Woodie Woodie Mine:

Targeted Northern Quoll Survey

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Executive Summary

Introduction

Woodie Woodie Manganese Mine (Woodie Woodie) operates in the East Pilbara region of Western Australia. Consolidated Minerals Limited (CML) has recently recommenced operations and proposes to mine 18 manganese prospects over the next five years. CML commissioned Western Wildlife to carry out a targeted survey for Northern Quoll (*Dasyurus hallucatus*) across the mine. This report details the findings of the survey conducted in June 2018.

Methods

The survey was undertaken in accordance with the *Statement of environmental principles, factors and objectives* (Environmental Protection Authority (EPA) 2016a), *Environmental factor guideline – terrestrial fauna* (EPA 2016b), *Technical guidance – terrestrial fauna surveys* (EPA 2016c), the *Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA and DEC 2010) and the EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus*) (Commonwealth of Australia 2016).

The field survey was carried out between the 5th and 14th June 2018. Ten sites of motion-sensitive camera traps were used to target the Northern Quoll. Each site included ten baited cameras set for four nights to give a total of 400 camera trap-nights. The images were analysed to identify individual quolls from their spot patterns, where possible. Northern quoll shelter habitat (rocky outcrops, breakaways or escarpments) were identified from aerial photography and where possible, ground-truthed in the field. Foraging habitat was determined to be all vegetation within 1km of shelter habitat.

Results and Discussion

The Northern Quoll was recorded at four of the ten camera trap sites, with eight individuals identified from their spot patterns. Although previous surveys did not record this species, quolls at Woodie Woodie are likely to be a permanent population. Quolls at Woodie Woodie shelter in rocky areas, including escarpments, breakaways and low gorges. High quality shelter habitat was large in extent and appeared to have many cracks and crevices for shelter. Of the five camera sites in shelter habitat, quolls were recorded at four. Although no dispersal was recorded in this survey, it is likely that quolls do disperse. When dispersing, even quite small outcrops may be important to allow this species to move through the landscape. Tree-lined creeks are also potential dispersal habitat.

Frequent fire is one of the potential threats to quolls currently operating at Woodie Woodie. Other potential threats include the presence of feral predators (cats and dingoes) and loss of habitat to current mining operations. Although not currently present, the Cane Toad may potentially invade this area as water is present and connected to the Oakover River.

Taken on its own, Woodie South is unlikely to currently support an 'important population' of quolls, as only a single individual was recorded. The northern section of the target survey area is likely to support an 'important population', as several individuals were recorded across several cameras, with multiple sightings.

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1. Introduction

Woodie Woodie Manganese Mine (Woodie Woodie) operates in the East Pilbara region of Western Australia. Consolidated Minerals Limited (CML) has recently recommenced operations and proposes to mine 18 manganese prospects over the next five years. The Northern Quoll (*Dasyurus hallucatus*) was recently confirmed as occurring at Woodie Woodie, despite remaining unrecorded on previous vertebrate fauna surveys between 2006 and 2013. The Northern Quoll is listed under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and under Schedule 2 (Endangered) of *The Western Australian Wildlife Conservation Act 1950* (WC Act). Thus CML commissioned Western Wildlife to investigate the status of the Northern Quoll at Woodie Woodie.

The objectives of the Northern Quoll survey were to:

- Identify potential Northern Quoll shelter habitat and foraging/dispersal habitat in the target survey area.
- Survey for the presence of Northern Quolls using methods recommended by Commonwealth of Australia (2016).

This report details the findings of the targeted survey conducted in June 2018.

1.1 Regional Location

The Woodie Woodie Manganese Mine is about 400 km southeast of Port Hedland, 170 km southeast of Marble Bar and 100 km east of Nullagine in the Eastern Pilbara region of Western Australia (Figure 1).

The Woodie Woodie Mine is within the Chichester subregion of the Pilbara Bioregion (DEWHA 2004), which is comprised of undulating plains of Achaean granite and basalt, with basalt ranges (Kendrick and McKenzie 2001). The climate is semi-desert tropical, receiving about 300mm of rain per year (Kendrick and McKenzie 2001). The dominant land-uses are grazing on native pastures, Aboriginal lands and reserves, Unallocated Crown Land and Crown Reserves, Conservation and Mining (Kendrick and McKenzie 2001).

A significant feature in the area surrounding the mine is the Oakover River and its various tributaries. The Oakover River contains permanent water at Running Waters, Yilgalong Pool and Carawine Pool (among others), and is thus important fauna habitat for wetland species. About 15km to the east of the study area is the Little Sandy Desert, which supports a different faunal assemblage. Species that favour rocky habitats are likely to be close to the eastern edge of their range in the region.

1.2 Study Area

The survey area for the Northern Quoll survey is 11,969 ha (Figure 2). The separate southern part of the target survey area is known as Woodie South.

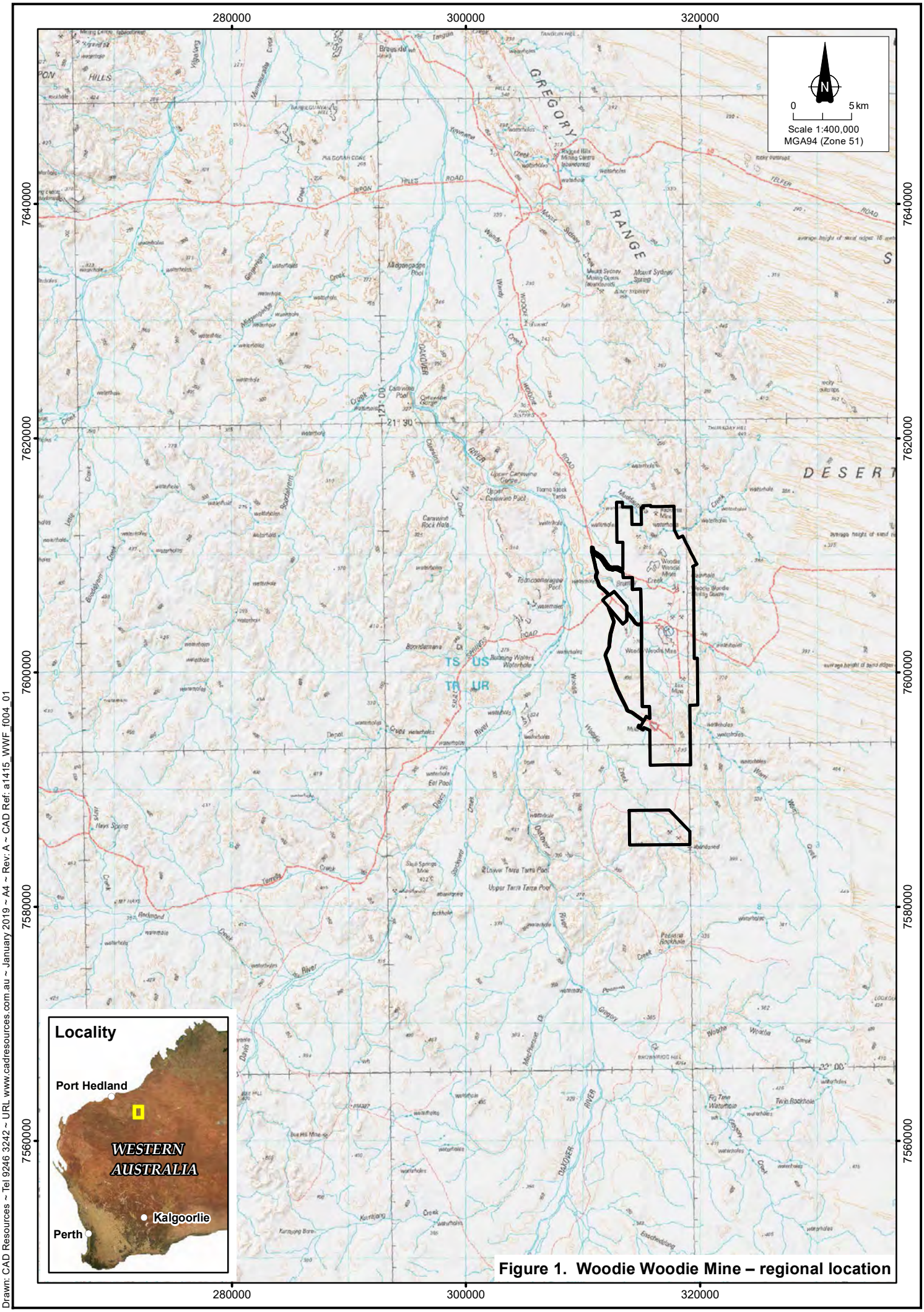

Figure 1. Woodie Woodie Mine – regional location

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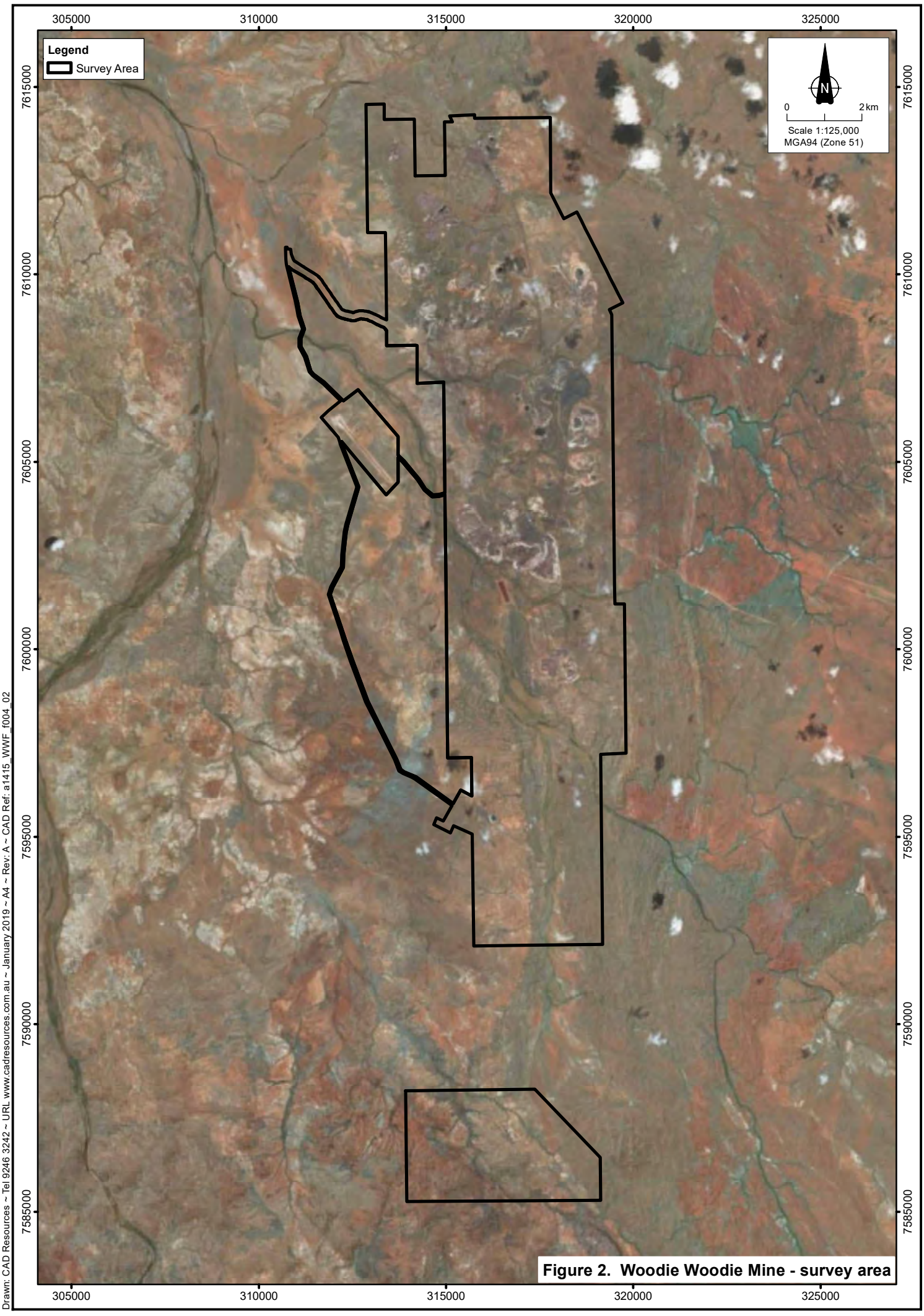

Figure 2. Woodie Woodie Mine - survey area

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1.3 Climate and Weather

The nearest weather station is Telfer Aero (Bureau of Meteorology Site 013030). The climate is characterised by hot wet summers and cool dry winters (Figure 3). The mean annual rainfall is 371.2mm. The monthly rainfall was well above average in January 2018, but very dry immediately prior to the field survey, with no rainfall recorded in April or May 2018. The weather during the survey period was typically warm and dry, with only one day of rain (Table 1).

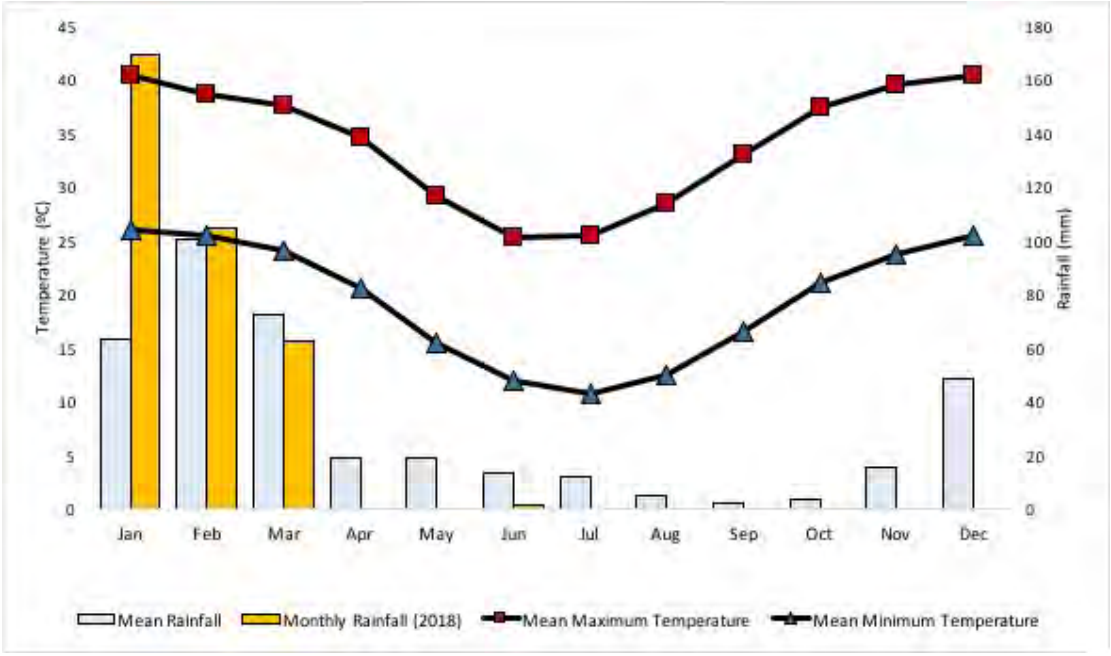

Figure 3. Climate statistics for Telfer Aero (data from Bureau of Meteorology 2018).

Table 1. Weather for Telfer Aero, 1 – 14 June 2018.

Day	Temperature (°C)		Rainfall (mm)	Survey Period
	Maximum	Minimum		
1	15.8	30	0	
2	15	29.5	0	
3	13.9	28.5	0	
4	8.5	28.2	0	
5	13	29.3	0	+
6	16.1	24.5	0	+
7	15.8	27.5	1.6	+
8	18.6	26.7	0	+
9	18.6	28.8	0	+
10	18.4	31.3	0	+
11	17.7	27.3	0	+
12	13.3	25.9	0	+
13	10.9	22.4	0	+
14	8.3	23.2	0	+

2. Methods

2.1 Guidance Documents and Licencing

The fauna surveys were conducted in accordance with:

- Statement of environmental principles, factors and objectives (Environmental Protection Authority (EPA) 2016a)
- Environmental factor guideline – terrestrial fauna (EPA 2016b)
- Technical guidance – terrestrial fauna surveys (EPA 2016c)
- Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA and DEC 2010)
- EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus*) (Commonwealth of Australia 2016).

All fauna works were carried out under Regulation 17 Licence 08-002218-1 issued by the Department of Biodiversity, Conservation and Attractions (DBCA).

2.2 Personnel

The personnel involved in the fauna survey are listed in Table 2.

Table 2. Personnel involved with the fauna survey.

Person	Qualification	Role	Experience
Jenny Wilcox	BSc. Hons.	Lead Zoologist • Plan, supervise and conduct fauna survey • Collate data • Prepare report	18 years
Mike Brown	BSc. Hons.	Senior Zoologist • Undertake fieldwork (4 – 11 June)	12 years
Julia White	BSc. Hons.	Assisting Zoologist • Undertake fieldwork (11 – 15 June)	5 years

2.3 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists. These were last updated in September 2018. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

2.4 Literature Review

A review of the relevant literature was undertaken in order to provide background information on the distribution, habitat, biology, ecology and current threats to the Northern Quoll. Sources consulted included general biology texts, action plans, recovery plans, referral guidelines, journal articles and unpublished environmental reports. In addition, DBCA's Threatened and Priority Fauna Database was searched for Northern Quoll records within 50km of a central point in the survey area (21° 39' 58" S, 121° 14' 09" E).

2.5 Habitat Mapping

Two types of habitat mapping were undertaken; fire age mapping and mapping of shelter, dispersal and foraging habitat. Fire age mapping was undertaken as fire is known to impact on Northern Quoll populations (Hill and Ward 2010). At a broad level, Landsat data of fire scars were mapped for Woodie Woodie and the surrounding region.

Shelter habitat (rocky areas such as escarpments, breakaways and gorges) was identified from aerial photography and where possible ground-truthed during the field survey. Foraging and dispersal habitat is defined in the referral guidelines as habitat within 1 km of shelter habitat (Commonwealth of Australia 2016). This was mapped as a 1 km buffer around shelter habitat.

2.6 Field Studies

Ten camera trap sites, each with a transect of ten cameras set 100m apart, were used to target the Northern Quoll (Table 3, Figure 4). Sites were chosen to represent potential shelter habitat or foraging/dispersal habitat. Each site was operated for four nights, to give a total of 40 camera-trap-nights per site, and 400 camera-trap-nights across the survey. See Appendix 1 for individual camera locations and Appenidx 2 for representative photographs of each site.

Bait was placed high (20 – 40cm) on a rock wall, boulder or pile of stones, in order to encourage the quoll to spend time in front of the camera, and be angled away from the camera to maximise collection of quoll spot patterns of the sides and back (Plate 1). Bait was a handful of universal bait (rolled oats, peanut butter and tinned sardines) and a liberal splash of fish oil (burley oil).

2.7 Data Analysis

All fauna recorded on cameras were recorded with the date and time of record to the nearest minute. Fauna were identified to species level where possible. Records of Northern Quoll were clustered into 'sightings', where a collection of photographs less than five minutes apart were considered to be of a single individual. Where possible, the spot patterns of the quolls in each sighting were visually compared to identify those that were of the same individual. For example, the photographs in Plate 2 are of the same individual at different camera locations. Some sightings were unable to be identified, usually due to being too brief and/or the quoll facing the camera.

Table 3. Camera trap sites.

Site	Start Date	Stop Date	Transect Start	Transect Finish	Habitat	Rationale for inclusion
WNQ01	5/6/18	9/6/18	51K 316380 E 7611853 N	51K 315812 E, 7611463 N	Rocky escarpment near creek. Many cracks and crevices.	Potential shelter habitat.
WNQ02	5/6/18	9/6/18	51K 318235 E, 7608298 N	51K 318647 E, 7607862 N	Series of small rocky hills, some crevices.	Potential shelter habitat. Near possible quoll sighting by Woodie Woodie personnel.
WNQ03	5/6/18	9/6/18	51K 317479 E, 7614120 N	51K 317757 E, 7613352N	Rocky escarpment.	Potential shelter habitat.
WNQ04	6/6/18	10/6/18	51K 317859 E, 7595005 N	51K 317702 E, 7595837 N	Eucalypt-lined creek near rocky area. Many old trees with hollows.	Potential foraging/dispersal habitat.
WNQ05	6/6/18	10/6/18	51K 316789 E, 7598137 N	51K 316805 E, 7597655 N	Rocky hills, low gorges and breakaways.	Potential shelter habitat.
WNQ06	9/6/18	13/6/18	51K 316989 E, 7605181 N	51K 316344 E, 7604914 N	Eucalypt-lined creek near camp. Close to wet mess (often attractive to quolls at other sites). Some old trees with hollows.	Potential foraging/dispersal habitat.
WNQ07	9/6/18	13/6/18	51K 315162 E, 7613347 N	51K 314758 E, 7613441 N	Rocky escarpment near creek. Many cracks and crevices. Water present.	Potential shelter habitat.
WNQ08	10/6/18	14/6/18	51K 315634 E 7587266 N	51K 315842 E, 7586501 N	Eucalypt-lined creek near rocky area. Some old trees with hollows.	Potential foraging/dispersal habitat.
WNQ09	10/6/18	14/6/18	51K 317415 E, 7586359 N	51K 317351 E, 7585929 N	Rocky hills and breakaways. Many cracks, crevices and some small caves.	Potential shelter habitat.
WNQ10	10/6/18	14/6/18	51K 318035 E 7599003 N	51K 318022 E, 7598303 N	Series of small rocky hills and breakaways. In burnt area but adjacent to unburnt foraging habitat.	Potential shelter habitat.

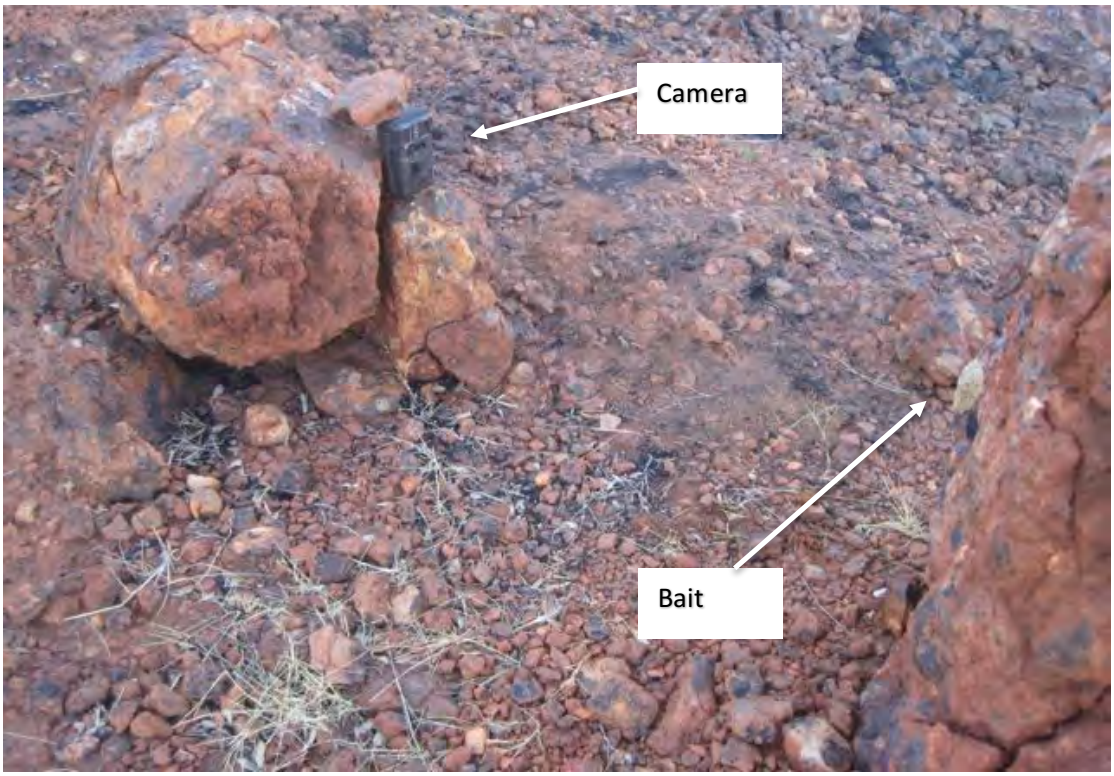

Plate 1. Camera trap set-up.

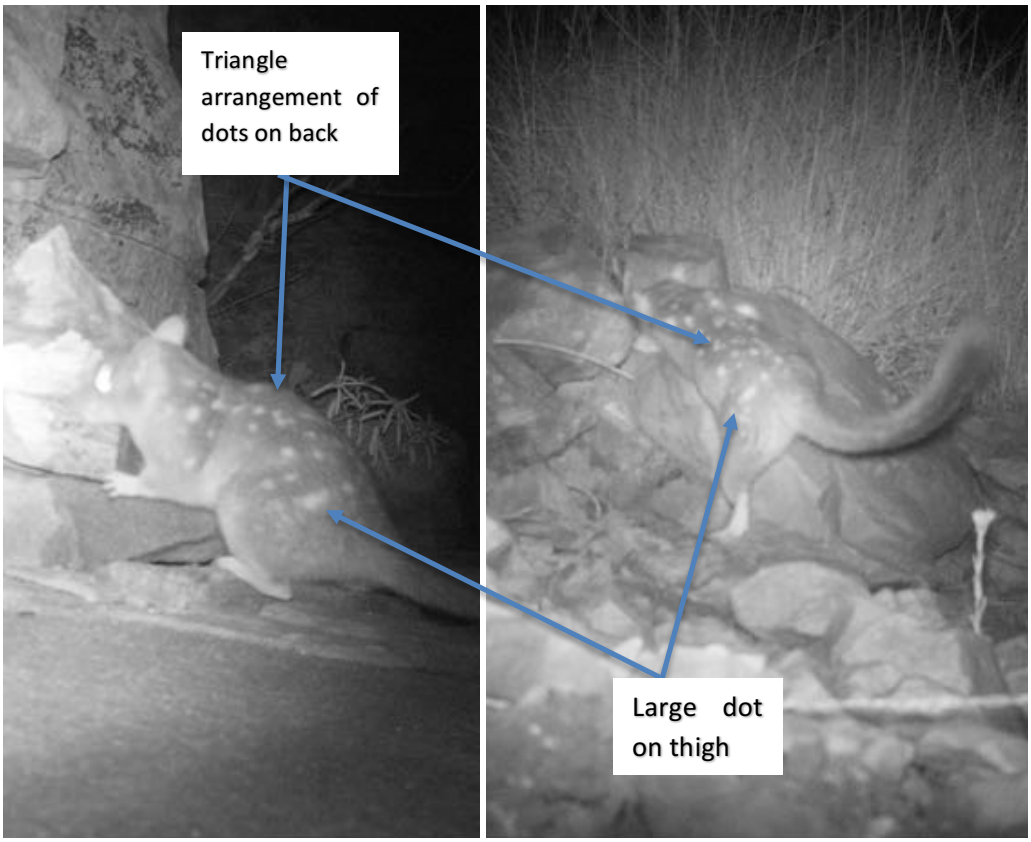

Plate 2. Using spot patterns to identify individual quolls.

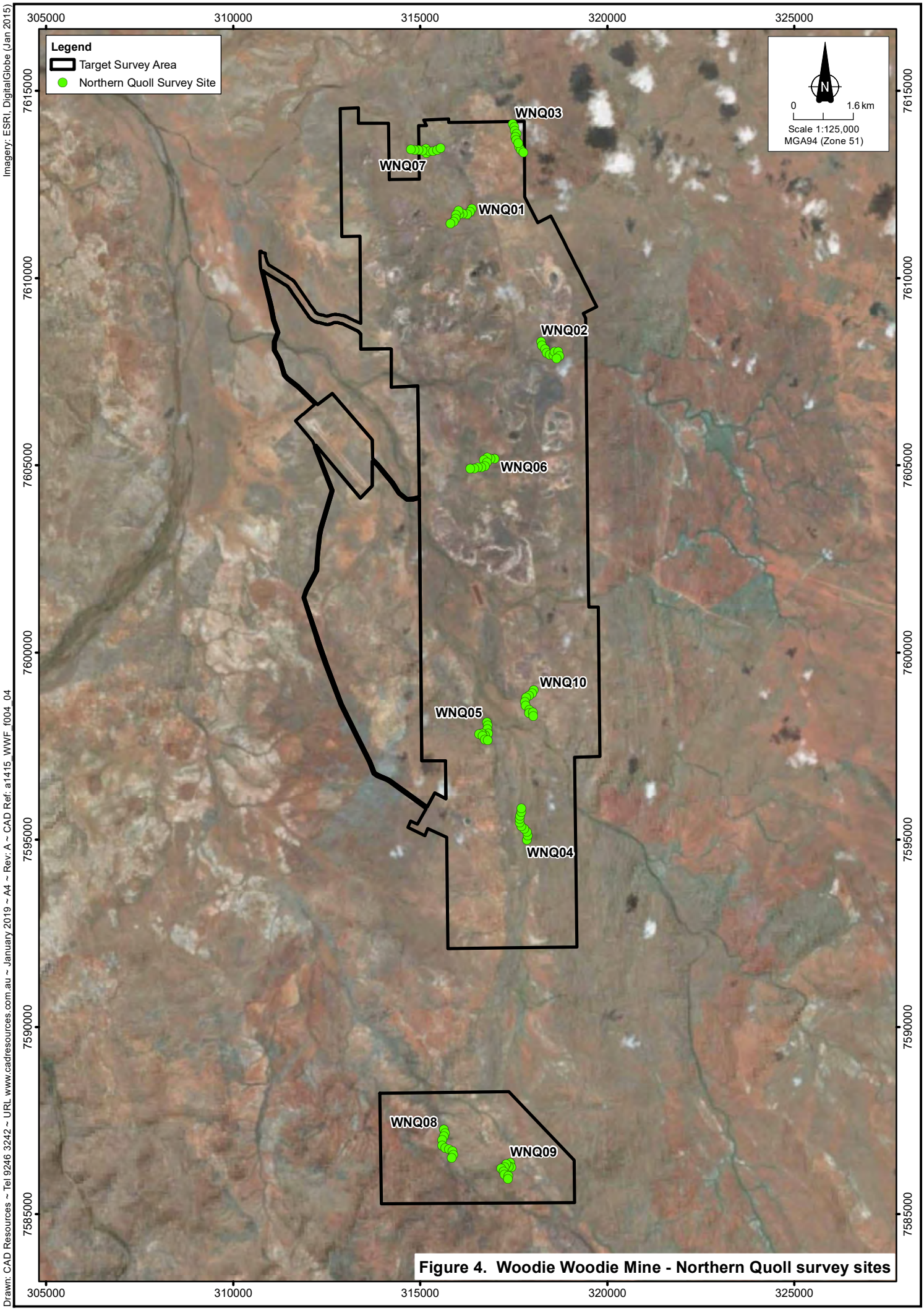

Figure 4. Woodie Woodie Mine - Northern Quoll survey sites

3. Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Technical Guidance (EPA 2016c), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 4 below. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 4. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Competency /experience of the team carrying out the survey	Not limiting	Supervising zoologist has 18 years' experience with fauna surveys in Western Australia, including surveys in the Pilbara Bioregion and at Woodie Woodie in particular. Assisting zoologists have 12 – 5 years' experience.
Proportion of fauna identified, recorded and/or collected.	Not limiting	Quolls were successfully recorded.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Not limiting	The Pilbara Biological Survey (2002 – 2013) undertaken by DBCA provides context for surveys in this Bioregion. Several fauna surveys have been undertaken at Woodie Woodie, providing relevant background information.
Timing/weather/season/cycle	Not limiting	Timing was suitable for Northern Quoll detection.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Not limiting	No disturbances during the field survey. Some Northern Quoll sites were burnt, but sufficient unburnt habitats were available to sample.
Intensity (in retrospect, was the intensity adequate)	Not limiting	Sufficient time was allowed to survey representative habitats within the survey area.
Completeness (e.g. was relevant area fully surveyed)	Not limiting	Good geographic coverage over survey area.
Resources (e.g. degree of expertise available in animal identification to taxon level)	Not limiting	No taxonomic issues were encountered.
Remoteness and/or access problems	Minor limitation	Survey area was large and not all areas could be accessed to view habitats. However, a good proportion was able to be accessed and vegetation data were available for the majority of the area.
Availability of contextual (e.g. biogeographic) information on the region	Minor limitation	The Pilbara Biological Survey (2002 – 2013) undertaken by DBCA provides context for surveys in this Bioregion, however, there are few records of Northern Quoll in the surrounding area.

4. Results

4.1 Background

The Northern Quoll is listed as Endangered under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and under Schedule 2 (Endangered) of *The Western Australian Wildlife Conservation Act 1950* (WC Act).

The Northern Quoll occurs across the northern parts of Australia including Western Australia, the Northern Territory, Queensland and some offshore islands (Van Dyck and Strahan 2008). The Northern Quoll has declined, now occurring as several disjunct populations, of which the Pilbara population is one (Braithwaite and Griffiths 1994). The reduction in population size is estimated at 50% over the last decade, with a further 25% reduction expected over the next decade (Woinarski *et al*. 2014).

Within 50km of the survey area, there are three records of Northern Quoll on DBCA's Threatened and Priority Fauna Database (Figure 5). One record is from Woodie Woodie in 2018 and two from Nifty Mine in 2012, about 35km east of the survey area.

The Northern Quoll is reproductively mature at 11 months, and breed in their first year (Van Dyck and Strahan 2008). Breeding occurs between July and September, and is usually synchronised within a population. At about two months old the young are left in a den while the mother forages, and at six months about two or three young are weaned (Van Dyck and Strahan 2008). In general, all adults die after breeding, though some females have been recorded living up to three years in the wild (Van Dyck and Strahan 2008).

The Northern Quoll occurs in a variety of habitats across its range, but in the Pilbara favours dissected rocky escarpments (Hill and Ward 2010, Van Dyck and Strahan 2008). Where shelter habitat occurs with the Northern Quolls predicted range, it is considered 'habitat critical to the survival of the species' (Commonwealth of Australia 2016). In the Pilbara, shelter and denning habitat consists of rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields and major drainage lines (Commonwealth of Australia 2016).

Little is known about Northern Quoll foraging and dispersal habitats (Commonwealth of Australia 2016). Northern Quolls have been recorded dispersing considerable distance between trapping locations, such as 2.5km in one day (Schmitt *et al*. 1989), 3.5km in seven days (King 1989), 2 – 3km at Poondano (Process Minerals International, unpublished data) and 2km at the Buckland Project (Phoenix Environmental Sciences 2012). However, the referral guidelines recognise that all native vegetation within 1km of shelter habitat or Northern Quoll records may be considered foraging and dispersal habitat (Commonwealth of Australia 2016). Foraging and dispersal habitat may also be considered 'habitat critical to the survival of the species' when it is connected to shelter habitat that supports an 'important population'.

An 'important population' is one that is important to the long-term survival of the Northern Quoll. This may be a population that is high density, a population free of Cane Toads and where Cane Toads are unlikely to gain a foothold, or a population subject to on-going research.

The Northern Quoll is the subject of a National Recovery Plan (Hill and Ward 2010), which lists the potential threats to the species as:

- Cane Toads (*Bufo marinus*)
- Feral predators
- Inappropriate fire regimes
- Habitat degradation and destruction
- Weeds
- Disease
- Hunting and persecution
- Population isolation

Cane Toads are considered the main threat to the Northern Quoll in the parts of its range that overlap the Cane Toad distribution (Hill and Ward 2010). As yet the Pilbara is free of Cane Toads, though it is uncertain whether this will be the case in the future. The Northern Quoll was already in decline in parts of its range prior to Cane Toad invasion, so other threatening processes are thought to be at play (Hill and Ward 2010).

Feral Predators, such as the Fox (*Vulpes vulpes*) and Cat (*Felis catus*), are likely to prey on Northern Quolls. Henandez Santin (2018) suggests that in the Pilbara Cats may exclude quolls from open spinifex plains, restricting them to rocky habitats.

After a wildfire, a monitored population in the Pilbara showed a reduction in captures from nine before the fire to one after the fire, and captures in a second population dropped from 15 to zero (Dunlop 2017). Inappropriate fire regimes, such as too-frequent fires, appear to impact Northern Quolls, possibly through decreased cover resulting in increased predation, changes to habitat structure or reduction in food availability. However, these mechanisms are not well understood (Hill and Ward 2010).

Habitat degradation caused by livestock is of concern in the northern savannah habitats, and together with inappropriate fire regimes, may be the cause of declines of this species in the Pilbara (Hill and Ward 2010). Habitat destruction occurs through developments such as mining, housing and agriculture, and though it occurs on a smaller scale than habitat degradation, it may still have a significant impact on critical habitat (Hill and Ward 2010). Weeds such as Gamba Grass (*Andropogon gayanus*) and Mission Grass (*Pennisetum spp.*) are dense and may hinder ground movements of Northern Quolls, or foster wildfire (Hill and Ward 2010), however, these grasses are unlikely to be of concern in the survey area.

The short lifespan of the Northern Quoll may leave them susceptible to local extinction when populations become isolated. Disease may play a role in local extinctions, though as yet there is only circumstantial evidence for Northern Quoll population crashes due to disease (Hill and Ward 2010).

Hunting and persecution are generally historical pressures in many areas, where Northern Quolls were hunted by Aboriginal peoples, persecuted by Europeans or subject to broad-scale poisoning (Hill and Ward 2010).

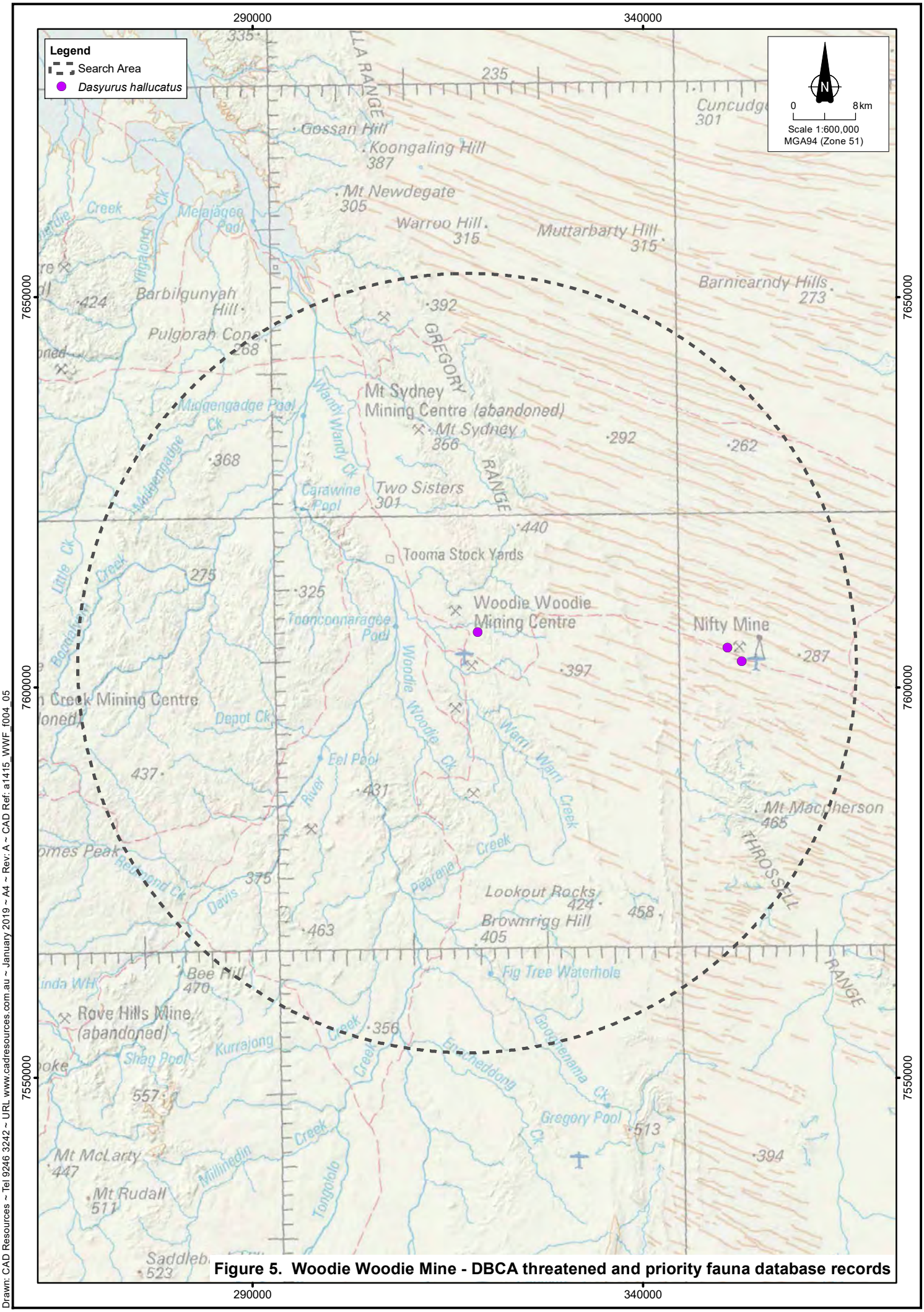

Figure 5. Woodie Woodie Mine - DBCA threatened and priority fauna database records

4.2 Northern Quoll Habitat

Shelter habitat in the survey area consisted of rocky outcrops, low gorges and breakaways (Table 5, Plate 3, Appendix 2). This was identified from aerial photography, and where possible ground-truthed during the field survey. Foraging and dispersal habitat was considered to be all areas within 1km of shelter habitat (Figure 6). It should be noted that some waste rock dumps may be artificial shelter habitat when they consist of tumbled boulders with crevices to provide shelter.

Table 5. Northern Quoll habitat.

Habitat type	Brief description	Area (ha)		Total (ha)
		Woodie (main)	Woodie South	
Shelter habitat	Rocky outcrops, low gorges and breakaways	230.18	77.60	307.77
Foraging/dispersal habitat	All habitat within 1km of shelter habitat	5,904.86	1,209.05	7,113.91
Other	Habitat unlikely to be important for quolls	4,499.47	94.15	4,593.62

Plate 3. Examples of rocky outcrops and breakaways at Woodie Woodie.

Figure 6. Woodie Woodie Mine - Northern Quoll records and habitat

Imagery: ESRI, Digital Globe (2015)
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4.3 Northern Quoll Records

Northern Quolls were recorded at four of the ten camera trap sites (Table 6, Figure 6). All four sites were rocky shelter sites rather than dispersal or foraging habitat (Table 3, Appendix 2). No quolls were recorded at Site 7, despite this also being shelter habitat and in close proximity to Sites 1 and 3 where quoll were recorded. Other species recorded included Feral Cats and Dingos, the Common Rock Rat (a food species for quolls) and a range of birds.

Eight quoll individuals were identified from their spot patterns (Table 7). A further ten sightings were unable to be attributed. Therefore, a minimum of seven and a maximum of 18 individual quolls were recorded during the survey. However, it is likely that most of the unattributed records are of the quolls already identified. No unattributed record overlapped in time with an identified individual, and the records were made on camera traps that were the same or in close proximity to known individuals.

Table 6. Fauna recorded at each camera trap site.

Species		Camera site									
		WNQ01	WNQ02	WNQ03	WNQ04	WNQ05	WNQ06	WNQ07	WNQ08	WNQ09	WNQ10
MAMMALS											
Bos taurus	Cow							+			
Canis familiaris	Dog / Dingo	+	+				+	+	+		
Dasyurus hallucatus	**Northern Quoll**	**+**		**+**		**+**				**+**	
Felis catus	Feral Cat					+	+	+			+
Mus / Pseudomys sp.	Unidentified Mouse			+			+	+			
Pseudantechinus woolleyae	Woolley's Pseudantechinus									+	+
Tachyglossus aculeatus	Echidna	+									
Zyzomys argurus	Common Rock Rat	+	+	+		+		+	+	+	+
BIRDS											
Ardea pacifica	White-necked Heron							+			
Coracina novaehollandiae	Black-faced Cuckoo-shrike							+			
Corvus orru	Torresian Crow						+	+	+		
Cracticus nigrogularis	Pied Butcherbird									+	
Colluricincla harmonica	Grey Shrike-thrush					+					
Emblema pictum	Painted Finch										+
Geopelia cuneata	Diamond Dove						+		+		
Geophaps plumifera	Spinifex Pigeon		+					+			+
Grallina cyanoleuca	Magpie-lark	+			+			+	+		
Ptilotula keartlandi	Grey-headed Honeyeater					+					
Rhipidura leucophrys	Willie Wagtail	+				+	+		+	+	+
Turnix velox	Little Button-quail						+				

Table 7. Number of sightings and individual Northern Quoll at each site.

Record type	Camera site				
	WNQ01	WNQ03	WNQ05	WNQ09	Total
Number of cameras triggered at each site (out of 10)	5	5	5	2	17
Number of quoll sightings at each site	216	64	84	11	375
Number of individual quolls identified	2	4	1	1	8
Number of unattributed quoll sightings	3	4	3	0	10
Potential number of quolls recorded per site:	**2 - 5**	**4 - 8**	**1 - 4**	**1**	**7 - 18**

5. Discussion and Conclusions

The Northern Quoll was confirmed as occurring at Woodie Woodie during this survey. Although previous surveys did not record this species, quolls at Woodie Woodie are likely to be a permanent population, rather than a transitory (i.e. dispersing or males in search of mates) population. Quolls are generally sedentary, this survey was undertaken in June, prior to breeding, and multiple individuals were recorded.

Previous fauna surveys in the survey area were undertaken prior to the common usage of motion sensitive camera traps (Western Wildlife 2007, 2009, 2010). In addition, Woodie Woodie and its surrounds have been subject to frequent fires (Figure 7). Fire may impact quoll populations, reducing them below detectable levels. A survey at Woodie South in 2013 did use camera traps, but failed to detect quolls (Western Wildlife 2014). At the time of survey, the central part of Woodie South had been burnt about four years prior, and in 2018 only a single individual was recorded. Site WNQ10 was sited in recently burnt habitat (albeit immediately adjacent to unburnt habitats), and no quolls were recorded despite the habitat appearing suitable.

Frequent fire is one of the potential threats to quolls currently operating at Woodie Woodie. Other potential threats include the presence of feral predators (cats and dingoes) and loss of habitat to current mining operations. Although not currently present, the Cane Toad may potentially invade this area as water is present and connected to the Oakover River.

Quolls at Woodie Woodie shelter in rocky areas, including escarpments, breakaways and low gorges. The sites chosen in likely shelter habitat (sites WNQ01, WNQ03, WNQ05, WNQ09 and WNQ10) were some of highest quality habitat observed in the survey area, in that it was large in extent and appeared to have many cracks and crevices for shelter. Of these five sites, quolls were recorded at four.

Although no dispersal between sites or in potential dispersal habitat was recorded in this survey, it is likely that individuals do disperse. Later in the year, it is likely that males will disperse searching for mates, and then young will disperse to find territory away from their mother. When dispersing, even quite small outcrops may be important to allow this species to move through the landscape. Tree-lined creeks are also potential dispersal habitat.

The 2018 survey provides a current snapshot of the quoll population at Woodie Woodie, but the population distribution and density may change over time in response to factors such as climate, fire and the presence of feral predators. Taken on its own, Woodie South is unlikely to currently support an 'important population' of quolls, as only a single individual was recorded. The northern section of the survey area is likely to support an 'important population', as several individuals were recorded across several cameras, with multiple sightings.

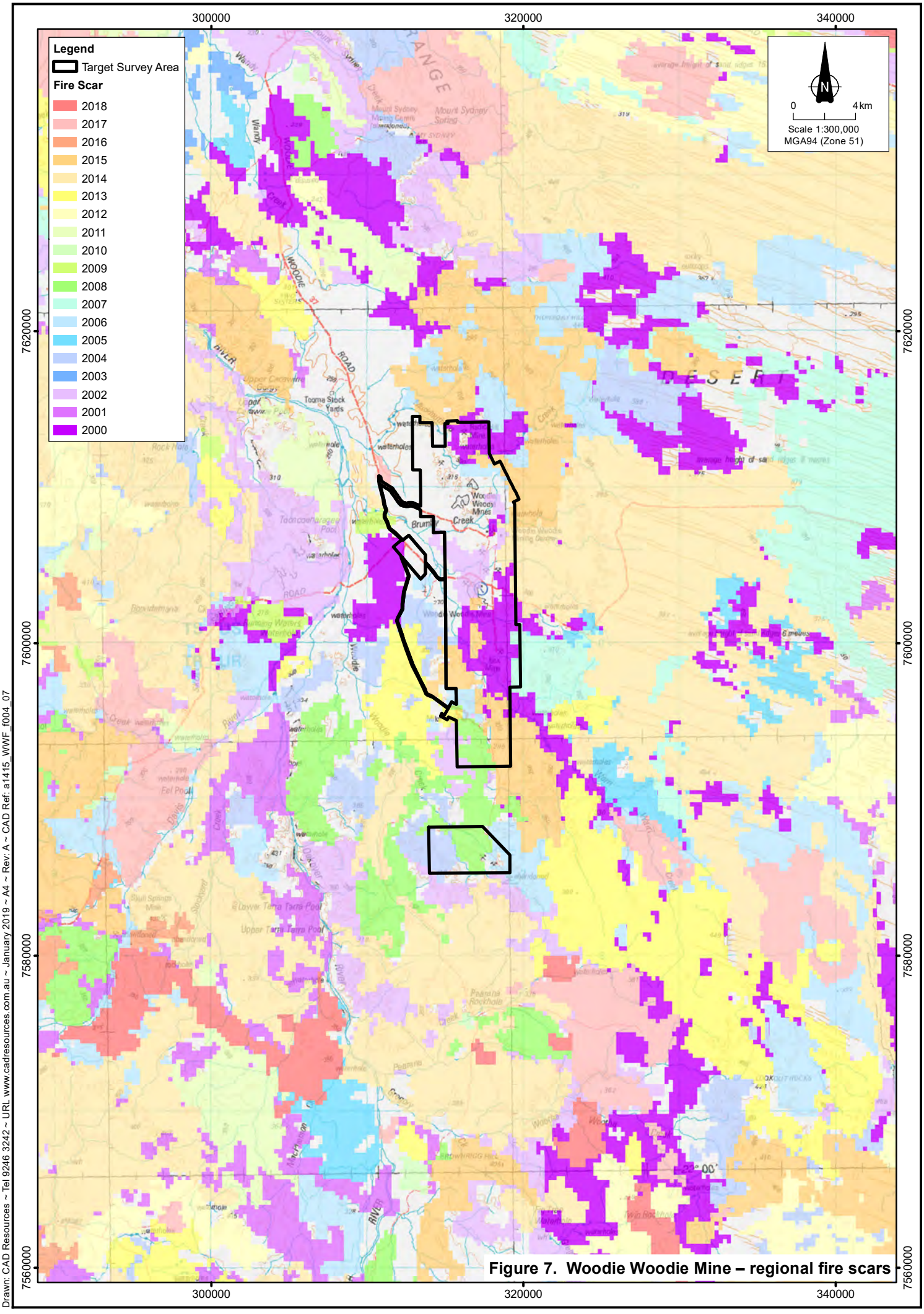

Figure 7. Woodie Woodie Mine – regional fire scars

Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ January 2019 ~ A4 ~ Rev: A ~ CAD Ref: a1415_WWF_f004_07

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Appendices.

Appendix 1. Northern Quoll survey sites – individual camera locations.

Site and Camera ID	Zone	Easting	Northing
WNQ01			
1-01-W20	51	316380	7611853
1-02-W3	51	316331	7611766
1-03-W8	51	316254	7611718
1-04-W19	51	316145	7611727
1-05-W17	51	316048	7611718
1-06-W9	51	316029	7611803
1-07-W4	51	315965	7611696
1-08-W10	51	315950	7611587
1-09-W2	51	315899	7611506
1-10-W21	51	315812	7611463
WNQ02			
2-01-Fa9	51	318235	7608298
2-02-Fd5	51	318256	7608212
2-03-Fc3	51	318346	7608104
2-04-Fb9	51	318381	7608008
2-05-Fc9	51	318469	7607952
2-06-Fd4	51	318569	7607950
2-07-Fc4	51	318599	7608044
2-08-Fc10	51	318688	7608030
2-09-Fd1	51	318721	7607928
2-10-Fb7	51	318647	7607862
WNQ03			
3-01-Fa2	51	317479	7614120
3-02-Fc1	51	317521	7614033
3-03-Fb3	51	317524	7613938
3-04-Fd3	51	317583	7613864
3-05-Fa4	51	317545	7613781
3-06-Fb2	51	317574	7613693
3-07-Fb10	51	317642	7613508
3-08-Fa8	51	317693	7613425
3-09-Fd2	51	317619	7613607
3-10-W12	51	317757	7613352
WNQ04			
4-01-W7	51	317859	7595005
4-02-Fc2	51	317874	7595111
4-03-Fa1	51	317851	7595214
4-04-Fa10	51	317781	7595291
4-05-Fb8	51	317711	7595363
4-06-Fa7	51	317665	7595454
4-07-Fc6	51	317661	7595548
4-08-Fa3	51	317672	7595645
4-09-W22	51	317710	7595742
4-10-W14	51	317702	7595837

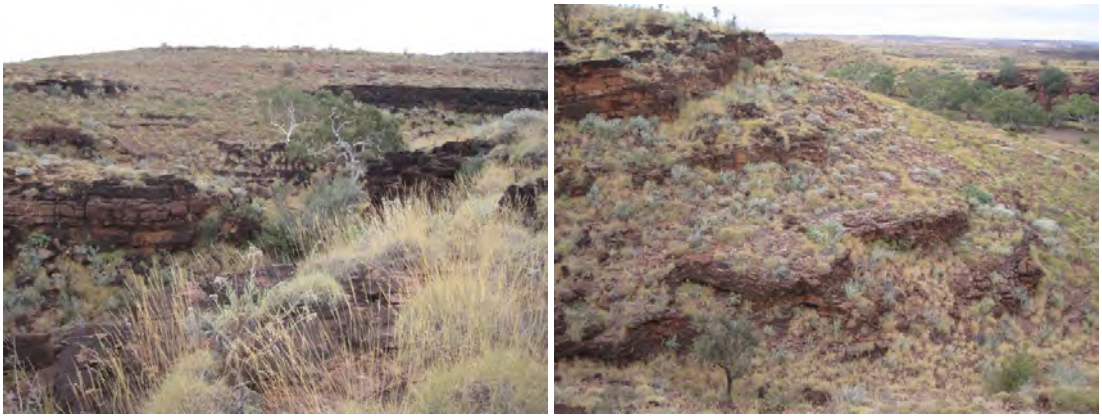
Site and Camera ID	Zone	Easting	Northing
WNQ06			
6-01-Fd3	51	316986	7605181
6-02-W4	51	316883	7605179
6-03-Fb10	51	316792	7605203
6-04-Fc1	51	316706	7605141
6-05-Fa4	51	316782	7605072
6-06-Fa8	51	316739	7604986
6-07-Fb3	51	316642	7604950
6-08-Fb2	51	316541	7604946
6-09-Fa2	51	316450	7604903
6-10-Fd2	51	316344	7604914
WNQ07			
7-01-W3	51	315162	7613347
7-02-Fd5	51	315158	7613447
7-03-W9	51	315249	7613399
7-04-W21	51	315351	7613391
7-05-Fb7	51	315452	7613430
7-06-Fa9	51	315552	7613487
7-07-W12	51	315064	7613410
7-08-W20	51	314958	7613422
7-09-W10	51	314854	7613422
7-10-Fc4	51	314758	7613441
WNQ08			
8-01-W18	51	315634	7587266
8-02-W6	51	315669	7587168
8-03-Fa7	51	315636	7587071
8-04-W13	51	315588	7586976
8-05-Fc2	51	315586	7586832
8-06-Fc6	51	315680	7586765
8-07-fa10	51	315772	7586728
8-08-Fb8	51	315862	7586679
8-09-W16	51	315888	7586582
8-10-W7	51	315842	7586501
WNQ09			
9-01-W17	51	317415	7586359
9-02-W5	51	317446	7586263
9-03-Fd4	51	317373	7586271
9-04-W1	51	317303	7586333
9-05-Fc7	51	317260	7586262
9-06-Fa1	51	317172	7586216
9-07-W15	51	317229	7586134
9-08-W8	51	317252	7586042
9-09-Fb4	51	317361	7586022
9-10-Fb1	51	317351	7585929

Appendix 1. (cont.)

Site and Camera ID	Zone	Easting	Northing
WNQ05			
5-01-W6	51	316789	7598137
5-02-W1	51	316804	7598055
5-03-W18	51	316802	7597956
5-04-W16	51	316816	7597839
5-05-W13	51	316738	7597794
5-06-W15	51	316654	7597836
5-07-Fc7	51	316571	7597813
5-08-W5	51	316672	7597776
5-09-Fb1	51	316732	7597684
5-10-Fb4	51	316805	7597655

Site and Camera ID	Zone	Easting	Northing
WNQ10			
10-01-Fc9	51	318035	7599003
10-02-W14	51	317990	7598915
10-03-Fc3	51	317909	7598856
10-04-Fc10	51	317835	7598786
10-05-Fa3	51	317805	7598681
10-06-Fb9	51	317826	7598586
10-07-Fd1	51	317920	7598472
10-08-W19	51	317913	7598376
10-09-W2	51	318014	7598402
10-10-W22	51	318022	7598305

Appendix 2. Northern Quoll survey sites – representative photographs.



Quoll Site WNQ01

Quoll Site WNQ02

Appendix 1 (cont.)


Quoll Site WNQ03


Quoll Site WNQ04


Quoll Site WNQ05

Appendix 1 (cont.)


Quoll Site WNQ06


Quoll Site WNQ07


Quoll Site WNQ08

Appendix 1 (cont.)


Quoll Site WNQ09


Quoll Site WNQ010