693292	7634956	Active	-
BB33	693126	7634935	Active	-
BB34	693166	7634939	Active	Individual recorded on camera trap
BB35	693639	7635081	Active	-
BB36	693653	7635033	Active	-
BB39	693627	7635108	Active	-
ML B3				
BB24	697448	7617932	Active	-
BB25	697450	7617917	Active	-
BB26	697491	7617889	Active	-
BB27	697539	7617895	Active	-
BB28	698018	7617736	Inactive, old	-
ML B4				
BB1	701904	7614274	Inactive, old	-
BB2	702662	7614630	Inactive, old	-
BB3	701292	7614277	Active	Individual recorded on camera trap
BB4	700938	7614027	Inactive, recently active	-
BB5	700664	7613960	Active	At least two individuals recorded on camera trap
BB6	700341	7613974	Inactive, recently active	-
BB44	700877	7614025	Active	At least two individuals recorded on camera trap
BB45	700821	7614021	Active	At least two individuals recorded on camera trap (Figure 3.10, Figure 3.11)

Figure 3.7 – Active Greater Bilby burrow (BB25) recorded

Figure 3.8 – Fresh Greater Bilby diggings recorded

Figure 3.9 – Greater Bilby tracks in soft sand and in wet sand

Figure 3.10 – Large Greater Bilby individual recorded from burrow BB45

Figure 3.11 – Smaller Greater Bilby individual recorded from burrow BB45

3.3 CULVERT MONITORING

A total of 11 species were recorded utilising culverts, through direct sightings and secondary evidence. No EPBC Act listed species were recorded. Species recorded are shown in Table 3.10.

Table 3.10 – Fauna species recorded utilising culverts

Common name	Species name
Mammals	
Macropod (kangaroo) species	*Macropus* spp.
Gould's Wattled Bat	*Chalinolobus gouldii*
Cow	*Bos taurus*
Cat	*Felis catus*
Dog	*Canis lupus*
Birds	
Fairy Martin	*Petrochelidon ariel*
Reptiles	
Long-nosed Dragon	*Amphibolurus longirostris*
Ring-tailed Dragon	*Ctenophorus caudicinctus*
Banded Knob-tailed Gecko	*Nephrurus wheeleri*
Stimson's Python	*Antaresia stimsoni*
Sand Monitor	*Varanus gouldii*
Yellow-spotted Monitor	*Varanus panoptes*

3.4 STATISTICAL ANALYSES

As this is the first year of monitoring, insufficient data is available for statistical analysis. Forthcoming monitoring will allow the identification of changes in activity levels and population sizes of conservation significant fauna, by applying the robust design model (Kendall *et al.* 1995) to the mark-recapture data collected where applicable. This information will then be interpreted in terms of analysis of variation in environmental attributes between years. Environmental attributes (temperature, rainfall, relative humidity) are being captured by two weather stations that have been established along the Mainline.

3.5 NON-TARGETED FAUNA RECORDS

A combined total of 27 mammal, 93 bird, 31 reptile and six amphibian species were recorded from the various Mainline monitoring phases. These results are presented in Appendix E.

3.6 NON-TARGETED CONSERVATION SIGNIFICANT SPECIES RECORDS

An additional total of eight non-targeted conservation significant fauna species were recorded while conducting the targeted species monitoring. These species being: Eastern Great Egret, Rainbow Bee-eater, Common Sandpiper, Common Greenshank, Grey Falcon (Figure 3.12), Australian Bustard (Figure 3.13), Bush Stone-curlew (Figure 3.14) and Star Finch (western). These records are shown in Appendix H and mapped in Figure 3.23.

Figure 3.12 – Grey Falcon recorded

Figure 3.13 – Australian Bustard recorded by camera trap

Figure 3.14 – Bush Stone -curlew recorded by camera trap

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NORTH WEST COASTAL HIGHWAY
PIPPINGARRA ROAD
INDEE ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD
Ch 25
Ch 50
Ch 75
Ch 100
Ch 125
Ch 150
Ch 175
Ch 200
Ch 225
Ch 250
Ch 275

Legend

- Trapped individual
- Motion Camera recording
- Tracks
- Mainline
- Railway Chainage
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20

Kilometres

Absolute Scale - 1:750,000

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FMG Fortescue The New Force in Iron Ore

Northern Quoll records

Figure: 3.15
Project ID: 1463

Drawn: BG
Date: 4/2/13

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

Unique Map ID: BG273

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GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
PIPPINGARRA ROAD
INDEE ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
MUNJINA WITTENOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

- Pilbara Leaf-nosed Bat record
- Railway Chainage
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Pilbara Leaf-nosed Bat records

Figure: 3.16
Project ID: 1463
Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG293

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GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
INDEE ROAD
PIPPINGARRA ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
NOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

- Trap capture
- Camera trap
- Scat
- Railway Chainage
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Mulgara records

Figure: 3.17
Project ID: 1463
Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG294

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NORTH WEST COASTAL HIGHWAY
GOLDSWORTHY SHAY GAP ROAD
INDEE ROAD
PIPPINGARRA ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
MUNJINA ROY HILL ROAD

Legend

Burrow activity status

- Active
- Inactive, old
- Inactive, recently active
- Railway Chainage
- Mainline
- Impact zone
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Greater Bilby burrows recorded

Figure: 3.18
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG295

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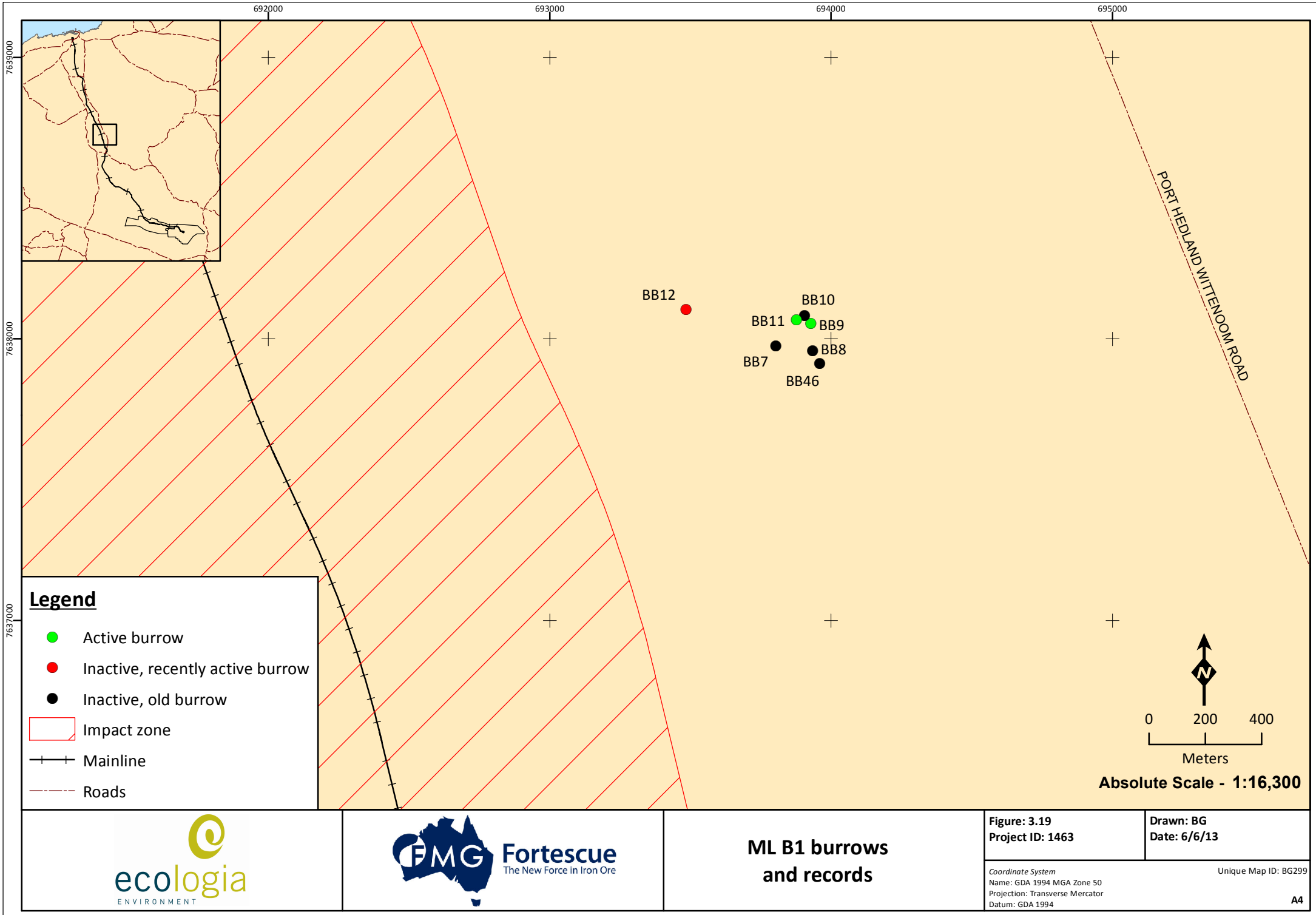

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

ML B1 burrows and records

Figure: 3.19
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG299

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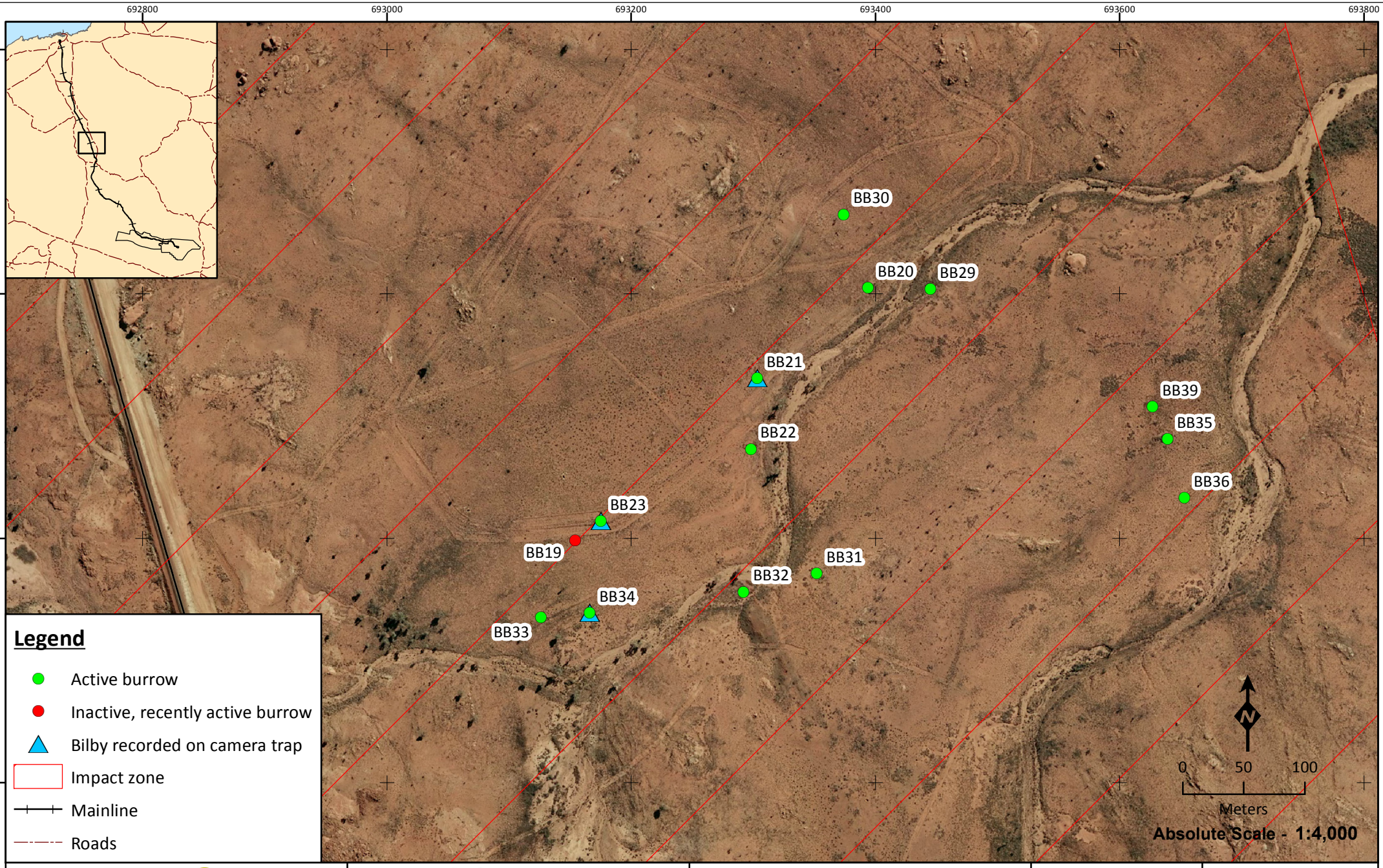


ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

ML B2 burrows and records

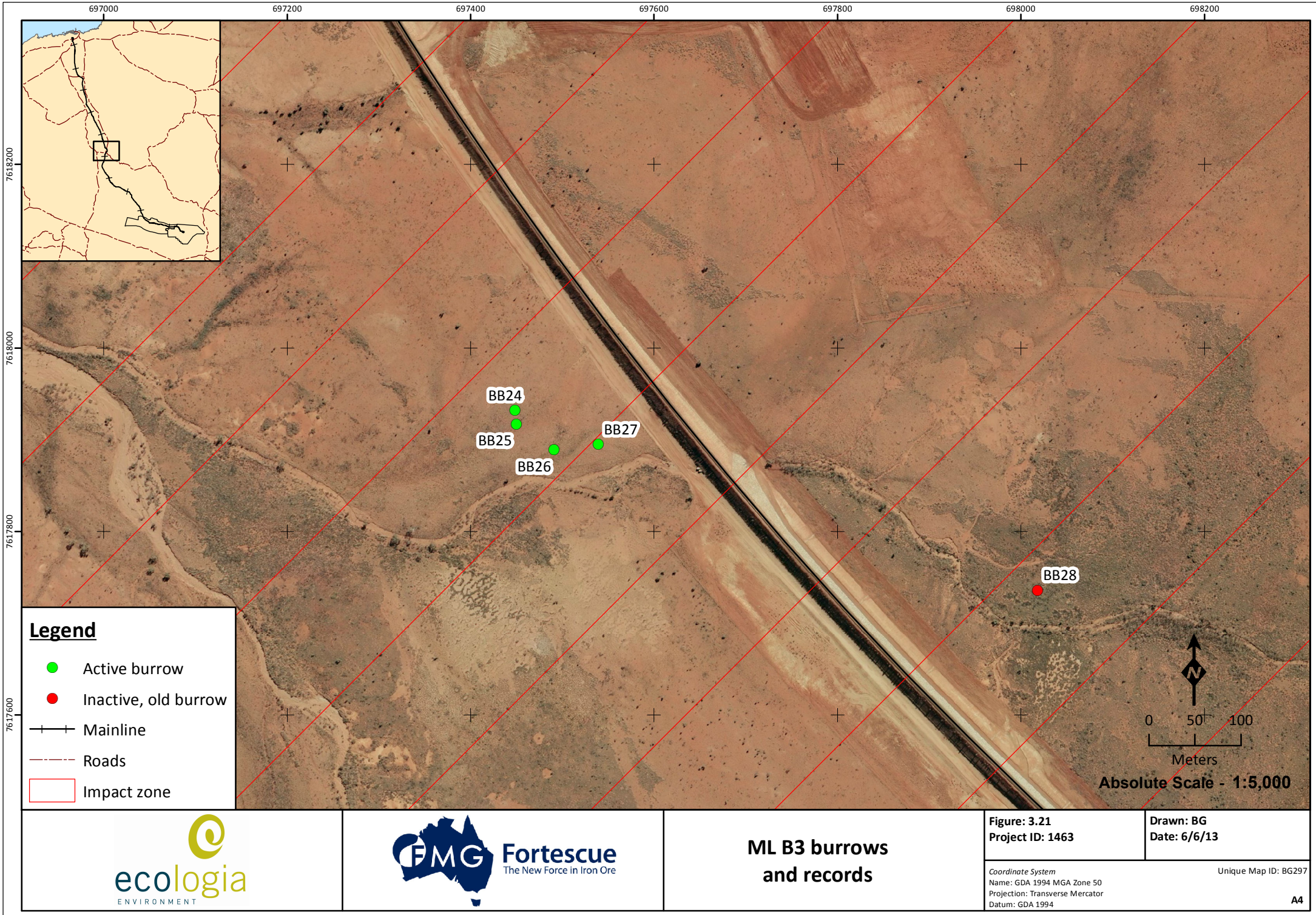
Figure: 3.20
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG296

A4



ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

ML B3 burrows and records

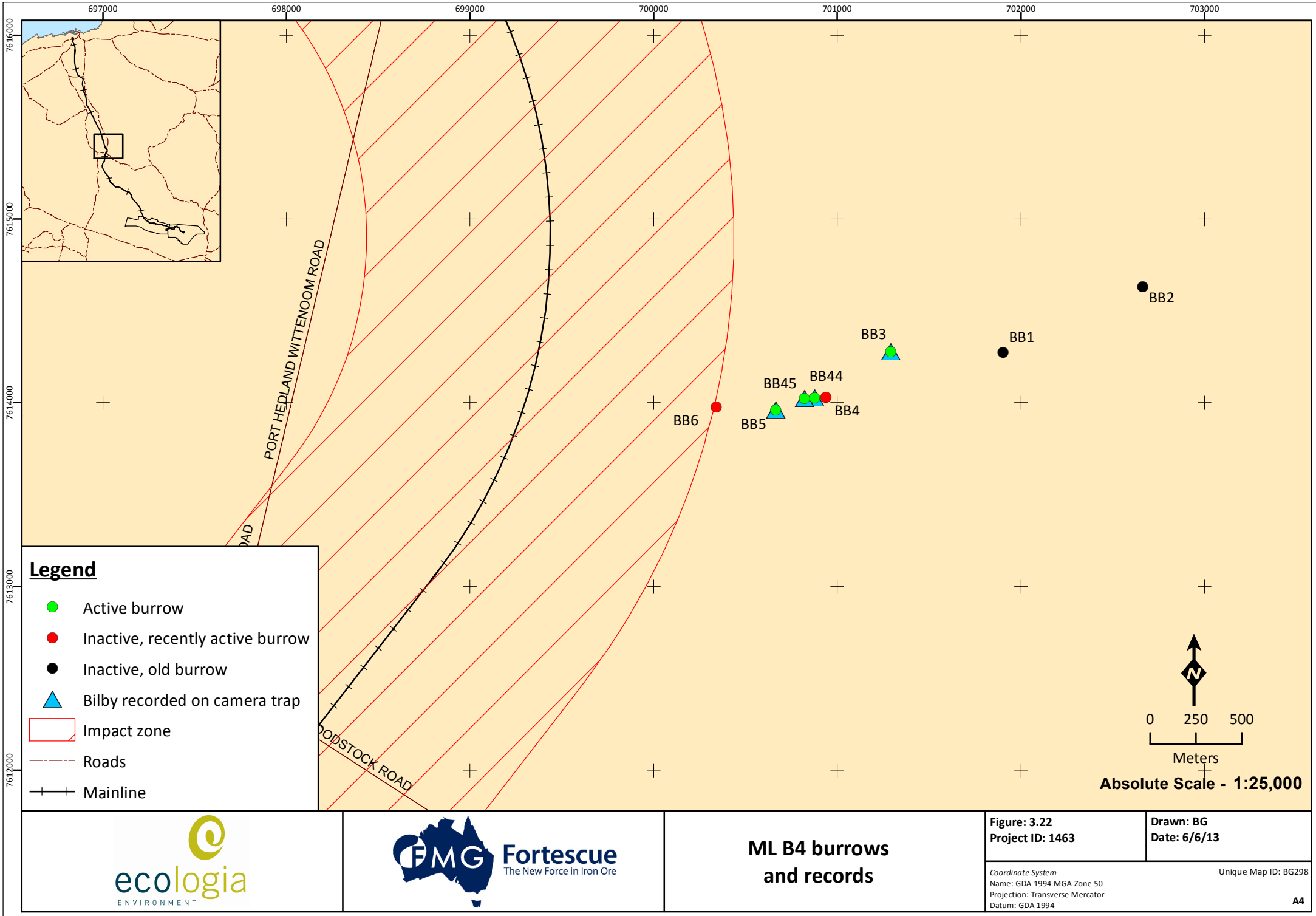
Figure: 3.21
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG297

A4



ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

ML B4 burrows and records

Figure: 3.22
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG298

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GOLDSWORTHY SHAY GAP ROAD
NORTH WEST COASTAL HIGHWAY
PIPPINGARRA ROAD
INDEE ROAD
MARBLE BAR ROAD
GREAT NORTHERN HIGHWAY
PORT HEDLAND WITTENOOM ROAD
HILLSIDE WOODSTOCK ROAD
HILLSIDE MARBLE BAR ROAD
BONNEY DOWNS HILLSIDE ROAD
NOOM ROAD
MUNJINA ROY HILL ROAD
MARBLE BAR ROAD

Legend

Species

- Australian Bustard
- Bush-stone Curlew
- Common Greenshank
- Common Sandpiper
- Eastern Great Egret
- Grey Falcon
- Rainbow Bee-eater
- Star Finch (western)

- Railway Chainage
- Impact zone
- Mainline
- Cloudbreak and Christmas Creek
- Fortescue Marsh

N

0 10 20
Kilometres

Absolute Scale - 1:750,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Non-targeted conservation significant species recorded

Figure: 3.23
Project ID: 1463

Drawn: BG
Date: 6/6/13

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

Unique Map ID: BG300

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4 DISCUSSION

4.1 HOT SPOT MONITORING

4.1.1 Northern Quoll

4.1.1.1 Species description

Conservation Status: EPBC Act Endangered, WC Act Schedule 1 (Endangered).

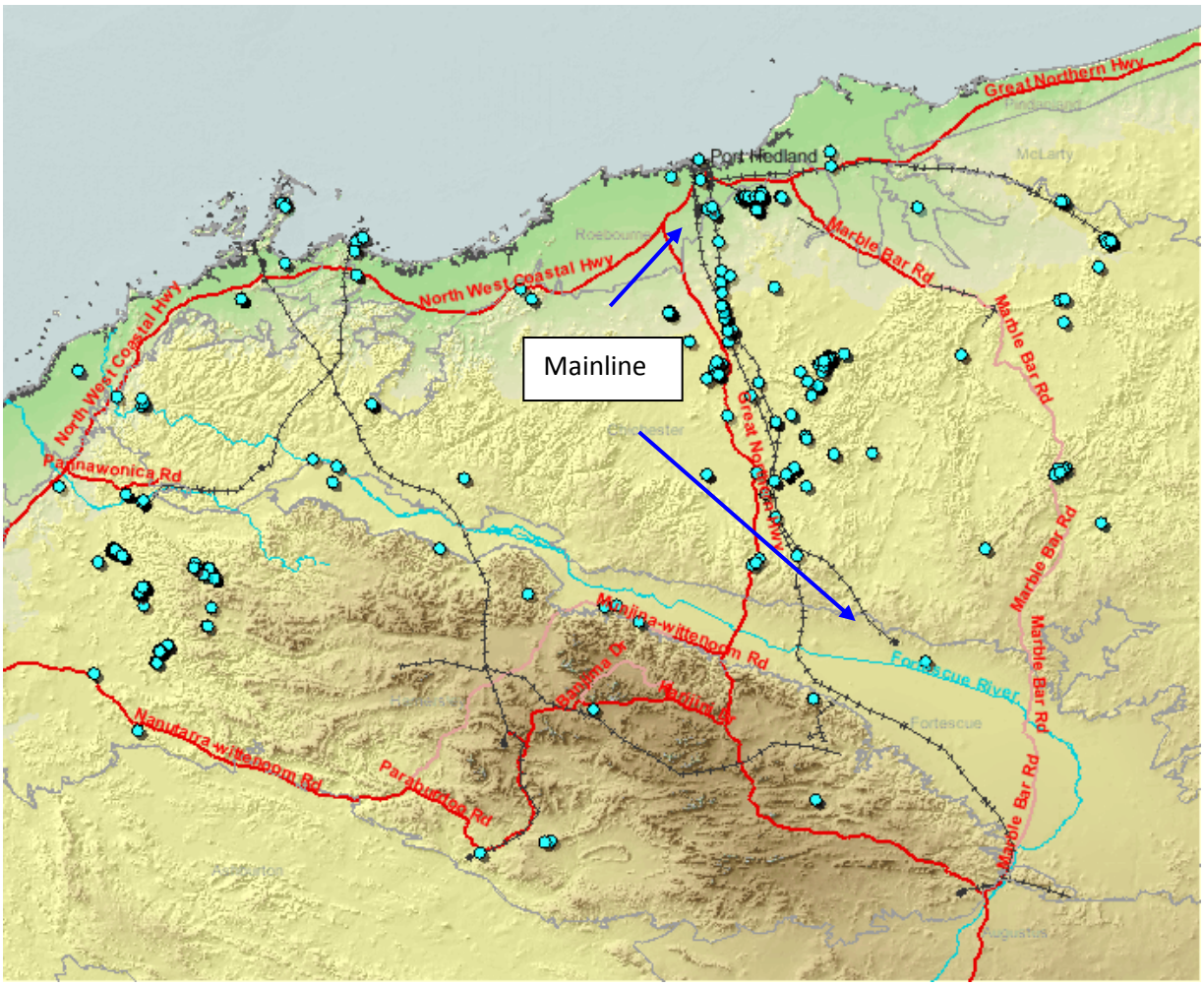
Distribution and Habitat: The Northern Quoll formerly occurred across northern Australia, from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction of available habitat occurred during the 20th century, so that the species is now restricted to the Pilbara and northern Kimberley in Western Australia, and a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite and Griffiths 1994). Northern Quolls are most common on dissected rocky escarpments, but are also found in eucalypt forest and woodland (Oakwood 2008). They are both arboreal and terrestrial and use a variety of den sites, including rock crevices, tree hollows, logs, termite mounds, house roofs and goanna burrows (Oakwood 2008).

Ecology: Northern Quolls are the smallest of the Australian quolls. Northern Quolls are nocturnal and opportunistic omnivores feeding primarily on small vertebrates, large insects and soft fruits. Breeding tends to occur near creeklines, where individuals go to drink when water is available.

The most common cause of adult mortality is predation by dingoes, feral cats, snakes, owls and kites (Maxwell *et al.* 1996; Oakwood 2008). Other causes of mortality include predation by domestic dogs, motor vehicle strikes and pesticide poisoning. The level of predation is increased through the removal of groundcover by fire.

4.1.1.2 Previous records

The Northern Quoll has previously been recorded in the vicinity of the Mainline during fauna surveys (ATA 2006; Biota 2004). In addition, numerous individuals of this species were previously recorded along BHP's Mount Newman Railroad (*ecologia* 2009). Figure 4.1 displays regional records of the Northern Quoll within the Pilbara (DPaW 2014). Northern Quoll has been recorded throughout much of the Pilbara, with clusters of records appearing in the western Hamersley Range, rocky ranges north of the Chichester Range and throughout the Abydos Plain region south of Port Hedland. The Northern Quoll is a highly mobile species which is likely to fluctuate in occurrence at locations as a result of habitat quality , which is predominantly affected by weather conditions. As a result, local populations of this species can change between years.



Source: NatureMap (2013)

Figure 4.1 – Regional Northern Quoll records of the Pilbara

4.1.1.3 Mainline targeted Northern Quoll

Two individual Northern Quolls were captured at one trapping site (impact site 5B) within the impact zone of the Mainline. Both individuals were identified as males, of which one individual showed signs of fighting such as bite marks and tears in its ear. This indicates that this initial phase of monitoring was conducted during the mating season which represents the preferred timing for Northern Quoll trapping. The individuals recorded on camera traps cannot be individually identified and therefore the actual number of individuals recorded is unclear.

Habitats initially targeted for Northern Quoll trapping along the Mainline comprised of granite outcrops and boulders which were assessed to be potential denning and foraging habitat. These areas contain large rocky crevices within the boulder piles and fissures within the larger boulders (Figure 4.2). Despite the previous records from this habitat type along the Mainline, all capture records made during monitoring were located within other habitat types.

Figure 4.2 – Granite boulder pile of potential denning habitat for Northern Quoll at site ML NQI1

In addition, areas of constructed rocky arms extending out from bridges on major river crossings were assessed during the field trip as potential foraging and denning habitat for Northern Quolls. Northern Quolls were recently recorded re-colonising disused quarries along the BHP Mount Newman Railroad (*ecologia* 2009). The rocky arms under bridges along the Mainline represent similar habitat to unused quarries, where the numerous large granite boulders provide abundant crevices for shelter and denning. Two individuals were recorded at impact site ML NQ I5B within this habitat, with additional records made from camera trapping at Chinnamon Creek bridge crossing.

Figure 4.3 – Rocky arm providing potential denning habitat for Northern Quoll at site ML NQ I5B

During future monitoring, trapping sites will be setup at locations where Northern Quolls were recorded by camera trapping during this monitoring.

One Northern Quoll individual was also captured at control site ML NQ C2. Habitats targeted for Northern Quoll within the control sites consisted of granite outcrops, which is representative of similar habitat within the impact zone along Mainline.

4.1.2 Night Parrot

4.1.2.1 Species Description

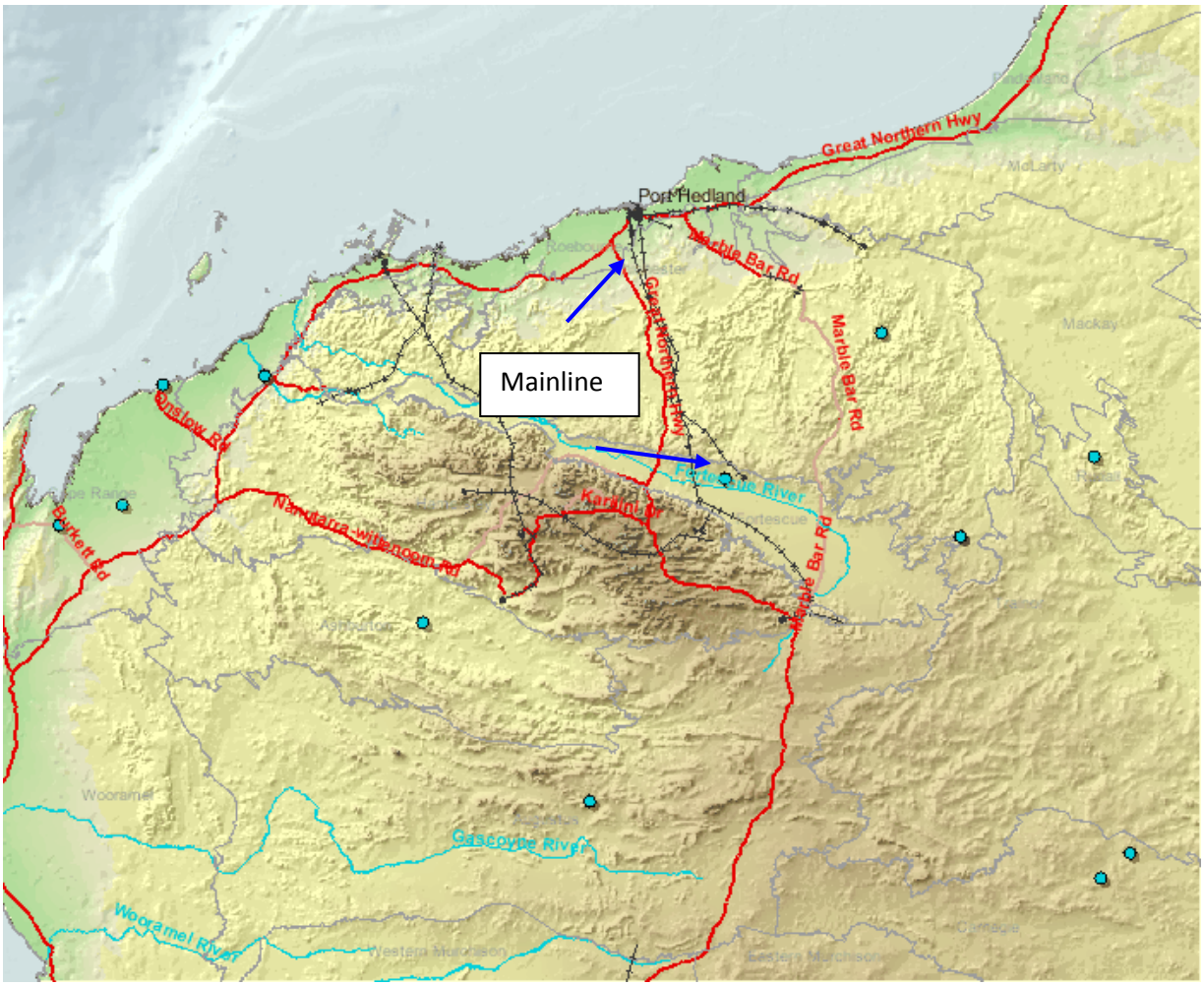
Conservation Status: EPBC Act Endangered, WC Act Schedule 1 (Critically Endangered).

Distribution and Habitat: The Night Parrot is a rarely encountered, nocturnal parrot that spends much of its time on the ground. Historical evidence indicates that Night Parrots were distributed over much of semi-arid and arid Australia (Garnett and Crowley 2000). Extremely secretive and hard to flush, there are only six accepted records of Night Parrots since 1935, with three from the Pilbara region (1979, 1980 and 2005; DEWHA 2008a). The most recent accepted sighting record in WA is from Minga Well recorded during a fauna survey at Fortescue Metals Group's Cloud Break lease (Bamford Consulting Ecologists 2005).

Ecology: Although biological information on this species is limited, preferred habitat is thought to be spinifex grasslands or samphire and chenopod shrublands near waterbodies (DEWHA 2008a; Johnstone and Storr 1998).

4.1.2.2 Previous records

Figure 4.4 displays previous records of the Night Parrot within the Pilbara. This map shows the Night Parrot has been recorded on very few occasions, with the majority of records consisting of historical records before 1900. The exception to this is the 2005 record from Minga Well (Bamford Consulting Ecologists 2005).



Source: NatureMap (2013)

Figure 4.4 – Regional Night Parrot records within the Pilbara

4.1.2.3 Mainline targeted Night Parrot

No Night Parrots or secondary evidence of Night Parrots was recorded from this phase of monitoring. Water point surveys complemented with camera trapping at water points were the primary survey method used for detection. No reliable survey method for Night Parrot currently exists, although Fortescue is currently funding a research program to develop repeatable survey techniques. In 2005, the Night Parrot was recorded at Minga Well, with three individuals observed at dusk as they presumably came in to the waterhole to drink (Bamford Consulting Ecologists 2005). This record demonstrates that the Night Parrot can be recorded using this survey method. However, significant subsequent survey effort conducting dawn and dusk water point surveys over the past several years have failed to record further sightings of the Night Parrot (Bamford 2012).

Weather conditions prior to and during the monitoring were ideal for water point surveys, with conditions generally dry and hot, increasing the likelihood of bird species visiting water sources. Weather experienced during monitoring is shown in Appendix B. Prior to monitoring, a total 29.6 mm of rain was recorded from Newman in the previous six months from May to October (BoM 2012). The success of this method in recording avifauna during the monitoring survey is shown by the total of 62 bird species being recorded at water points during this survey. The only bird species recorded from monitoring not at a water point was a Black Kite (opportunistic sighting while driving along the Mainline). The total number of bird species recorded is shown in Appendix E.

Water point surveys were conducted at artificial water sources (turkey nests and bores) and at natural pools of surface water remaining from the wet season. Of the water points along the Mainline, Chainage 229 water point was assessed as the most likely to attract Night Parrots to drink from. This is due to the proximity of this location to the Fortescue Marsh (Fortescue Marsh approximately 15 km south), minimally impacted habitat in the surrounding landscape and water availability at ground level with surrounding vegetation that acts as cover.

To complement water point surveys, camera trapping using motion cameras was also conducted at water points. The use of this method proved successful in recording bird species, with a total of 37 species recorded from camera trapping. Included in these records were Budgerigars which are slightly smaller in size and less bulky, compared to a Night Parrot (Figure 4.5). This suggests that this survey method should be effective for the Night Parrot.

Figure 4.5 – Budgerigars recorded from camera trap

In addition to motion camera trapping, three permanent feeding stations were established. All three feeding stations were positioned within the Chichester Ranges. The Chichester Ranges are located approximately 5 to 30 km from the Fortescue Marsh. Night Parrot habitat is described as seeding spinifex on stony rises, breakaway country, shrubby glasswort, chenopods, succulents on flats around salt marsh (Pizzey and Knight 2003). A literature review of all previous museum specimens shows specimens collected have been unambiguously associated with habitats containing one or more species of spinifex (*Trioda* spp.) and habitats containing one or more species of chenopods (pers. comm. S. Murphy 2013). Hence the rocky ranges and breakaways within the Chichester Ranges being in reasonably close proximity to the Fortescue Marsh appear to represent suitable habitat.

Night Parrots may potentially utilise drainage lines as networks through the landscape, using the denser vegetation as cover and water pools to drink from when available. Therefore, feeding

stations 2 and 3 were positioned in close proximity to drainage lines which link up to the drainage system entering in to the Fortescue Marsh near Minga Well. Regional site descriptions of feeding station locations are shown in Appendix A.

Analysis of images recorded from the feeding station motion cameras resulted in a total of 11 bird species being recorded (Table 6.1). This is a relatively low number when compared to other bird detection methods used during the monitoring. However it is anticipated it will take a period of time for local birds to become familiar with the feeders and regularly utilise the food sources.

Figure 4.6 shows a motion camera photograph of feeding station 3 which was visited by Diamond Doves at the time of the triggered photo. Motion cameras and feeding stations were setup on a permanent basis and vision will continue to be downloaded during future monitoring programs.

Figure 4.6 – Image of Diamond Doves from motion camera at feeding station 2

Sound recordings from SM2 devices were analysed for calls that were unfamiliar and which matched Night Parrot calls described in literature (Johnstone and Storr 1998; Pizzey and Knight 2003). This involved configuring the sound analysis software (Wildlife Acoustic's Song Scope) to scan for all calls recorded by the SM2s, which in turn were individually listened to by ornithologists experienced with bird calls from the Pilbara. No potential Night Parrot calls were identified using this method. Although analysing sound recordings from SM2s is commonly used for the detection of the Western Ground Parrot (pers. comm. A. Burbridge), for the Night Parrot, it is currently limited to scanning for all calls, due to the unavailability of Night Parrot recogniser (reference) calls. However, if a recogniser call is developed, this could increase the efficiency and effectiveness of detecting Night Parrots using SM2s.

4.1.3 Pilbara Olive Python

4.1.3.1 Species description

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1

Distribution and habitat: The Pilbara subspecies of the Olive Python (*Liasis olivaceus barroni*) only occurs in the ranges of the Pilbara region of Western Australia. This subspecies is currently listed under the Wildlife Conservation Act 1950 as "fauna that is rare or likely to become extinct" (Schedule 1) and as "Vulnerable" under the Commonwealth Environment Protection and Biodiversity Conservation Act (1999). The Great Sandy Desert separates the Pilbara Olive Python from northern populations of *Liasis olivaceus olivaceus*, from which it is distinguished on the basis of midbody scale rows and ventral scale counts. It is a dull olive-brown or pale fawn python that can grow to 2.5 m.

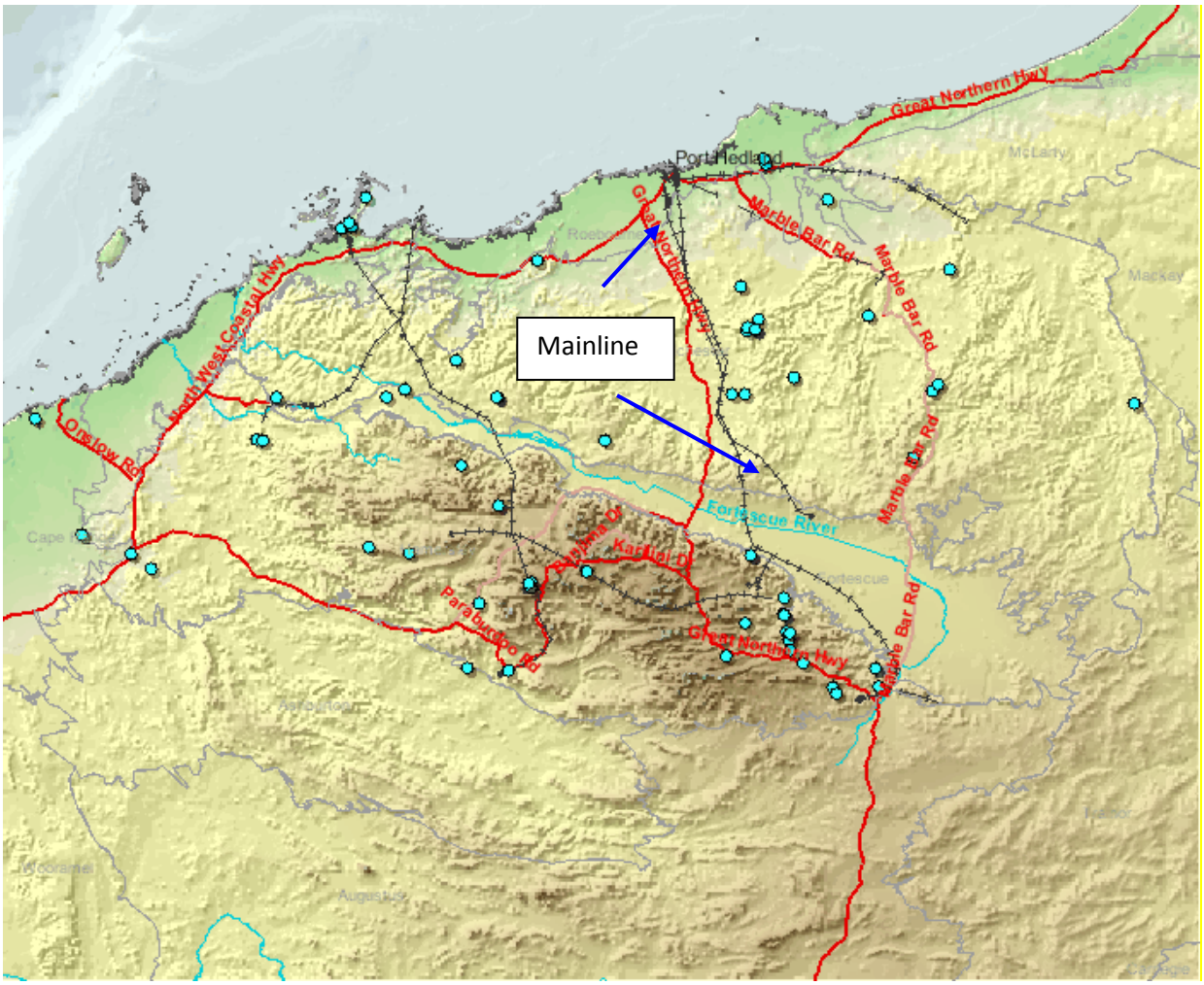
This subspecies is found throughout the Pilbara with the extremities of its range bounded by the Tropic of Capricorn in the South, the North West Coast Highway in the West, the Indian Ocean in the North, and the Great Sandy Desert in the East. In the Pilbara it inhabits watercourses, riverine woodland, and areas of permanent water in rocky gorges and gullies (Pearson 2006). It is often found directly adjacent to pools of water, usually among rocks and water plants, and sometimes even submerged. Permanent water is thought to be important for attracting prey species. Though primarily found in close proximity to water, overburden heaps and railway embankments may also be utilized. Radiotelemetry has found that individuals spend the cooler winter months sheltering in caves and rock crevices, often some distance from permanent water. In the warmer months the pythons can move widely, usually in close proximity to water and rock outcrops (TSSC 2008).

Ecology: This subspecies is an adept swimmer, often hunting in water. It feeds on a variety of vertebrates including rock-wallabies, fruit bats, ducks, and pigeons. In late winter or early spring males will travel large distances to find and mate with females. Eggs are laid in November and hatch approximately two months later.

Population size estimates are difficult due to the species cryptic nature and lack of a reliable trapping or census (TSSC 2008). The main threats to this subspecies are likely to come from predation from feral cats and foxes, particularly of juveniles, competition with foxes for food, and destruction of habitat, principally due to gas and mining development (Pearson 2006).

4.1.3.2 Previous records

Previous records for the Pilbara Olive Python are shown in Figure 4.7. The distribution of records indicates the Pilbara Olive Python occurs across most of the Pilbara, but in low, widely spread densities. The Pilbara Olive Python was not recorded along the Mainline during previous fauna surveys. Recent surveys by *ecologia* for Fortescue's North Star Project (*ecologia* 2011a, b) recorded a number of individuals and secondary evidence approximately 30 km east of the Mainline. This species was also recorded approximately 12 km south-west of the Mainline within the Chichester Ranges (*ecologia* internal database). Additionally, a record of the Pilbara Olive Python was made from Christmas Creek mine site crossing a haul road, within 5 km of the Mainline (ENV 2012).



Source: NatureMap (2013)

Figure 4.7 – Regional Pilbara Olive Python records of the Pilbara

4.1.3.3 Mainline targeted Pilbara Olive Python

No Pilbara Olive Pythons or secondary evidence was recorded during the current phase of monitoring. Conducting nocturnal road spotting proved a successful method in observing reptile species with a total of eight snake species recorded during this monitoring (Appendix G). This included two python species; the Stimsons and Black-headed Python, indicating that python species were active during the time of surveying. Weather conditions during monitoring were considered ideal, with daily maximum temperatures typically above 35°C, and minimum temperatures during surveying above 25°C. Isolated showers and downpours occurred regularly throughout monitoring, due to thunderstorm activity. The concurrent Pilbara Olive Python monitoring at Solomon Mine resulted in three individuals recorded during the time of surveying (*ecologia* 2013a). An indication of weather conditions experienced during monitoring survey, taken from Newman weather station, is shown in Appendix B.

Impact route 1 transect includes the most suitable habitat for Pilbara Olive Python. This impact route passes through the Chichester Ranges and includes medium sized rocky gorges and water holes which hold surface water following rainfall. The remaining transect routes (impact route 2, control route 1 and 2) are a combination of rolling hills, isolated granite outcrops and plain landform types, none of which contain typical high quality Pilbara Olive Python habitat for the majority of their length.

The Pilbara Olive Python has been recorded approximately 12 km from the Mainline within the Chichester Ranges (*ecologia* internal database). The presence of suitable habitat in the region suggests the Pilbara Olive Python will occasionally reside within close proximity to the impact zone of the Mainline, albeit most likely on a temporary basis. The Pilbara Olive Python is also anticipated to occur along the remaining transect routes (impact route 2, control route 1 and 2), although less frequently.

Minimal survey effort was invested along control route 1. This transect includes the Great Northern Highway which proved unsuitable for road spotting due to safety risks concerning high speed traffic. Control route 2 proved appropriate, with a mix of habitats similar to those experienced within the impact zone of the Mainline. It is recommended, that future monitoring substitute the Marble Bar Woodstock Road with the Great Northern Highway as control route 1, with the former more likely to be more suitable for nocturnal road spotting (based on more suitable habitat and reduced traffic presence).

4.1.4 Pilbara Leaf-nosed Bat

4.1.4.1 Species description

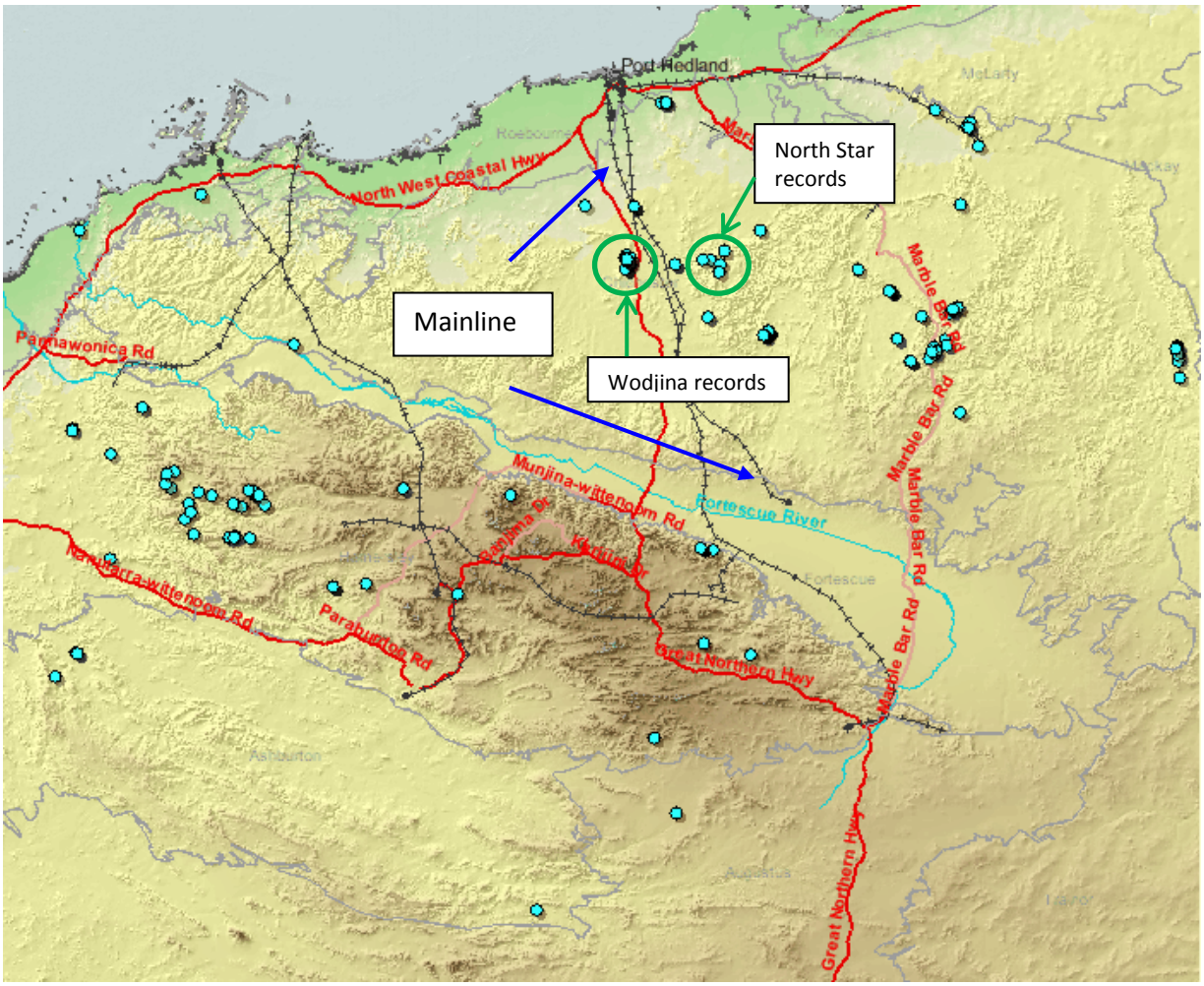
Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and habitat: Recent evidence suggests two main stronghold areas for the Pilbara Leaf-nosed Bat; in the western Pilbara and north of Marble Bar (Armstrong 2008). In the western Pilbara, they roost in caves formed in gorges that dissect siliceous sedimentary geology. They are most often observed in flight over waterholes in gorges, although they are rare even in the Hamersley Ranges where this habitat is common (Armstrong 2008). The Pilbara Leaf-nosed Bat roosts in disused mines and caves and areas of high relief with gorges and watercourses (Armstrong 2001). The Pilbara Leaf-nosed Bat requires dry season roost caves of specific temperature and humidity, with a narrow range of 28-30°C and approximately 94% relative humidity (Baudinette et al 2000). During the wet season from approximately November to February they abandon their dry season roost caves. This is achievable due to outside climatic conditions being hot and humid, similar to the dry season roost microclimate. It is believed these bats become forest dwellers at this time (Churchill 2008). They are unlikely to occur in the shallow 'breakaway' caves that occur along mesas and strike ridges.

Ecology: The Pilbara Leaf-nosed Bat is the Pilbara form of the Orange Leaf-nosed Bat (*Rhinonicteris aurantia*). While it is considered a separate form, formal reclassification has been hampered by the small sample size of the Pilbara population (Armstrong 2008) At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies and large watercourses for insects (van Dyck and Strahan 2008). They are susceptible to disturbance and will abandon roost caves if disturbed. Colonies in mines in the eastern Pilbara are subject to several pressures, including human visitation, and the collapse and flooding of disused mines (Armstrong 2008; DEWHA 2008b).

4.1.4.2 Previous records

As mentioned above, previous records of the Pilbara Leaf-nosed Bat within the Pilbara are congregated around the western Hamersley Range and Marble Bar region (Figure 4.8). Recently, numerous records were made by *ecologia* for Fortescue's North Star Project (*ecologia* 2011a, b) with records from 10 to 30 km east of the Mainline. On the same latitude of these records, approximately 15 km west of the Mainline, numerous records exist from Atlas Iron's Wodjina Project (DPaW 2014), (Figure 4.8). With the Mainline intersecting these two populations, future monitoring should give an indication as to the potential movements between these two known populations.



Source: NatureMap (2013)

Figure 4.8 – Regional Pilbara Leaf-nosed Bat records of the Pilbara

4.1.4.3 Mainline targeted Pilbara Leaf-nosed Bat

Typical roost cave habitat for the Pilbara Leaf-nosed Bat, as described above, appears to be absent within the impact zone of the Mainline. A substantial amount of survey effort was conducted within the Chichester Range during the summer monitoring surveys (January 2013), however no records were made.

The Pilbara Leaf-nosed Bat was recorded from two locations in the area intersecting the previous records at Wodjina and North Star mines during the Mulgara/Greater Bilby monitoring (May 2013). All records made were characteristic of foraging individuals.

Two calls were recorded at site SM2 4699 21/5 on the night of the 22nd May 2013. One of these calls was at 7:12 pm (Table 3.5), relatively early in the night, indicating this individual may have roosted in close proximity to the Mainline.

With the Mainline intersecting the home range of the two known populations at Wodjina and North Star (Figure 4.8), future surveying should give an indication as to the potential movements between these two known populations. Potentially, eucalypt lined watercourses intersecting the Mainline may provide habitat for wet season roosts for the Pilbara Leaf-nosed Bat, and may double as dispersal routes from dry season roosts. Further monitoring should be concentrated within this location. Future monitoring should also establish control sites within this vicinity in areas of suitable habitat outside the impact zone of Mainline.

4.2 DETAILED POPULATION BASED MONITORING

4.2.1 Mulgara

In 2005 and 2006, the Mulgara was redescribed into two species, The Brush-tailed Mulgara (*Dasycercus blythi*) and Crest-tailed Mulgara (*Dasycercus cristicauda*) (Woolley 2005; Woolley 2006). Records from before this time were labelled *D. cristicauda* and hence previous and historical records cannot be accurately allocated a correct species name. Therefore, the likelihood of occurrence of the two species has been determined based on presumed distributions of the two species.

Currently, only *D. cristicauda* is listed as Vulnerable (*D. blythi* listed as DPaW P4) under the *Environmental Protection Biodiversity and Conservation Act 1999* and Schedule 1 (Fauna considered rare or likely to become extinct) under the *Wildlife Conservation Act 1950*, although its status in WA and the Department of Environment's position on this species remains unclear.

Based on distributions and morphological information available, it is considered most likely that the Brush-tailed Mulgara (*D. blythi,* P4) is the only Mulgara that occurs within the vicinity of the Mainline. Both species are discussed below.

4.2.1.1 Crest-tailed Mulgara Species information

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and Habitat: Until recently, the Crest-tailed Mulgara was synonymous with the Brush-tailed Mulgara (*Dasycercus blythi*). Since previous records did not distinguish between the two species, there is some ambiguity over their exact distributions. However, in recent times, the Crest-tailed Mulgara has been found in the central Simpson Desert at the junction between South Australia, Queensland and the Northern Territory (Menkhorst and Knight 2009). The Crest-tailed Mulgara digs and inhabits burrows predominantly in dunes with a sparse cover of Sandhill Canegrass (*Zygochloa paradoxa*) or areas around saltlakes with Nitre Bush (*Nitraria billardieri*) (Masters 2008).

Ecology: The Crest-tailed Mulgara feeds at night on a range of invertebrates, lizards and small mammals. Breeding occurs from late winter to early spring (Woolley 2006).

4.2.1.2 Brush-tailed Mulgara Species information

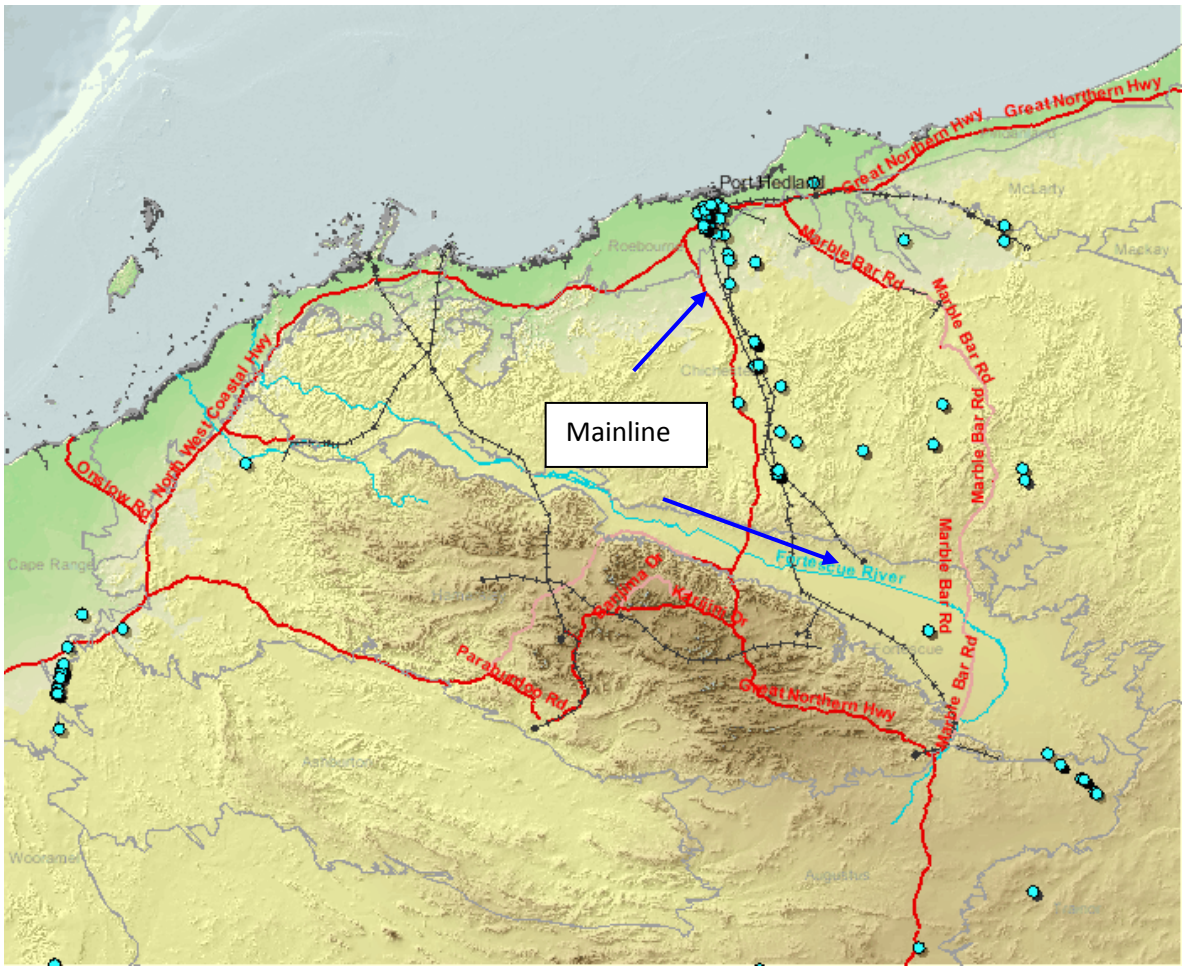
Conservation Status: DEC Priority 4.

Distribution and Habitat: Brush-tailed Mulgaras occur in spinifex grasslands throughout much of the arid zone, digging burrows in flats between low sand dunes (Woolley 2008). Believed to be generally solitary, Brush-tailed Mulgaras construct several single-entranced, multi-tunnelled burrows within their home range (Woolley 2008). According to Koertner *et al.* (2007), home ranges and burrows encompass both mature spinifex and open regrowth areas, with Brush-tailed Mulgaras not preferring either habitat type over the other. However, utilisation of open habitats might increase the risk of predation, especially following fire.

Ecology: Brush-tailed Mulgara are nocturnal hunters, feeding on arthropods and small vertebrates. Breeding is thought to occur from late winter to spring (Woolley 2008).

4.2.1.3 Previous records

Due to habitat requirements, the Mulgara is absent from the large areas of rocky habitat within the Pilbara. Numerous Naturemap records exist within the Abydos Plain in areas of suitable sandy habitat (Figure 4.9), with previous fauna surveys along the Mainline also recording this species (Bamford 2010; Biota 2004, 2005).



Source: NatureMap (2013)

Figure 4.9 – Regional Mulgara records of the Pilbara

4.2.1.4 Mainline targeted Mulgara

The focus of this phase of monitoring was to collect baseline data regarding the presence of Mulgara, in order to establish permanent systematic detailed trapping sites at active populations. This will allow for quantitative assessment and statistical analysis in to the future.

Mulgara were recorded from seven locations during this initial phase of annual monitoring. These records comprise eight individuals from two sites captured using Elliot traps (Figure 3.4) and detection of presence through secondary evidence and camera trapping (Figure 3.5 and Figure 3.6) at a further five locations. Mulgara records were all made from sand plains in association with minor drainage lines, or on flat open plains.

Mulgara that were captured exhibited typical Brush-tailed Mulgara (*D. blythi*) morphology, with a brushy hair structure on tail, six nipples in females and presence of two upper molar teeth. Ear clips were obtained from all captured individuals and submitted to the WAM to aid in genetic analysis of this species.

Figure 4.10 – Photo of Mulgara tail showing typical Brush-tailed Mulgara (*D. blythi*) morphology

Due to moderate rainfall during the first half of the survey (Appendix B), the detection of active burrows was made difficult, as small mammals tend to close burrow entrances during rain events (pers. obs. B. Greatwich).

Detailed habitat assessment will be completed for each systematic monitoring site during the next phase of monitoring, consistent with the analysis conducted with Solomon Rail Mulgara monitoring (*ecologia* 2013b).

4.2.2 Greater Bilby

4.2.2.1 Species information

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and habitat: The Greater Bilby (*Macrotis lagotis*) formerly occurred over 70% of mainland Australia's arid and semiarid regions prior to European settlement (ABAS 2002). During the 20th century its distribution range reduced significantly and is now absent from its previous southern and central range and restricted to northern Australia (Tyndale-Biscoe 2005). Greater Bilbies are currently patchily distributed through the Tanami, Great Sandy and Gibson Deserts (DSEWPaC 2013; Maxwell *et al.* 1996). Isolated populations also occur in south-west Queensland and to the north-east of Alice Springs. Greater Bilbies occur in a variety of habitats, including spinifex grassland, acacia shrubland, open woodland, fringes of salt lakes and cracking clays (Johnson 2008; Maxwell *et al.* 1996). Reasons for the decline include predation by feral predators on both young and adult Greater Bilbies, competition from rabbits and livestock, reduced food as a result of changed fire regimes, and drought (Johnson 2008; Maxwell *et al.* 1996; O'Malley 2006).

Records of the Greater Bilby from the database Global Biodiversity Information Facility are broadly distributed across most of Australia, giving a good indication of the historical range of this species. More recent records from the *ecologia* internal database and NatureMap show a few scattered records in the Pilbara region, mainly around the Abydos Plain and western Fortescue Marsh area. This region provides suitable habitat within the Pilbara due its predominately softer substrate then surrounding areas and represents the western extremity of the Greater Bilbies range.

Ecology: Unlike other bandicoot species, the Greater Bilby constructs burrows where it shelters during the day. The burrows are up to two meters deep and descend in a spiralling direction with each individual animal utilising up to 12 burrows within its home range (ABAS 2002). Greater Bilbies are strictly nocturnal and move up to five kilometres each night in search of food (Pavey 2006b).

Home ranges are variable and temporary, with individuals responding to changes in food availability (van Dyck and Strahan 2008) Males, females and juveniles may all have overlapping home ranges, where densities in optimum habitat can be 12-16 individuals per km^2, however typically densities are 1-2 individuals per km^2 (Pavey 2006b). Estimates of short-term home ranges vary from 1.1 to 3.16km^2, however females have been recorded with a home range as little as 0.18km^2 (Pavey 2006a). Male home ranges and male-female home ranges overlap considerably, however overlap between females has not been recorded (Pavey 2006a).

The breeding season also reflects the opportunistic nature of this species, with Greater Bilbies being able to breed throughout the year whenever conditions are right (van Dyck and Strahan 2008). They are rapid breeders, with reproduction being much faster than any other group of marsupials (Tyndale-Biscoe 2005).

The Greater Bilby is a mainly solitary omnivorous marsupial and is the sole surviving species from the family Thylacomyidae, of which the Lesser Bilby (*Macrotis leucura*) has gone extinct (Tyndale-Biscoe 2005). As with all bandicoot species, the Greater Bilby are generalists in their diet and very effective opportunists, exploiting their environment by their wide choice of food, fast growth and rapid reproduction, particularly when conditions are favourable (Tyndale-Biscoe 2005). Their typical diet consists of insects and larvae, seeds, bulbs, fruit and fungi (van Dyck and Strahan 2008).

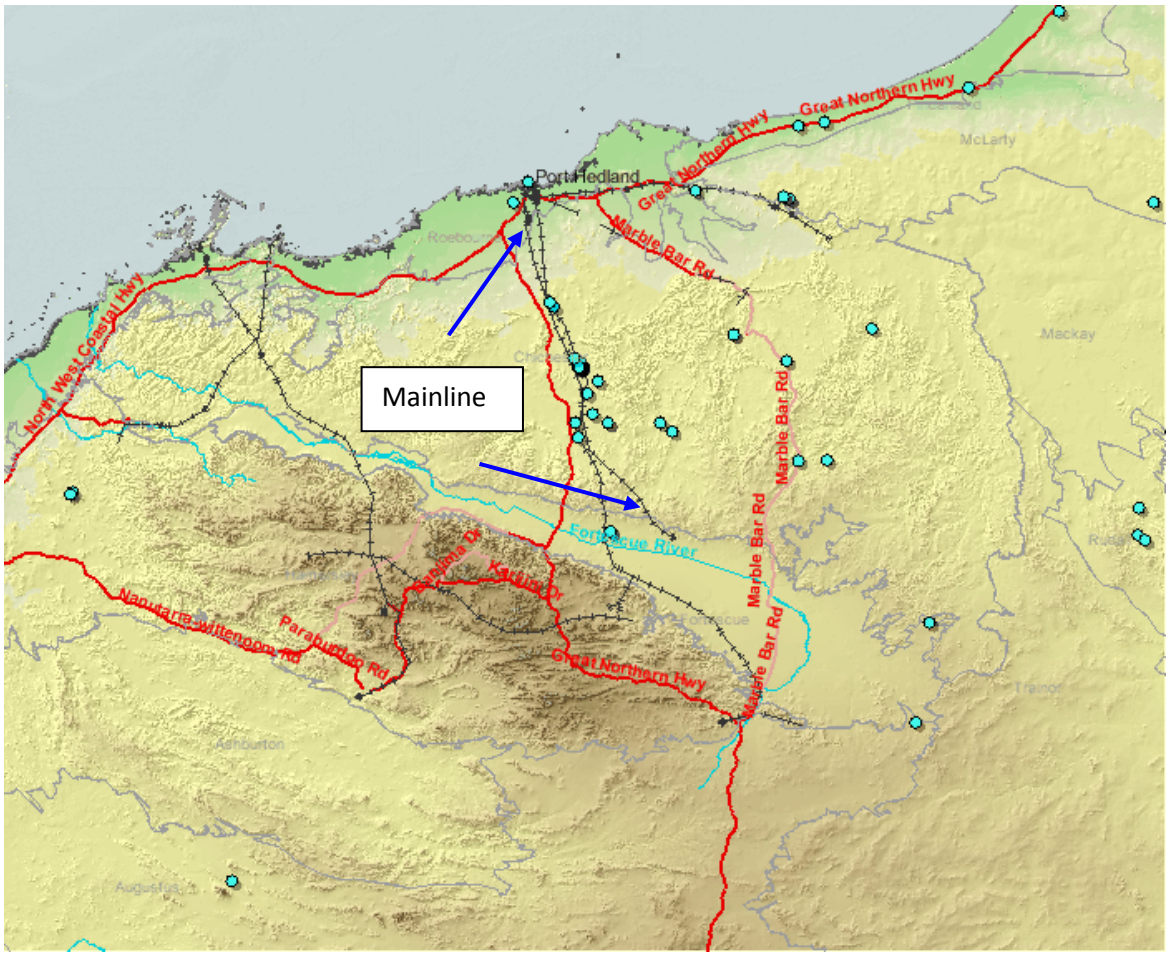
4.2.2.2 Previous records

The Greater Bilby shares similar habitat requirements to the Mulgara, and as such, is absent from the large areas of rocky habitat within the Pilbara. Naturemap shows a number of records within the broad scale sandy habitat of the Abydos Plain (Figure 4.12). Previous fauna surveys along the Mainline recorded numerous secondary evidence of the Greater Bilby (diggings and burrows), although there were no actual sightings or captured individuals (ATA 2007; Bamford 2010; Biota 2004, 2005). However, presence of secondary evidence is considered the primary source of detection for this species, particularly where active burrows are present, with recent evidence from Lorna Glen Conservation Reserve suggesting one Greater Bilby individual exists for every five active burrows present (pers. comm. M. Dziminski 2012).

In May 2012, during a wild dog and fox baiting survey along the Mainline (Animal Pest Management Services 2012), a Greater Bilby was recorded exiting a burrow by a motion camera (Figure 4.11). This record was made approximately 3.5 km east of the Mainline (Zone 50, 702641e, 7614409n) within a sandy creekline (Edgina Creek), which continues in a westerly direction, intersecting the Mainline.

Source: Animal Pest Management Services (2012)

Figure 4.11 – Image of Greater Bilby captured by motion camera 3.5 km from Mainline



Source: NatureMap (2013)

Figure 4.12 – Regional Greater Bilby records of the Pilbara

4.2.2.3 Mainline targeted Greater Bilby

The initial phase of Greater Bilby monitoring recorded four populations of Greater Bilby. Due to the difficulty in trapping the Greater Bilby, the number of individuals at each population was unable to be determined. Populations were discovered through detecting secondary evidence (active burrows, diggings, tracks and scats), and at two populations, individuals were confirmed by camera traps. These populations range from within the impact zone directly adjacent to Mainline (impact sites ML B2, ML B3), to being greater than 1 km from the Mainline (control sites ML B1, ML B4).

The four populations recorded are located in an area of habitat within a distance of 27 km of each other. This patch of habitat is between railway chainages 120 to 145 (Figure 2.8). No active populations were recorded further north of these locations, despite numerous previous records, and numerous inactive burrows recorded during this monitoring (Table 3.9, Figure 3.18). These areas should continue to be monitored in the future to confirm whether Greater Bilby populations are resident in these areas.

The habitat and landform features recorded at each Greater Bilby population were consistent. These landscape features consisted of a fringing sand plain adjacent to a minor drainage line. More detailed habitat descriptions of the Greater Bilby monitoring sites are provided in Appendix A. It is likely these plains formed through deposition from the surrounding granite hills, resulting in a relatively deep sandy substrate. This provides ideal habitat for the Greater Bilby to construct its burrow systems, with the substrate being soft enough to be readily dug out, but still firm enough to maintain internal structure and not collapse (Southgate 2013). However, as previous records indicate, the Greater Bilby is not restricted solely to fringing sand plains on drainage lines, but can be found across broad sand plains, anywhere suitable substrate for burrowing exists. Drainage lines may assist in acting as dispersal routes, providing links between less suitable habitat such as rocky areas.

Greater Bilby monitoring sites ML B1 and B2 both represent preferred habitat, and based on the number of burrows (both active and inactive) suggests permanent and stable populations at these two locations. Monitoring site ML B1 was located outside the impact zone, between Mainline and the BHP Mount Newman railway. Monitoring site ML B2 was located within an area of habitat that has been previously disturbed through mining exploration activities. This level of disturbance is still evident in the aerial photography, as can be seen in Figure 3.20. The habitat at this site has since been rehabilitated with only minor disturbance still noticeable on site, indicating that rehabilitated sites can form suitable habitat.

Suitable habitat at monitoring site ML B3 is limited and may be occupied by a single individual, indicated by a low level of activity at this site. Although supporting at least two individuals (as indicated in Figure 3.10 and Figure 3.11), habitat at monitoring site ML B4 is highly degraded. This is a result of a large number of cattle within this area which has degraded vegetation and compacted soil. The degraded nature of this site is indicated by the presence of *Senna notabilis* and *Acacia farnesiana*, both regarded as colonisers of degraded areas (Moore 2005). Additionally, feral predators such as cats and dogs were present at this site with numerous tracks of both species noted. A single feral cat was recorded by a camera trap (Figure 4.13) walking past an active burrow (BB3) where a Greater Bilby was later recorded.

Figure 4.13 – Feral cat captured by camera trap at BB3

Observations regarding burrow usage appear to be consistent with that specified in the literature, in that an individual can have many burrows and utilise them in an unpredictable manner (ABAS 2002). Four active burrows at monitoring site ML B4 were recorded, all of which also had Greater Bilbies recorded on camera traps. However monitoring site ML B3, which also had four active burrows recorded, did not record any individuals via camera traps. This was despite having camera traps on each burrow for three consecutive nights, with significant activity recorded including many diggings, tracks and scats. This result indicates the mobility of Greater Bilbies, and their potential use of multiple burrows at multiple sites. Hence, re-visiting previous records and areas of suitable habitat should be completed regularly to try and record relocating individuals.

It was noted during the monitoring that Greater Bilby diggings were most frequently encountered near *Acacia bivenosa* shrubs. At the monitoring sites, there was evidence of diggings at the base of most shrubs observed (Figure 4.14). This suggests that the roots or root dwelling larvae associated with this species of shrub are potentially an important food source for the local populations of Greater Bilby. At monitoring site ML B4, additional diggings were found amongst *Acacia trachycarpa* shrubs. This shrub species was not recorded from the remaining monitoring sites.

Figure 4.14 – Greater Bilby diggings at base of *Acacia bivenosa*

Due to the difficulty of trapping Greater Bilbies, a reliable ongoing method for individual and population density monitoring is yet to be developed. A potential method for future monitoring could utilise the characteristic tracks of the Greater Bilby and the '2 ha plot method' outlined in Moseby's "Tales of the Sand" (Moseby *et al.* 2011). This method consists of documenting all tracks within a 2 ha area, by assessing the size of the tracks, an estimation of the number of individuals, and activity levels of individuals in the area can be made. The Greater Bilby typically exhibits a quadrupedal bounding overstep gait when moving, where all four feet touch the ground during locomotion (Moseby *et al.* 2011). An example of the tracks resulting from this gait, recorded from monitoring is shown in Figure 3.9.

An example of accurate measurements of tracks recorded from Greater Bilby monitoring site ML B4 is shown in Figure 4.15. By utilising the measurements given in Table 4.1, it can be identified that two separate tracks identified at ML B4 belong to two separate individuals, an adult male, and an adult female or juvenile. These results are supported by camera trap evidence, which captured a large adult male and an adult (presumable female) at burrow BB45 (Figure 3.10, Figure 3.11). Potentially, the tracks illustrated below belong to these individuals. This example shows how track identification and detailed measurements will aid in determining population numbers and activity levels.

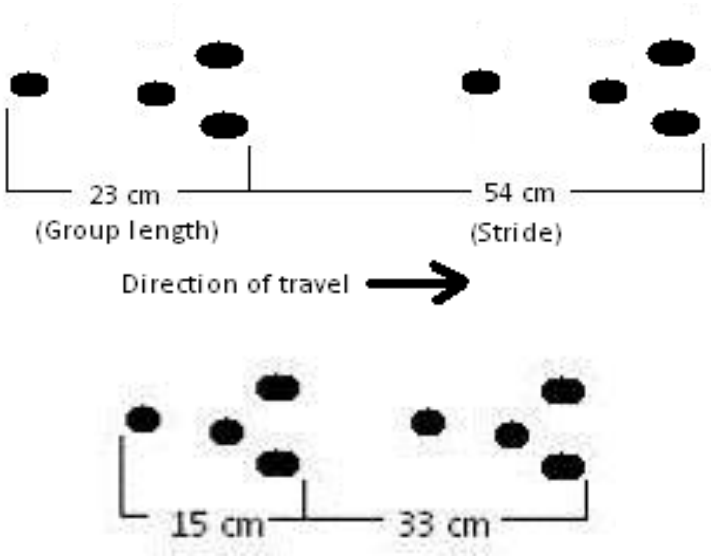


Figure 4.15 – Diagram showing an example of two different Greater Bilby gaits recorded from ML B4

Table 4.1 – Greater Bilby identification based on gait measurements

Greater Bilby identification	Group length
Adult male (>1800 gram)	203-281 mm
Adult (500-1200 gram)	130-220 mm
Juvenile (150-500 gram)	117-162 mm

Source: Moseby *et al*. (2011)

It is recommended, that future Greater Bilby monitoring incorporate the '2 ha plot method' as an additional method in determining Greater Bilby population densities and activity levels. The same plot can be revisited annually, which will provide a useful comparison across different years. The population at site ML B4 has been present for a minimum of one year (First recorded on the 28/5/12 (Animal Pest Management Services 2012). In addition, monitoring sites ML B1 and B2 may support a local population due to the high quality habitat and presence of a number of burrows. The '2 ha plot' could be assessed at the beginning of the monitoring survey and then cleared from all tracks. The '2 ha plot' would then be re-assessed at the conclusion of the monitoring survey, allowing an assessment of activity to be made prior to monitoring, and activity during monitoring. This method would also be useful in providing an indication as to feral cat and dog activity at these monitoring sites.

4.3 CULVERT MONITORING

Monitoring of culverts showed fauna species are utilising culverts as a link between areas of habitat dissected by the rail. Tracks were recorded of numerous larger fauna species (eg. macropod (kangaroo) species, Yellow-spotted Monitor, Sand Goanna) through the entire length of the culvert, showing they are moving through them.

A number of fauna species were also observed occupying culverts directly as habitat. The Fairy Martin was recorded nesting within culverts, where they construct dried bottle-shaped mud nests on the roof of the culvert. Disused Fairy martin nests then become attractive to other fauna species. Gould's Wattled Bats were observed roosting within disused Fairy martin nests, with a Stimson's Python also observed occupying a disused nest.

Secondary evidence also suggested feral species such as cows, cats and dogs also regularly pass through culverts.

Following the results of this initial year of monitoring, motion cameras will be strategically selected and installed on culverts in areas where targeted fauna monitoring species were recorded or areas that represent high quality habitat. Repeatable survey effort and locations will allow for quantitative assessment of the use of culverts by fauna in future annual monitoring.

4.4 NON-TARGETED FAUNA RECORDS

A total of 27 mammal, 93 bird, 31 reptile and six amphibian species were recorded during this initial phase of the Mainline monitoring. These species are shown in Appendix E.

Amphibian species were predominately recorded during the Pilbara Olive Python phase of monitoring. This was a result of the hot, wet conditions experienced during monitoring. Waterbird species were encountered irregularly along Mainline, when pools of water were present. The Elegant Parrot was recorded during the Mulgara/Greater Bilby phase of monitoring. This species is infrequently recorded in the Pilbara, predominately during Autumn where it is thought to migrate from its more typical southern range (Johnstone *et al.* 2013). Two captures of Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) were made during the Mulgara/Greater Bilby phase. One of these individuals was vouchered due to a request from the WA Museum who is currently conducting genetic analysis of this genus (Voucher number WAMTS196).

4.5 NON-TARGETED CONSERVATION SIGNIFICANT SPECIES RECORDS

An additional total of eight non-targeted conservation significant fauna species were recorded while conducting the various species monitoring. These species include: Eastern Great Egret, Rainbow Bee-eater, Common Sandpiper, Common Greenshank, Grey Falcon, Australian Bustard, Bush Stone-curlew and Star Finch (western subspecies) (Appendix H and Figure 3.23).

Wetland habitat birds Eastern Great Egret, Common Greenshank and Common Sandpiper were recorded in pools of water when present. The Rainbow Bee-eater and Grey Falcon were recorded in creek line habitats. The conservation status of the Grey Falcon was recently changed from DEC Priority 4 to WC Act Schedule 1. Two individuals were observed, and a potential nest site may exist along the Yule River where this species was observed. The Australian Bustard and Bush Stone-curlew were recorded in plain and creek line habitat throughout the impact zone of the Mainline. The Star Finch (western subspecies) was recorded at Chainage 225 water point.

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5 CONCLUSION

The key conclusions of the initial 2012/2013 conservation significant fauna monitoring program for the Mainline are as follows:

- In accordance with the Fauna Management Plan, targeted "hot spot" monitoring sites were completed for Northern Quoll, Night Parrot, Pilbara Olive Python and Pilbara Leaf-nosed Bat. Detailed population-based monitoring using systematic monitoring sites for Mulgara and Greater Bilby has been established.
- Impact and control sites were established in suitable and representative habitat for Northern Quoll, Pilbara Olive Python and Greater Bilby. Suitable control sites have been selected for Mulgara and Pilbara Leaf-nosed Bat and will be established in the next phase of monitoring.
- Two individual male Northern Quolls were captured within the impact zone. Records were made from an additional nine locations within the impact zone from secondary evidence (camera trap, tracks). One individual male Northern Quoll was captured at control site 2, with no records at any of the other control sites. Habitats targeted for Northern Quoll included granite outcrop and boulder piles, and constructed rocky arms at bridges of major river crossings. Locations of secondary evidence records will be targeted for trapping in future monitoring.
- No Night Parrots or secondary evidence of Night Parrots were recorded during this initial phase of monitoring. The recording of 62 other bird species from waterhole observations (a primary survey method) suggests the effectiveness of techniques used in recording avifauna at the time of monitoring.
- No Pilbara Olive Pythons or secondary evidence of this species was recorded during this initial phase of monitoring. The nocturnal road spotting and active searches conducted resulted in seven gecko species, one pygopod, two skinks and eight species of snakes (one blind snake, two pythons and five elapids) being recorded, indicating the success of this method in detecting reptile species. Impact route 1 and 2 and control route 2 represent suitable habitat for this species. It is recommended that control route 1 be changed for future monitoring due to habitat unsuitability.
- Pilbara Leaf-nosed Bat echolocation calls were recorded from two locations within the impact zone. These records intersect the two known roosting populations at Wodjina (Atlas Iron) and North Star (Fortescue), and continued monitoring will give an indication as to the potential movements between these two known populations. Future monitoring should also establish control sites within this vicinity, in areas of suitable habitat outside the impact zone of Mainline.
- Mulgara were recorded from seven locations during this initial phase of annual monitoring. These records comprise eight individuals from two sites captured using Elliot traps and detection of presence through secondary evidence and camera trapping at a further five locations. Based on the outcomes of this phase of monitoring, a total of twelve detailed population monitoring sites (six impact and six control) have been selected and will be completed in future monitoring.
- A total of four Greater Bilby populations were recorded from separate locations. Populations were located through the recording of signs of activity (burrows, diggings, tracks and scats), with images of Greater Bilby individuals captured on camera traps at two of these sites. Two sites were recorded in close proximity to the Mainline (within 1 km) as impact sites (ML B2 and ML B3). Sites ML B1 and ML B4 were recorded further then 1 km from the Mainline and are control sites.

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APPENDIX A SITE DESCRIPTIONS

Site Description	Site Photo
Northern Quoll	
Impact Site 1 (ML NQ I1) Granite outcrop with course sand and spinifex hummock grassland enclosing granite boulders.	
Impact Site 2 (ML NQ I2) Several smaller granite outcrops with some mixed lower shrubs and spinifex hummock grassland on brown course sand.	

Impact Site 3 ((ML NQ I3) Granite outcrop with scattered *Corymbia* sp. over open layer of *Acacia trachycarpa* over small spinifex hummock grassland on sand.	
Impact Site 4A (ML NQ I4A) Granite outcrop with occasional *Ficus brachypoda* over open to moderately dense mixed acacia shrubs and *Grevillea wickhamii* over *Triodia* sp. hummock grassland and occasional *Cymbopogon* sp.	

Impact Site 4B (ML NQ I4B) Granite outcrops with some *Ficus bracypoda* over occasional *Grevillea wickhamii* and *Acacia bivenosa* over soft grasses (*Aristida* sp) and Spinifex hummock grassland (*Triodia* sp.) on coarse sand.	
Impact Site 4C (ML NQ I4C) Granite outcrops with sparse *Acacia inaequilatera* and other mixed acacia shrubs over *Triodia* hummock grassland on coarse sand.	

Impact Site 5A (ML NQ I5A) Bridge with rock piles and adjacent river bed with fringing *Eucalyptus camaldulensis* and *Melaleuca* sp. over *Gossypium robinsonii* and *Acacia* sp. over Buffel grassland *Triodia* hummock grassland on coarse sand.	
Impact Site 5B (ML NQ I5B) Rock piles and adjacent river bed with fringing *E. camaldulensis* and *Melaleuca* sp. over reeds (*Cyperus vaginatus*) and Buffel grass (*Cenchrus ciliaris*) on coarse sand.	

Impact Site 5C (ML NQ I5C) Rock pile of rail bridge adjacent to Riverbed with *Eucalyptus victrix* and *Melaleuca* sp. over some *Acacia trachycarpa* and *Senna* sp. over patches of over reeds (*Cyperus vaginatus*) and Buffel grass (*Cenchrus ciliaris*) on course sand.	
Control Site 1 (ML NQ C1) Numerous lower granite outcrops and boulder piles part of extensive surrounding habitat with some *Acacia ancistrocarpa* and *Acacia inequilatera* over *Triodia* hummock grassland on sandy substrate.	

Control Site 2 (ML NQ C2) Granite outcrops and boulder piles part of surrounding extensive habitat with patches of *A. ancistrocarpa* over dense spinifex hummock grassland on sandy substrate.	
Control Site 3 (ML NQ C3) Isolated large granite outcrop and boulder piles with mixed tall to medium sized shrubs (*Acacia colei, Acacia elacantha, A. inaequilatera, A. maitlandii, A. ancistrocarpa, Senna* sp.) over large clumps of moderate spinifex.	

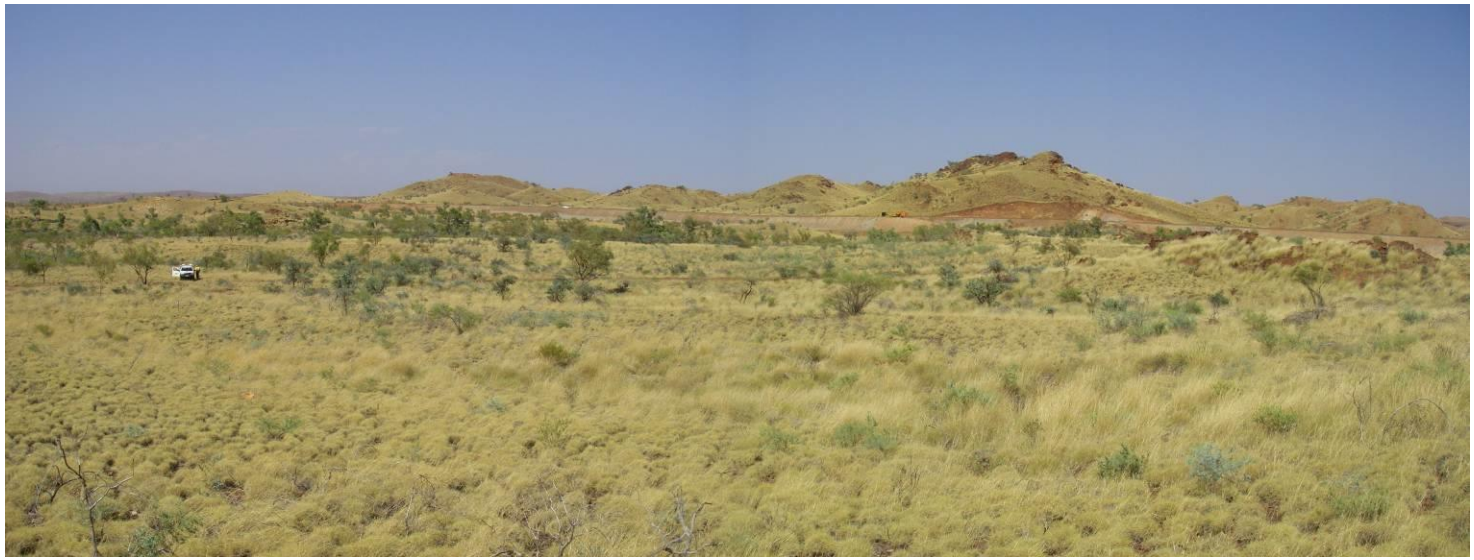
Site Description	Site Photo
Night Parrot	
Water point Chainage 37 A large clay pan collection point. Pool holds water for a long period of time. Bank of water exposed with no vegetation, with hummock grass and mixed Acacia spp. shrubs on sandy plain in the surrounding landscape.	
Water point Chainage 54 Small isolated water hole resulting from overflow of nearby bore. Some large spinifex close by. Water at ground level.	

Water point Chainage 77 Medium sized pool at Chinnamon creek bridge. Pool regularly fills to much larger size following the wet season. Water and surrounds highly degraded by cattle activity.	
Water point Chainage 137 Small pool of surface water. Water and surrounds highly degraded by cattle activity.	

Water point Chainage 151 Large shallow clay pan. Water level receding quickly each day.	
Water point Chainage 170 Turkey nest with no surrounding vegetation. Water below ground level on sloping bank.	

Water point Chainage 190 Turkey nest with no surrounding vegetation but sedges growing along the edge of water providing cover. Water level with ground providing good access for birds to drink from.	
Water point Chainage 214 Turkey nest with no surrounding vegetation. Water below ground level on sloping bank.	No photo due to construction activities in the area
Water point Chainage 227 Turkey nest with no surrounding vegetation. Water below ground level on sloping bank.	

Water point Chainage 229 Small network of puddles (approximately 20 m long) resulting from overflow of water tanks for livestock filled by a bore. Water at ground level with surrounding ground cover degraded from cattle. In close proximity to river system and rocky hills.	
Water point Chainage 231 Turkey nest with some surrounding vegetation. Water below ground level on sloping bank.	

Water point Chainage 242 Turkey nest with some surrounding vegetation. Water below ground level on sloping bank.	
Feeding station 1 Feeding station located within small feeder creek to river system approximately 100 m away, within a large open valley with rocky hills, ranges and breakaways within 500 m. Vegetation consists of very dense spinifex hummock grassland with scattered Acacia inequalatera and Acacia binevosa shrubs species. Occasional Corymbia sp. trees occur in the immediate vicinity. No water present in the vicinity of the feeding station.	

Feeding station 2 Feeding station located on a footslope within a broad valley with river system approximately 200 m away. River system part of drainage network which drains in to Fortescue Marsh near Minga Well, approximately 20 km south. Rocky hills, ranges and breakaways present within the landscape. Permanent water from over flow bore (Ch 229 water point) approximately 100 m away. Vegetation consisting of dense spinifex hummock grassland, scattered Acacia inequalatera and Hakea lorea shrubs with scattered Corymbia sp. trees.	
Feeding station 3 Feeding station within narrow valley with large creekline close by. Turkey nest with water availability approximately 50 m away. Vegetation described as a dense shrubland with Acacia maitlandi, Acacia ancistrocarpa, Acacia tumida, Acacia sp. and Grevillea wickhamii over dense spinifex hummock. Trees are regular within the immediate area, consisting of Corymbia sp. and Eucalyptus camaldulensis. Creekline drains in to network which drains in to Fortescue Marsh near Minga Well, approximately 6 km south-west.	

Site Description	Site Photo
Mulgara	
ML MI1 A flat plain consisting of *Triodia pungens* and T*riodia wiseana* hummock grassland. Few scattered shrubs species consisting of *Acacia bivenosa*and *Acacia stellaticeps*. Soil substrate consisting of medium coarse red sand of medium strength.	
ML MI2 A flat plain consisting of *Triodia pungens* and T*riodia wiseana* hummock grassland. Shrub species scattered throughout, consisting of *Acacia inaequilatera, Acacia colei, Acacia ancistrocarpa* and *Indigofera monophylla*. Soil substrate consisting of medium coarse red sand of medium strength.	

ML MI4 Flat plain with very minor drainage line and small rise within trapping grid. Vegetation consisting of *Triodia longifolia* and *Triodia wiseana* hummock grass of relatively open density, with dominant shrubs being *Pluchea furdinandi-muelleri* and Malvaceae shrubs. Scattered *Acacia stellaticeps* and *Acacia inaequilatera* throughout. Soil substrate consisting of red clay sand of lose strength.	
ML MI5 A flat, gently sloping plain. Vegetation consisting of *Triodia longifolia* and *Triodia wiseana* hummock grass at moderate density and various ages regenerating from fire. Shrub species consisting of *Acacia bivenosa, Acacia inqequilatera, Hakea lorea, Senna glutinosa glutinosa, Acacia stellaticeps, Acacia arthocarpa Grevillia wickhamii* and *Acacia colei* scattered throughout the trapping grid. Soil substrate consisting of orange sand clay of lose strength.	

ML MI6 Fringing sandplain in association with footslopes of surrounding granite rocky hills and minor drainage line. Hummock grass consisting of *Triodia wiseana* and *Triodia pungens* of moderate density in patches, with patches of the small shrub *Acacia stellaticeps* exclusively dominant. Other common shrubs being *Acacia bivenosa, Indigofera monophylla* and Malvaceae shrubs. Less common shrubs include *Acacia colei, Grevillia wickhamii* and *Acacia inequalatera*. Trees in the area include *Corymbia hamerslyana* and *Eucalyptus camaldulensis* in drainage line. Soil substrate red medium coarse sand of lose strength.	

Site Description	Site Photo
Bilby	
ML B1 Fringing sandplain in association with footslopes of surrounding granite rocky hills and minor drainage line. Hummock grass consisting of *Triodia wiseana* and *Triodia pungens* of moderate density in patches, with patches of the small shrub *Acacia stellaticeps* exclusively dominant. Other common shrubs being *Acacia bivenosa, Indigofera monophylla* and Malvaceae shrubs. Less common shrubs include *Acacia colei, Grevillia wickhamii* and *Acacia inequalatera*. Trees in the area restricted to *Eucalyptus camaldulensis* in drainage line. Soil substrate red, yellow medium coarse sand of lose strength.	
ML B2 Fringing sandplain in association with footslopes of surrounding granite rocky hills and minor drainage line. Hummock grass consisting of *Triodia wiseana* and *Triodia pungens* of moderate density, with patches of the small shrub *Acacia stellaticeps* exclusively dominant . Other common shrubs being *Acacia bivenosa, Indigofera monophylla* and Malvaceae shrubs. Less common shrubs include *Acacia colei, Grevillia wickhamii* and *Acacia inequalatera*. Trees in the area include *Corymbia hamerslyana* and *Eucalyptus camaldulensis* in drainage line. Soil substrate red medium coarse sand of lose strength. Very similar to ML B1.	

ML B3 Fringing sandplain amongst small rises adjacent to minor drainage line. Medium density hummock grass of *Triodia wiseana.* Shrub species consisting of *Acacia bivenosa, Acacia ancistrocarpa, Acacia inqequilatera,* Malvaceae shrubs, *Acacia stellaticeps, Acacia colei* and *Acacia maitlandii.* Tree species in the area are restricted to *Corymbia zygophylla*. Soil substrate red medium grain sand of medium strength	
ML B4 Fringing narrow sandplain in association with drainage line with bordering small rockier rises. Hummock grass consisting of medium dense to open *Triodia longifolia, Triodia wiseana* and *Triodia augusta*. Shrub species consisting of *Acacia trachycarpa, Acacia stellaticeps, Pluchea furdinandi-muelleri, Acacia farnesiana* and *Senna notabilis*. Soil substrate consisting of red, orange clay sand. Significantly disturbed by cattle which has degraded much of the vegetation.	

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APPENDIX B DAILY WEATHER DATA DURING MONITORING

Weather data taken from Newman, weather station 7176 (BoM 2012)

Date	Minimum temperature	Maximum temperature	Rainfall (mm)
Northern Quoll			
2/8/12	9.4	25.0	0
3/8/12	8.4	25.8	0
4/8/12	7.5	27.3	0
5/8/12	7.1	27.3	0
6/8/12	5.8	28.3	0
7/8/12	7.2	29.0	0
8/8/12	10.2	27.8	0
9/8/12	12.1	28.2	0
10/8/12	8.2	29.9	0
15/8/12	10.5	29.6	0
16/8/12	10.9	27.7	0
17/8/12	10.7	28.6	0
18/8/12	8.9	30.0	0
19/8/12	8.4	30.6	0
20/8/12	9.5	32.0	0
21/8/12	12.4	30.9	0
22/8/12	13.7	25.1	0
23/8/12	8.7	25.3	0
Night Parrot			
13/11/12	20.7	37.3	7.6
14/11/12	22.6	40.9	0
15/11/12	27.4	40.3	0
16/11/12	24.4	42.3	0
17/11/12	27.4	41.6	0
18/11/12	26.2	41.8	0
19/11/12	23.7	41.0	0
20/11/12	24.4	40.8	0
21/11/12	26.7	40.6	0
Pilbara Olive Python / Pilbara Leaf-nosed Bat			
17/1/13	26.7	40.7	0
18/1/13	22.1	35.0	5.2
19/1/13	21.8	37.9	0
20/1/13	26.6	40.2	0
21/1/13	23.2	38.1	4.8
22/1/13	23.5	37.7	11.6
23/1/13	24.6	33.4	2.8
Mulgara / Greater Bilby			
17/5/13	10.1	24.5	0
18/5/13	9.7	27.1	0
19/5/13	14.0	27.8	0
20/5/13	13.5	23.1	1.2

Date	Minimum temperature	Maximum temperature	Rainfall (mm)
21/5/13	10.0	23.0	0
22/5/13	8.8	22.3	0
23/5/13	9.5	23.4	0
24/5/13	11.1	23.3	0
25/5/13	8.9	25.5	0
26/5/13	15.1	24.4	0
27/5/13	13.9	26.5	0
28/5/13	15.1	27.0	0
29/5/13	14.2	28.4	0

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APPENDIX C PHOTOS OF ACTIVE GREATER BILBY BURROWS

Burrow	Photo
ML B1	
BB9	
BB11	

ML B2	
BB20	
BB21	

BB22	
BB23	

BB29	
BB30	

BB31	
BB32	

BB33	
BB34	

BB35	
BB36	

BB39	
ML B3	
BB24	

BB25	
BB26	

BB27	
ML B4	
BB3	

BB5	
BB44	

BB45	

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APPENDIX D LOCATION OF INACTIVE GREATER BILBY BURROWS

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APPENDIX E FAUNA SPECIES RECORDED DURING MONITORING

Mammals

Family and species	Common name	Conservation Status			NQ	NP	POP/PLNB	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
TACHYGLOSSIDAE								
Tachyglossus aculeatus	Echidna				1			
DASYURIDAE								
Dasycercus blythi	Brush-tailed Mulgara	**VU**	**S1**	**P4**				8
Dasykaluta rosamondae	Little Red Kaluta							25
Dasyurus hallucatus	Northern Quoll	**EN**	**S1**	**EN**	3	●		S
Pseudantechinus woolleyae	Woolley's Pseudantechinus							2
THYLACOMYIDAE								
Macrotis lagotis	Greater Bilby	**VU**	**S1**	**VU**				4+
MACROPODIDAE								
Macropus robustus	Euro					6	●	
Macropus rufus	Red Kangaroo					6		4
Petrogale rothschildi	Rothschild's Rock-wallaby				1			
HIPPOSIDERIDAE								
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	**VU**	**S1**	**VU**				●
EMBALLONURIDAE								
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat						●	●
Taphozous georgianus	Common Sheathtail Bat						●	●
VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat						●	●
Nyctophilus geoffroyi	Lesser Long-eared Bat						●	
Scotorepens greyii	Little Broad-nosed Bat						●	●
Vespadelus finlaysoni	Finlayson's Cave Bat						●	●
MOLOSSIDAE								
Chaerephon jobensis	Northern Freetail Bat						●	●
Mormopterus beccarii	Beccari's Freetail Bat						●	
Tadarida australis	White-striped Freetail Bat							●
MURIDAE								
Notomys alexis	Spinifex Hopping-mouse							38
Pseudomys desertor	Desert Mouse							9
Pseudomys hermannsburgensis	Sandy Inland Mouse							45
Zyzomys argurus	Common Rock-rat				19			
INTRODUCED MAMMALS								
Bos taurus	Cow				●	5	25	40
Canis lupus familiaris	Dog						●	S
Felis catus	Cat				●	1	●	S
Oryctolagus cuniculus	Rabbit						1	

● Count of species not determined.

Birds

Family and species	Common name	Conservation Status			NQ	NP	POP/PLN	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
PHASIANIDAE								
Coturnix ypsilophora	Brown Quail				1	7		2
ANATIDAE								
Dendrocygna eytoni	Plumed Whistling-Duck				5			25
Chenonetta jubata	Australian Wood Duck					17	1	10
Malacorhynchus membranaceus	Pink-eared Duck						2	3
Anas gracilis	Grey Teal				21	35	4	80
Anas superciliosa	Pacific Black Duck				1	18	3	15
Aythya australis	Hardhead				●			12
PODICIPEDIDAE								
Tachybaptus novaehollandiae	Australasian Grebe					3		2
Poliocephalus poliocephalus	Hoary-headed Grebe				●			1
COLUMBIDAE								
Phaps chalcoptera	Common Bronzewing					9		5
Ocyphaps lophotes	Crested Pigeon				3	2		18
Geophaps plumifera	Spinifex Pigeon				3	32	5	35
Geopelia cuneata	Diamond Dove				3	141	4	12
Geopelia striata	Peaceful Dove				2			
EUROSTOPODIDAE								
Eurostopodus argus	Spotted Nightjar					6	1	
ANHINGIDAE								
Anhinga novaehollandiae	Australasian Darter				1			
PHALACROCORACIDAE								
Microcarbo melanoleucos	Little Pied Cormorant				●			1
Phalacrocorax sulcirostris	Little Black Cormorant				1	10	3	
Phalacrocorax varius	Pied Cormorant				●			
PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican				●		1	
CICONIIDAE								
Ephippiorhynchus asiaticus	Black-necked Stork				4	10		
ARDEIDAE								
Ardea pacifica	White-necked Heron				4	2		4
Ardea modesta	Eastern Great Egret	**M**	**S3**		3	3		
Egretta novaehollandiae	White-faced Heron				2	4	2	6
Egretta garzetta	Little Egret				2			
THRESKIORNITHIDAE								
Threskiornis spinicollis	Straw-necked Ibis				1	2		
ACCIPITRIDAE								
Elanus axillaris	Black-shouldered Kite				1		1	8
Haliastur sphenurus	Whistling Kite				9	3		25
Milvus migrans	Black Kite					1		22
Accipiter fasciatus	Brown Goshawk				1	3		3
Accipiter cirrocephalus	Collared Sparrowhawk				1			
Circus assimilis	Spotted Harrier				4	4	1	13
Aquila audax	Wedge-tailed Eagle				1			2
Hieraaetus morphnoides	Little Eagle				1			3
FALCONIDAE								

Family and species	Common name	Conservation Status			NQ	NP	POP/PLN	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
Falco cenchroides	Nankeen Kestrel				3			12
Falco berigora	Brown Falcon				5	1		10
Falco hypoleucos	Grey Falcon		**S1**		1	2		
Falco longipennis	Australian Hobby							1
RALLIDAE								
Tribonyx ventralis	Black-tailed Native-hen					13	2	5
OTIDIDAE								
Ardeotis australis	Australian Bustard			**P4**	1	8	2	8
BURHINIDAE								
Burhinus grallarius	Bush Stone-curlew			**P4**	5	1	1	S
RECURVIROSTRIDAE								
Himantopus himantopus	Black-winged Stilt					4	3	1
CHARADRIIDAE								
Elseyornis melanops	Black-fronted Dotterel				1	22	4	5
Erythrogonys cinctus	Red-kneed Dotterel					3	2	
SCOLOPACIDAE								
Actitis hypoleucos	Common Sandpiper	**M**	**S3**			1		
Tringa nebularia	Common Greenshank	**M**	**S3**			2		
TURNICIDAE								
Turnix velox	Little Button-quail				3		1	5
CACATUIDAE								
Eolophus roseicapillus	Galah				3	117	4	25
Cacatua sanguinea	Little Corella				4	143		15
Nymphicus hollandicus	Cockatiel					2		42
PSITTACIDAE								
Barnardius zonarius	Australian Ringneck				●			2
Melopsittacus undulatus	Budgerigar				201	22	3	55
Neophema elegans	Elegant Parrot							2
CUCULIDAE								
Chalcites basalis	Horsfield's Bronze-Cuckoo					1		1
Cacomantis pallidus	Pallid Cuckoo							5
STRIGIDAE								
Ninox novaeseelandiae	Southern Boobook					2		1
TYTONIDAE								
Tyto javanica	Eastern Barn Owl					2	1	
HALCYONIDAE								
Todiramphus pyrrhopygius	Red-backed Kingfisher					1		3
Todiramphus sanctus	Sacred Kingfisher				1	2	2	
MEROPIDAE								
Merops ornatus	Rainbow Bee-eater	**M**	**S3**		3	2	1	5
PTILONORHYNCHIDAE								
Ptilonorhynchus guttatus	Western Bowerbird				1	1		
MALURIDAE								
Malurus leucopterus	White-winged Fairy-wren				●			12
Malurus lamberti	Variegated Fairy-wren				2			
ACANTHIZIDAE								
Gerygone fusca	Western Gerygone							2
PARDALOTIDAE								
Pardalotus rubricatus	Red-browed Pardalote				3	1		5

Family and species	Common name	Conservation Status			NQ	NP	POP/PLN	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
MELIPHAGIDAE								
Lichenostomus virescens	Singing Honeyeater				1	5		10
Lichenostomus keartlandi	Grey-headed Honeyeater					7	2	2
Lichenostomus penicillatus	White-plumed Honeyeater				2	9	2	19
Manorina flavigula	Yellow-throated Miner				1	12	4	15
Epthianura tricolor	Crimson Chat				1	5		45
Sugomel niger	Black Honeyeater				●			12
Lichmera indistincta	Brown Honeyeater				1	3		5
POMATOSTOMIDAE								
Pomatostomus temporalis	Grey-crowned Babbler				●			
CAMPEPHAGIDAE								
Coracina novaehollandiae	Black-faced Cuckoo-shrike				1	6		4
Lalage sueurii	White-winged Triller					2	1	4
ARTAMIDAE								
Artamus personatus	Masked Woodswallow				●			75
Artamus cinereus	Black-faced Woodswallow				3	8	5	14
Cracticus nigrogularis	Pied Butcherbird				4	2	3	6
Cracticus tibicen	Australian Magpie				1	4	1	11
RHIPIDURIDAE								
Rhipidura leucophrys	Willie Wagtail				4	1		10
CORVIDAE								
Corvus orru	Torresian Crow				5	15	3	18
MONARCHIDAE								
Grallina cyanoleuca	Magpie-lark				3	21	4	6
PETROICIDAE								
Petroica goodenovii	Red-capped Robin				1			1
Melanodryas cucullata	Hooded Robin					2		
ALAUDIDAE								
Mirafra javanica	Horsfield's Bushlark				1	1		13
MEGALURIDAE								
Cincloramphus mathewsi	Rufous Songlark					1	8	5
Cincloramphus cruralis	Brown Songlark						1	4
Eremiornis carteri	Spinifexbird				3	2	2	9
HIRUNDINIDAE								
Petrochelidon ariel	Fairy Martin				16	103	23	25
ESTRILDIDAE								
Taeniopygia guttata	Zebra Finch				16	810	35	80
Neochmia ruficauda subclarescens	Star Finch (western)			**P4**			3	
Emblema pictum	Painted Finch				8	28	10	25
MOTACILLIDAE								
Anthus novaeseelandiae	Australasian Pipit				1	3	4	8

● Count of species not determined.

Reptiles

Family and species	Common name	Conservation Status			NQ	NP	POP/PLNB	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
CHELUIDAE								
Chelodina steindachneri	Flat-shelled Turtle						2	S
AGAMIDAE								
Amphibolurus longirostris	Long-nosed Dragon						●	4
Ctenophorus caudicinctus	Ring-tailed Dragon					1		10
Ctenophorus isolepis	Central Military Dragon						●	15
Ctenophorus nuchalis	Central Netted Dragon						●	
Pogona minor	Dwarf Bearded Dragon						1	1
DIPLODACTYLIDAE								
Diplodactylus conspicillatus	Fat-tailed Gecko						3	
Lucasium stenodactylum							2	
Rhynchoedura ornata	Beaked Gecko						1	
CARPHODACTYLIDAE								
Nephrurus levis								1
Nephrurus wheeleri							1	
GEKKONIDAE								
Gehyra punctata							2	4
Gehyra variegata							6	2
Heteronotia binoei	Bynoe's Gecko						2	
PYGOPODIDAE								
Lialis burtonis	Burtons Legless Lizard						1	1
SCINCIDAE								
Cyclodomorphus melanops	Slender Blue-tongue						1	1
Egernia ebsisolus								1
Proablepharus reginae								3
Tiliqua multifasciata	Central Blue-tongue						3	
VARANIDAE								
Varanus giganteus	Perentie					1		
Varanus gouldii	Sand Monitor						4	
Varanus panoptes	Yellow-spotted Monitor					1		1
Varanus pilbarensis	Pilbara Rock Monitor							2
TYPHLOPIDAE								
Ramphotyphlops grypus							1	
BOIDAE								
Antaresia stimsoni	Stimson's Python						2	
Aspidites melanocephalus	Black-headed Python				2		3	
ELAPIDAE								
Acanthophis wellsi	Pilbara Death Adder						1	
Furina ornata	Moon Snake						1	
Pseudonaja mengdeni	Western Brown Snake						2	
Pseudonaja modesta	Ringed Brown Snake						2	
Pseudechis australis	Mulga Snake				1	1	2	1

● Count of species not determined.

Amphibians

Family and species	Common name	Conservation Status			NQ	NP	POP/PLNB	Mulgara/Greater Bilby/ PLNB
		EPBC Act	WC Act	DEC				
HYLIDAE								
Cyclorana australis	Giant Frog						7	
Cyclorana maini	Sheep Frog						170	
Litoria rubella	Little Red Tree Frog					1	150	
LIMNODYNASTIDAE								
Notaden nichollsi	Desert Spadefoot						2	
Platyplectrum spenceri	Centralian Burrowing Frog						50	10
MYOBATRACHIDAE								
Uperoleia saxatilis	Pilbara Toadlet						130	

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APPENDIX F FAUNA CAPTURED ON MOTION CAMERA AT TARGETED NIGHT PARROT FEEDING STATION

Table 6.1 – Fauna captured on feeding stations

Species	Feeding station 1	Feeding station 2	Feeding station 3
Birds			
Australian Owlett-nightjar	●		
Australasian Pipit			●
Common Bronzewing	●		
Crested Pigeon	●	●	
Diamond Dove		●	●
Little Button-quail	●		●
Magpie-lark	●	●	●
Singing Honeyeater			●
Spinifex Pigeon		●	●
Torresian Crow	●		●
Zebra Finch			●
Other fauna			
Cow	●		
Feral cat		●	●
Red Kangaroo	●	●	●
Common Rock-rat	●		
Long-nosed Dragon			●
Dwarf Bearded Dragon	●		

APPENDIX G NOCTURNAL HERPETOFAUNA RECORDED DURING ROAD SPOTTING TRANSECTS

Family and species	Common name	Impact Route 1	Impact Route 2	Control Route 1	Control Route 2
Reptiles					
DIPLODACTYLIDAE					
Diplodactylus conspicillatus	Fat-tailed Gecko	3			
Lucasium stenodactylum		2			
Rhynchoedura ornata	Beaked Gecko				1
CARPHODACTYLIDAE					
Nephrurus wheeleri		1			
GEKKONIDAE					
Gehyra punctata			1		1
Gehyra variegata		4	2		
Heteronotia binoei	Bynoe's Gecko		2		
PYGOPODIDAE					
Lialis burtonis	Burtons Legless Lizard				1
SCINCIDAE					
Cyclodomorphus melanops	Slender Blue-tongue		1		
Tiliqua multifasciata	Central Blue-tongue		3		
TYPHLOPIDAE					
Ramphotyphlops grypus		1			
BOIDAE					
Antaresia stimsoni	Stimson's Python	1	1		
Aspidites melanocephalus	Black-headed Python		1		2
ELAPIDAE					
Acanthophis wellsi	Pilbara Death Adder				1
Furina ornata	Moon Snake	1			
Pseudonaja mengdeni	Western Brown Snake	2			
Pseudonaja modesta	Ringed Brown Snake		1		1
Pseudechis australis	Mulga Snake		2		
Amphibians					
HYLIDAE					
Cyclorana australis	Giant Frog		2	5	
Cyclorana maini	Sheep Frog	150	30		20
Litoria rubella	Little Red Tree Frog	150			
LIMNODYNASTIDAE					
Notaden nichollsi	Desert Spadefoot		1		1
Platyplectrum spenceri	Centralian Burrowing Frog	50			
MYOBATRACHIDAE					
Uperoleia saxatilis	Pilbara Toadlet	100	30		

APPENDIX H NON-TARGETED CONSERVATION SIGNIFICANT SPECIES RECORDED

Species	Conservation status			Coordinates		Record
	EPBC Act	WC Act	DEC	Easting	Northing	
Northern Quoll monitoring						
Eastern Great Egret (*Ardea modesta*)	M	S3		677226	7674943	1 individual
Eastern Great Egret (*Ardea modesta*)	M	S3		733968	7548175	1 individual
Rainbow Bee-eater (*Merops ornatus*)	M	S3		687256	7647662	1 individual
Rainbow Bee-eater (*Merops ornatus*)	M	S3		696697	7607420	1 individual
Rainbow Bee-eater (*Merops ornatus*)	M	S3		693995	7595217	1 individual
Grey Falcon (*Falco hypoleucos*)		S1		696680	7605346	1 individual recorded at Yule river bridge (Figure 3.12)
Bush-stone Curlew (*Burhinus grallarius*)			P4	674223	7643525	tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	687348	7647525	tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	696664	7607340	tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	696597	7605324	tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	706521	7573358	1 calling
Australian Bustard (*Ardeotis australis*)			P4	691809	7612874	tracks only
Australian Bustard (*Ardeotis australis*)			P4	701464	7614297	tracks only
Australian Bustard (*Ardeotis australis*)			P4	691574	7612354	tracks only
Australian Bustard (*Ardeotis australis*)			P4	669766	7701634	1 individual
Night Parrot monitoring						
Eastern Great Egret (*Ardea modesta*)	M	S3		665935	7711813	One individual recorded at Ch 37 water point
Eastern Great Egret (*Ardea modesta*)	M	S3		677181	7674961	Two observations made plus recorded by motion camera at Ch 77 water point
Common Sandpiper (*Actitis hypoleucos*)	M	S3		696756	7606350	Single individual recorded at Ch 151 water point

Species	Conservation status			Coordinates		Record
	EPBC Act	WC Act	DEC	Easting	Northing	
Common Greenshank (*Tringa nebularia*)	M	S3		696756	7606350	Two records made from Ch 151
Rainbow Bee-eater (*Merops ornatus*)	M	S3		697340	7614183	Single record from Ch 137 water point
Rainbow Bee-eater (*Merops ornatus*)	M	S3		734800	7546231	Single record from Ch 231 water point
Grey Falcon (*Falco hypoleucos*)		S1		696756	7606350	Two individuals recorded at Ch 151 water point
Australian Bustard (*Ardeotis australis*)			P4	677181	7674961	Single individual at Ch 77 water point
Australian Bustard (*Ardeotis australis*)			P4	707122	7573469	Five records from Ch 190 water point
Australian Bustard (*Ardeotis australis*)			P4	734143	7548070	Individual observed and individual recorded by motion camera (Figure 3.13) at Ch 229 water point.
Australian Bustard (*Ardeotis australis*)			P4	733666	7550184	Single individual observed at Ch 227 water point
Bush-stone Curlew (*Burhinus grallarius*)			P4	677181	7674961	Recorded by motion camera at Ch 77 water point
Bush-stone Curlew (*Burhinus grallarius*)			P4	734143	7548070	Recorded by motion camera at Ch 229 water point (Figure 3.14)
Bush-stone Curlew (*Burhinus grallarius*)			P4	700439	7609653	Opportunistic record near Ch 145
Pilbara Olive Python/Pilbara Leaf-nosed Bat monitoring						
Rainbow Bee-eater (*Merops ornatus*)	M	S3		726258	7561232	
Australian Bustard (*Ardeotis australis*)			P4	706633	7573147	Flying over RC 195
Bush-stone Curlew (*Burhinus grallarius*)			P4	696930	7619084	
Bush-stone Curlew (*Burhinus grallarius*)			P4	723901	7596493	
Star Finch (western) (*Neochmia ruficauda subclarenscens*)			P4	734143	7548070	At least 3 individuals, of which all were males.
Mulgara/Greater Bilby monitoring						
Rainbow Bee-eater (*Merops ornatus*)	M	S3		677450	7670193	5 individuals
Australian Bustard (*Ardeotis australis*)			P4	701470	7609328	Two individuals

Species	Conservation status			Coordinates		Record
	EPBC Act	WC Act	DEC	Easting	Northing	
Australian Bustard (*Ardeotis australis*)			P4	693595	7632408	One individual
Australian Bustard (*Ardeotis australis*)			P4	677089	7675522	Two individuals
Australian Bustard (*Ardeotis australis*)			P4	675422	7676557	Two individuals
Australian Bustard (*Ardeotis australis*)			P4	668444	7702905	One individual
Bush-stone Curlew (*Burhinus grallarius*)			P4	701503	7614304	Tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	699742	7613935	Tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	697142	7614327	Tracks only
Bush-stone Curlew (*Burhinus grallarius*)			P4	686924	7648350	Tracks only