Robe Valley Mesa A to Mesa 2405A, impact of mining on Ghost bat presence and activity, April 2017, including assessment of caves on Mesas F and G

Prepared for Rio Tinto

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Frontispiece: Yeera Bluff and the lower Robe River valley looking south west from the top of Mesa H by Tenielle Brown.

Images: Tenielle Brown or Bob Bullen unless otherwise noted.

Document Revision History

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Executive Summary

Rio Tinto commissioned Bat Call WA (Bat Call) to undertake an assessment of the impact on Ghost bat populations of open cut iron ore mining on the Robe River valley's Deepdale, East Deepdale and Middle Robe deposits, east and west of Pannawonica, in the Pilbara region of Western Australia. This area includes the current and proposed Rio Tinto operations on Mesas A to J/K and the previously mined East Deepdale and Middle Robe areas.

Level one and two fauna surveys have been conducted in the area previously. Early surveys by Biota (Biota 2006, 2009, 2010) and more recently by Biologic in 2014, Astron Environmental Services in 2015/16, Rio Tinto internal ecologists in 2016 and 2017 and Bat Call in 2016 and 2017 have confirmed the ongoing presence of Ghost bats in the Robe River valley.

Data collected indicate that Ghost bats forage generally across the mesas and are roosting in a number of caves along the mesa perimeters. Multiple records including visual observations, cave middens and echolocation recordings, have been detected within and adjacent to the mesas confirming the presence of permanent or semi-permanent roosts supporting a number of maternity colonies.

This survey was designed to provide an assessment of the impact of mining practices since the Middle Robe operations began last century and to confirm whether the current mining practices under Rio Tinto management are effective in retaining the numbers of Ghost bats present in the Robe River valley.

There are twenty mesas of the thirty four (including Pannawonica Hill) on the Robe River system that have recent Ghost bat records. In addition there are five other sites within 10 km of the river where Ghost bat activity has been recently recorded.

There are eighteen mesas which have not been mined. The surveys from 2015 to 2017 show that the perimeters of the mesas that have not been mined including those that have had intense drilling programs on their caps remain as proven Ghost bat habitat and the caves and deep shelters continue to offer diurnal and maternity roost opportunities for the species.

There are two mesas where current large scale open cut resource extraction activities are underway, Mesas A and J. Neither of these currently has a known diurnal presence of Ghost bats although this is speculative due to a lack of survey data on the mesas from recent years. Scats collected in a shelter on Mesa A (Emma Carroll pers. comm.) and under a breakaway on Mesa J (Astron 2016) suggests that the species is using the mesa perimeters for foraging on an

occasional basis. Based on data from other Pilbara iron ore mine sites (e.g. West Angelas and others; author's unpublished data), the lack of diurnal presence is thought to be due to the disturbance from the sound, vibration and airborne dust generated by the blasting, crushing and hauling operations nearby.

There are thirteen mesas where mining of the cap has been completed. Of those, ten have a percentage of the original escarpment retained. The percentage ranges from 16% on Mesa 2402E to 93% on Mesa 2403D. This supplementary assessment of data previously collected (e.g. Astron 2016) demonstrates that the perimeters of the mesas that have been mined and retained in original condition in the Robe River valley remain as viable Ghost bat habitat and the protected caves and deep shelters continue to offer nocturnal and diurnal roosting opportunities for the species. It is also probable that the retained deepest caves and shelters are used as maternity sites although no evidence of this is available at this time.

An estimate of the combined impact of the iron ore mining on the Ghost bat species in the Robe River valley mesas has been made by assessing the lengths of the perimeters that are retained to a width that protects the deepest caves and shelters. The total perimeter length of the mesas between Mesas A and 2405A is approximately 275 km. Of this, approximately 227 km, or 83% has been retained or is in place on mesas not yet mined. Virtually all of these escarpments are in good condition although there have been some localised collapses and cut-outs for access roads. By applying a ratio of 2 deep caves (caves and shelters over 10 m deep) per km of escarpment, assessed from detailed surveys carried out in 2016 and 2017 by Rio Tinto and Bat Call on Mesas B, C, G and H, to the undisturbed remaining perimeter it is possible that there may be as many as 400 deep shelters and caves suitable for Ghost bat usage remaining on the mesas. While the height and definition of the escarpments varies from mesa to mesa, work done to date suggests that the ratio of 2 caves per km may be applied over the length of the Robe valley. The mesas therefore provide, in combination with the Robe River riparian zone, a continuous habitat for Ghost bats.

For the 48 km of perimeter that have been removed or destroyed, up to 100 caves and deep shelters may have been removed. The impact of removing these on the Ghost bats is unclear. In the Robe River valley, the numbers present may be limited by roosting opportunities or may be limited by the availability of prey. Firstly, based on the current understanding that availability of roosts is a limiting factor to Ghost bat presence (Woinarski *et al*. 2014), this removal may have had an impact on the total number of Ghost bats. It is also apparent, based on the evidence from the supplementary sites within 10 km of the river, that the areas surrounding the mesas have

retained all of their Ghost bat population. With a current estimate of 150 Ghost bats (author's unpublished data consistent with the population estimates in TSSC 2016) in the lower and mid Robe River valley, and recognising that the number will vary with the quality of the northern wet seasons, the loss of Ghost bats from mining in the early decades due to the loss of roosting habitat could be less than 20 individuals. However, this impact is offset by the presence of the very productive Robe River riparian and the major tributaries of Jimmawurrada, Bungaroo and Mungarathoona Creeks. In such a productive district, it is possible that the Ghost bat numbers are limited by seasonal and annual variations in prey numbers in the available high quality foraging opportunities in the river riparian and surrounding areas as has been shown to be the case in a number of predator/prey studies. If this is the case, the minimal impact on the Robe River riparian zone by mining would have left the original population levels virtually unchanged.

Currently in accordance with the statement, "The implication from all genetic studies is that losses of maternity sites containing breeding females have the potential to reduce the Area of Occupancy significantly" in Woinarski *et al*. (2014) it must be assumed that the presence of the caves and deep shelters is a limiting factor. Therefore retaining a minimum perimeter width of 20 m so as not to destroy the caves internal characteristics, together with providing specific protection for identified diurnal/maternal roosts and other candidate caves over 20 m deep, is unlikely to result in any significant loss of Ghost bats in the Robe River valley.

1.0 Introduction.

1.1 Project Background

Rio Tinto commissioned Bat Call to undertake an assessment of the impact of mining on the Ghost bat presence and activity along the Robe River valley. There are a series of mesas of Robe tertiary pisolitic limonite deposits (also known as Channel Iron Deposits, CIDs) that are in various stages of mining along approximately 90 km of the valley in the Pilbara region of Western Australia (WA). Pannawonica, in the Robe valley, lies roughly central in this district, figure 1. Mesa naming convention in this study follows the Rio Tinto names from Mesa A to Mesa N. Mesas further to the east mined by predecessors have been labelled Mesas 2400A to 2405A, figure 2.

Rio Tinto and its predecessors have been mining the mesa deposits for iron ore for five decades beginning at the eastern end of the line of mesas and progressively moving west. The mining operations involve the following main components and activities:

- Initial resource definition surveying involving track building and skeletal drilling patterns.
- Detailed resource evaluation drilling at various scales down to 50 m grids.
- Progressive open pit mining of ore and overburden from mesa deposits using open-cut pit mining techniques. These operations have generally removed the inner core of the mesa while leaving lengths of the rocky face of the perimeter intact to a width of at least 20 m at the mesa surface except where cuts are required for access. During the early years of mining, the larger mesas at the eastern end of the valley, Mesas L to 2405A, had their perimeters either removed entirely or the majority removed, and had overburden dumped over the side on top of the original talus. In recent decades facades facing the Robe River have been retained to varying widths to preserve caves and shelters that have been identified as significant to indigenous cultural heritage and/or the presence of conservation significant fauna-flora, e.g. Mesas A and J.
- Placement of overburden in out-of-pit waste dumps either adjacent to the mesas or on top of the original low mesa perimeters, and
- Construction and use of haul and access roads to the mine areas within the mesas.

Recent surveys have identified that two species of cave roosting bat of conservation significance are present in the area, the Ghost bat (*Macroderma gigas*) and the Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) (PLNb). PLNb have been assessed as using the mesas for foraging while originating from a yet to be discovered roost further to the south or east (Bat Call 2016b, 2016d, 2017a). Multiple Ghost bat records including visual observations, echolocation recordings and cave middens have been detected within and adjacent to the study area (Biota 2006, 2009, 2010; Astron 2016, 2017; Bat Call 2015, 2016a, 2017a, 2017b, 2017c, 2017d).

The purpose of this survey was to assess the impact of open cut iron ore mining on the presence and activity of Ghost bats in the Robe valley, including bat colonies and/or nocturnal foraging. The study area is shown in figure 2. It includes all of the mesas between Mesa A and Mesa 2405A plus the areas immediately adjacent to the Robe River between these sites. In total, Ghost bats observations covering 33 mesas adjacent to the Robe River plus results from five sites within 10 km of the River are included in this assessment, figure 2.

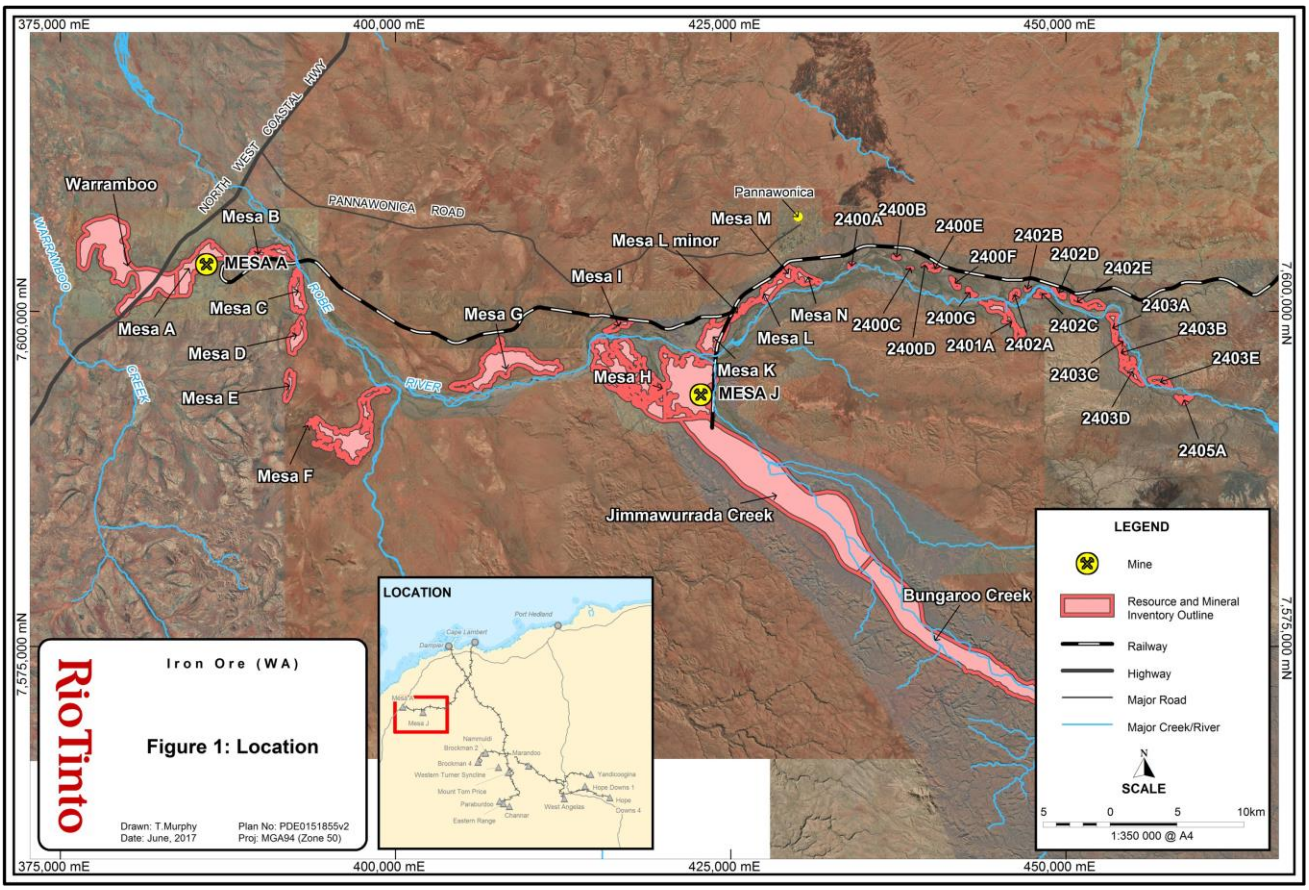

Figure 1. General Arrangement of Robe River valley mining area.

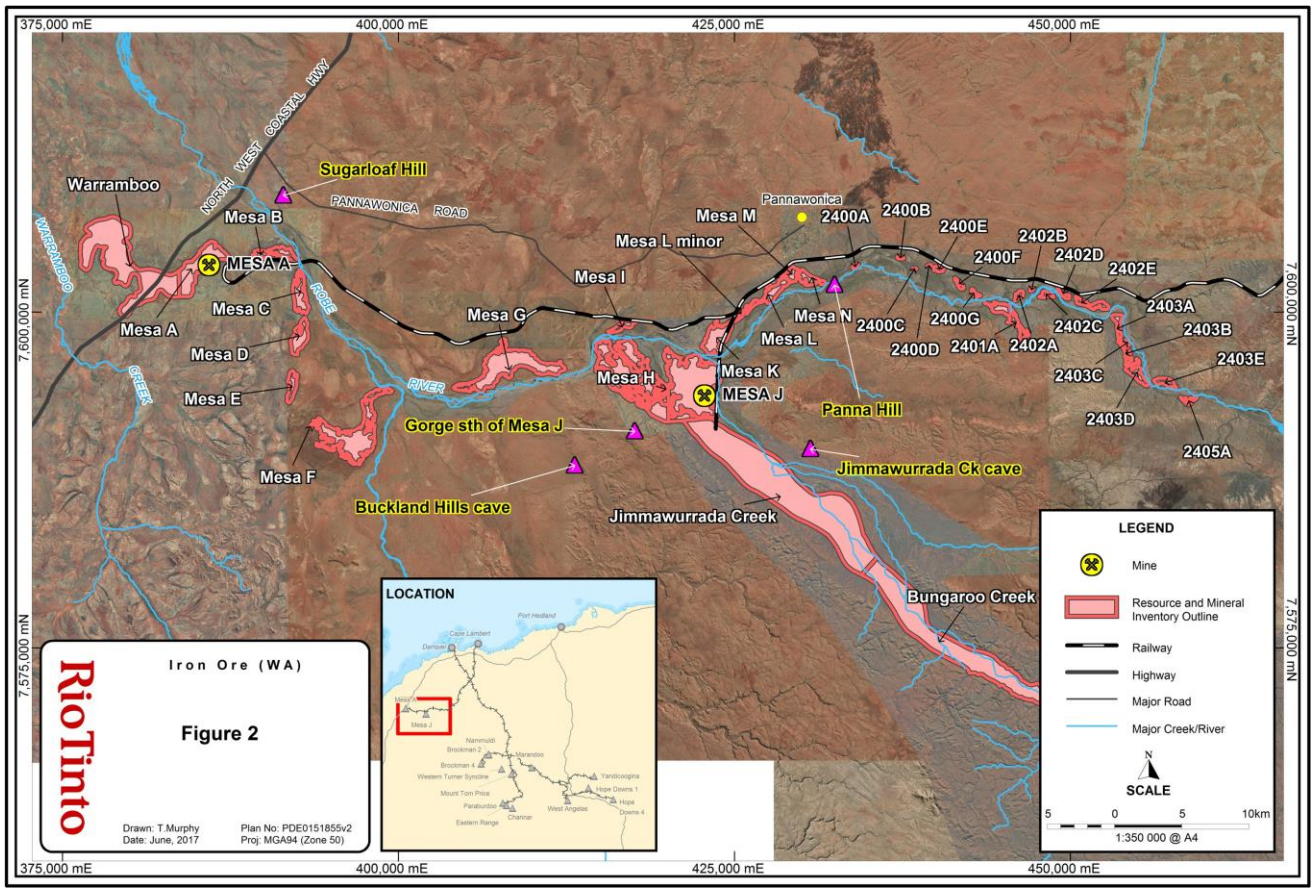

Figure 2. Mesas and supplementary sites (triangles) included in the assessment.

1.2 Existing Environment at Robe River valley Mesas and Surrounds

Topography

The Robe valley mesas cover an extensive area beginning at Mesa A in the west and running approximately 90 km eastward roughly paralleling the current orientation of the Robe River. They stand approximately 50 m higher than the flat plains that are crossed by the Robe River. Most of the mesas lie immediately adjacent to the river riparian zone with Mesas A, E and the majority of F being the most distant at 5 km. They vary in size from small unnamed pinnacles to very large mesas. The small unnamed pinnacles are not included further in this assessment. Pannawonica Hill is the smallest mesa with a cap of approximately 800 m^2 and perimeter of 0.11 km. Mesa F, with a cap of over 17 km^2 and a perimeter length over 39 km, is the largest. To the north and south the area is dominated by ironstone and basaltic uplands of the Hamersley Range, e.g. plate 1

Geology

In the Robe valley, the Robe Pisolite forms flat-topped mesa landforms (known as Channel Iron Deposits, CIDs) that are the remnants of the ancestral drainage channels of the Robe River formed during the Tertiary period. Erosion of the surrounding landscape has exposed the Pisolite formations creating an 'inverted topography' and subsequent erosion has created isolated mesa landforms. The larger mesas are incised with deep gullies around their perimeter. Pre mining, all mesas originally had overhangs, shelters and caves along extensive lengths of their perimeters and within major and minor gullies, e.g. plate 2.

Plate 1. Example of the three major land systems in the study area. This view is of the northern end of Yeera Bluff (Newman l.s., upper left), the Robe River riparian centre (River l.s., centre) and the north west rim of Mesa H (Robe l.s., right) showing the talus slope topped by the mesa cap.

Overhangs, shelters and caves are defined herein as:

- Overhangs are shallow hollows in a rock wall with a distinct roof structure. Their shape is such that they are fully lit by sunlight to their back wall. Their depth is typically 2 to 5 m.
- Shelters are deeper hollows or shallow caves in the rock wall that have ceiling structures from 1.0 to 5 m and higher and offer significant protection from predators and the weather. These are typically 5 to 15 m deep and have dark twilight conditions at their rear

extremities. Some have domed areas in their ceilings offering roosting and feeding opportunities to Ghost bats.

- Caves are defined as deep structures of various heights, widths and depths that are very dark in their deeper recesses. They often have one or more rear chambers separated from the entrance by constriction points. Those chambers that have ceiling heights of over 2.5m and an entrance constriction larger than 0.6 m square. They offer excellent roosting opportunities for Ghost bats.

- All three can have cracks or voids that continue back from their rear walls that may lead to additional internal cavities within the rock strata behind or above. Such cavities that are almost fully enclosed and can retain high levels of humidity are roosting opportunities for PLNb and Ghost bats if the entrance cracks are large enough.

Overhang and shelter density is high along the majority of the mesa perimeters with the rock strata forming numerous shallow shelters in mid and higher levels of the walls. There are a number of deeper caves formed in the Pisolite at mid and higher levels of the mesa walls but these rarely extend beyond 15 m in depth. Most shelters and caves were found on the mesa walls at or just above the top of the talus slope junction with the cliff wall.

Plate 2. Example of the presence of overhangs and shelters along the perimeters and within the incised gullies of mesas. This view is of a cave, shelter and overhang complex on Mesa H.

Land Systems (after Van Vreeswyk *et al.* 2004)

The mesas and their gullies and the surrounding talus slopes are elements of the Robe land system. They are low limonite mesas that support spinifex grasslands and thin Eucalypt (Snappy Gum) woodlands. The lower slopes and adjacent gravelly plains support spinifex grasslands and very scattered to moderately close Acacia and Eucalypt shrublands and woodlands, plate 2.

The adjacent Robe River flows westward from the distant Hamersley Range uplands. It is a very complex and productive linear river channel and flood plain with a Eucalyptus and Melaleuca woodland over tall Acacia and Petalostylis shrubland. It is an element of the Pilbara's River land system.

Yeera Bluff and the Buckland Hills to the south and west of Mesas H and J are rugged jaspilite ridges and hills of the Newman land system supporting Grevillia and Eucalypt shrublands and woodlands over hummock grasses.

The majority of the upland areas both north and south of the Robe to the east of Pannawonica are rounded and gently inclined basalt hills and plateau of the Rocklea land system. These support hummock grasslands with scattered Acacia and Senna shrublands.

The majority of the area to the north and south of the lower Robe mesas are stony plains of various land systems and low sedimentary hills of the Nanutarra land system. These support hummock grasslands with scattered Acacia and Senna shrublands.

Climate

The climate in the district is semi-desert tropical. Mean monthly minimum and maximum temperatures in the lower Robe valley range from 12 to 41 degrees Celsius (^{o}C). Annual rainfall is extremely variable and averages 400 mm, usually in cyclonic or thunderstorm events during the northern wet season. The northern dry season lasts from May to November and winter rainfall is uncommon.

Water Sources

Drainage systems in the district are associated with ephemeral gullies on the perimeters of the mesas that run into the Robe River drainage system. The Robe River riparian zone has a number of permanent and ephemeral pools along its length such as Gnieraoora Pool at the base of Yeera Bluff. Major tributary creeks include Jimmawurrada and Bungaroo Creeks to the south and east of Mesa J and Mungarathoona Creek to the south of Mesa F.

1.3 Bats of Conservation Significance

The Pilbara region contains 17 species of microbat, and of these, 13 have the potential to be found in the Robe valley (Van Dyke and Strahan 2008, McKenzie and Bullen 2009). A number of fauna surveys including targeted bat surveys have been previously conducted in the area, most recently by Astron in 2015 and 2016 and Bat Call in conjunction with internal Rio Tinto ecologists in 2016 and 2017, see table 1. Two Pilbara bat species of conservation significance have been recorded in the area, the Ghost bat (*Macroderma gigas*) and the PLNb (*Rhinonicteris aurantia*).

The Ghost bat is a large (130 g) carnivorous predator and the PLNb is a small (10 g) insectivore. Both are endemic to northern Australia and are obligate cave roosting species requiring specific cave environments for permanent roosting especially for supporting a successful maternity colony. The Ghost bat's foraging strategy and high trophic niche, as a top night-time carnivorous predator, is unique in Australian microbats. Both Ghost bat and PLNb populations are isolated from the main tropical populations that are extant across the mesic tropics by the uninhabitable arid zone of the Great Sandy Desert to the north and east. Both species are "conservation significant" as they are semi-desert adapted populations that have specific roosting requirements. The Ghost bat has suffered significant range loss in historical times. The reasons for the range contraction are open to speculation but it is known that the species is subject to disturbance (Richards *et al*. 2008, Woinarski *et al.* 2014). The Ghost bat has been detected within the study area and one or more caves are suspected as being maternity roost candidates.

The PLNb has been detected foraging across the mesas in the Robe valley. The PLNb is not discussed further in this report as a separate study is underway to determine the location of a PLNb roost thought to occur in the lower Robe valley.

Ghost bat (*Macroderma gigas*)

The Ghost bat has a conservation status of Vulnerable under the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act), Vulnerable under the Western Australian *Wildlife Conservation Act* (1950) and Vulnerable C1 (a vulnerable species numbering less than 10,000 and in decline) under the IUCN Redlist (IUCN 2017). These listings are on the basis of the impact of loss of suitable roost opportunities. The Pilbara Ghost bat population is estimated at 1500-2000 based on recently published estimates (approximately 600, N.L. McKenzie pers. comm. in IUCN 2017; approximately 1200, Armstrong and Anstee 2000; "more common than previously supposed", McKenzie and Bullen 2009) and author's unpublished database

summarising data from a range of surveys carried out in recent years by Pilbara mining companies, including Rio Tinto and other organisations, supplemented by author's own data (summarised in Threatened Species Scientific Committee (TSSC) (2016)). These recent data (estimates less than 15 years old) cover the entire Pilbara bioregion. Current population estimates in the Hamersley and Chichester subregions are approximately 350 and 1500 respectively (author's unpublished database summarised in TSSC (2016)).

There is no information available regarding the population size upper limits in an undisturbed environment. For a mammal such as a Ghost bat with a restricted roosting habitat niche, there are two possibilities limiting species density. The numbers may be limited by the availability and size of roost caves offering suitable habitat or the number may be limited by the availability of prey, especially during the post breeding season when lactating mothers and juveniles are in an energetic bottleneck. If the former is the dominant limit, then the number of bats in a district would be proportional to the availability of the roosts. If the latter is the primary determinant, as is the case in a number of classical predator-prey studies (e.g. Peterson and Page, 1988; discussion on predator-victim ratios in Rosenzweig, 1995; but see Peterson *et al*., 1998) then the population of Ghost bats would rise, fall and be limited by the availability of prey of the favoured size on a seasonal or annual basis. We therefore cannot directly attribute a loss of population to a measured loss of roost sites. Current knowledge based on populations in the Northern Territory and Queensland summarised in Woinarski *et al.* (2014) and TSSC (2016) supports the statement, "The implication from all genetic studies is that losses of maternity sites containing breeding females have the potential to reduce the Area of Occupancy significantly". Future research may resolve this for the Pilbara Ghost bat. Currently we must assume that the loss of roosting opportunities will have a negative and permanent impact on numbers.

Ghost bats hunt their prey in two primary ways. They hunt birds and bats at cave entrances and elsewhere "air-to-air" by swooping from above or from a perch. They also hunt ground level prey in their target food size range by dropping onto the prey from a perch, either tree branch or rock outcrop. Their diet includes small mammals (including other bats), birds, reptiles, frogs and large insects. The proportion of food items in the diet varies with availability and reported foraging areas vary from a few to 10 km from the roost cave. In May 2016, a Ghost bat carcass was found entangled in a barbed wire fence (DPaW 2016) over 12 km from the nearest cave forming rocky strata suitable for roosting.

Ghost bat breeding populations are known from a small number of maternity roosts in the Pilbara and reproduce during the northern wet season. The largest of these colonies are in abandoned

mines in the Chichester subregion and number up to several hundred (Armstrong and Anstee 2000, author's unpublished observations)). Hamersley Range populations are typically between five and twenty five individuals in local groups (author's unpublished data). There is one known large, permanent maternity roost numbering over 70 bats in the lower Robe River valley on Mesa F (see Results below). For these groups to persist the bats need an "apartment block" of roosting opportunities, at least one deep cave with characteristics of a maternity roost, multiple caves/shelters and overhangs in close proximity offering nocturnal feeding and refuge opportunities, a local productive set of gullies and gorges, a productive foraging area within 5-10 km radius, usually including a good quality riparian line or ephemeral fresh water lake bed and appropriate protection from human interference (author's unpublished data). These groups are known to reproduce in good years using suitable natural roost caves. Examples are a group numbering 5 to 10 including reproducing females at West Angelas caves in 1980 (Dr Nic Dunlop pers. comm.), a small group including reproducing females at caves at Nammuldi/Silvergrass area (Hamersley Iron 1999), observation of a heavily pregnant female at a cave near Mt Robinson by the author in 2013 and a group numbering 14 including four juveniles at another cave near Mt Robinson in 2015 (Mr. Morgan O'Connell pers. comm.). The Ghost bat is also known to spread great distances on an annual cycle from these locations depending upon seasonal weather conditions and availability of suitable day roosts. Sporadic records of Pilbara Ghost bats have been identified in the Gascoyne (author's unpublished data) and the Little Sandy Desert (sightings by W.H. Butler at Durba Springs in 1971 and others since). Genetic work by Worthington Wilmer and Armstrong (summarised in Woinarski *et al.* 2014) suggests that the females remain or return to their birthplace and that the males can move between districts.

Ghost bats use three types of roost regularly, these being nocturnal roosts or feeding sites, diurnal or day roosts that may be permanent or semi-permanent sites and maternity roosts that are diurnal roosts with the range of characteristics allowing regular or permanent occupancy.

Nocturnal roosts or feeding sites are only used at night, either habitually or for transitory visits. They are typically shallow caves and shelters that are well lit during the day. They are often high in the strata and may be well or poorly insulated from the elements. They often contain guano scatters and/or midden(s) of various sizes containing guano and food scraps but these remains are sometimes removed by rainfall, disturbed by various larger mammals and marsupials such as macropods and goats and/or removed by varieties of "dung beetle" that are known to forage on the scats (author's unpublished observations).

Diurnal roosts are caves and mine adits that are deeper and more complex. They typically have one or more large chambers at or beyond the twilight area with additional fissures or chambers at the rear in the fully dark regions. They have a minimum roof height in the chambers of 2 to 3 m providing protection from attack by terrestrial predators. They are often at mid-levels or lower in the strata and are well insulated overhead providing a stable temperature environment. They typically contain multiple scat piles and middens of guano and food remains that include feathers and skeletal material.

Maternity roosts are diurnal roosts that provide additional features listed above that are able to support a reproducing population. These features usually include an interior chamber that is rising toward the rear thereby trapping warmer and more humid air at the top allowing suitably benign conditions to form during the period when reproductive females and pups are present.

Being carnivorous predators, during a nights foraging they may also hang for short periods in any deep overhang, shelter or cave with a high enough ceiling or tree branch overhead a cleared patch of ground for feeding or resting on an opportunistic basis. These sites are not routinely visited and show no evidence of Ghost bat presence.

1.4 Summary of Previous Bat Surveys

Prior to 2017 there have been a number of fauna surveys commissioned by Rio Tinto and predecessors in the lower Robe valley that have included bat species listings. These indicated the presence of both significant species foraging across the area. More recent surveys carried out in 2015 and 2016, summarised in table 1 below and including caves on Mesas F and G whose assessments are included in attachment B herein, indicated that the Ghost bats are roosting locally and include maternity colonies on Mesas B and F, plus other diurnal roost candidates at various other mesas.

Table 1. Summary of Fauna Surveys that Include Ghost Bat records in the Robe valley.

Date	Reference	Ghost bat activity detected.
2006	Biota (2006)	• Ghost bat sighted at cave on Mesa A prior to commencement of mining.
2009	Biota (2009)	• Ghost bats harp trapped at Mesa G
2010	Biota (2010)	• Group of Ghost bats sighted at Mesa F cave MF-01
2014	Biologic (2014)	• Visual sightings of Ghost bats at several caves within 10 km of the lower Robe River in the Yarraloola district.
2015	Astron (2015)	• Mid Robe survey where Ghost bats were detected at several locations between Mesas L and 2405A. Diurnal roost candidates identified at Mesas 2400E, 2402B and nearby 2403E
2015	Astron (2016)	• Ghost bat echolocation calls detected at Mesa H and surrounding area. A number of shelters/caves with scats recorded. Diurnal roost candidates identified on Mesas G and H and in hills south of Mesa H.
2015, 16 and 17	RTIO internal heritage staff	• Surveys of caves and shelters on various mesas. Several candidate diurnal roosts identified on Mesas B, C, G and H.
2016	Bat Call (2016a, b, d)	• Ghost bat visual sightings, cave assessments and echolocation calls detected at mesas between B and F. Maternity roost cave identified at Mesa B. Candidate diurnal roost identified on Mesa C.
2016	Astron (2017)	• Ghost bat echolocation calls detected at various mesas in East Deepdale and Middle Robe and a number of shelters/caves with scats recorded.
2017	RTIO internal ecologists	• Ghost bat seen at Mesa H at cave H27. Presence detected at Mesa F cave MF-01. Maternity roost candidate identified near Jimmawurrada Creek (Bat Call 2017b)

Date	Reference	Ghost bat activity detected.
2017	Bat Call (2017a, b, c, d)	• Visual sightings including bats, middens and scats and echolocation call detections at Mesas A, B, C, D, F, G, H. Maternity roost identified at Mesa F. Diurnal roosts identified at Mesas G and H.

2.0 Survey and Assessment Methods

2.1 Categorisation of status of mesas.

Mesas were measured for area and perimeter using aerial photography available on GOOGLE EARTH PRO. The complete perimeter of the upper cap of each mesa was outlined with a polygon and the area and perimeter length recorded. The length of the retained undamaged perimeter was then measured, e.g. figure 3.

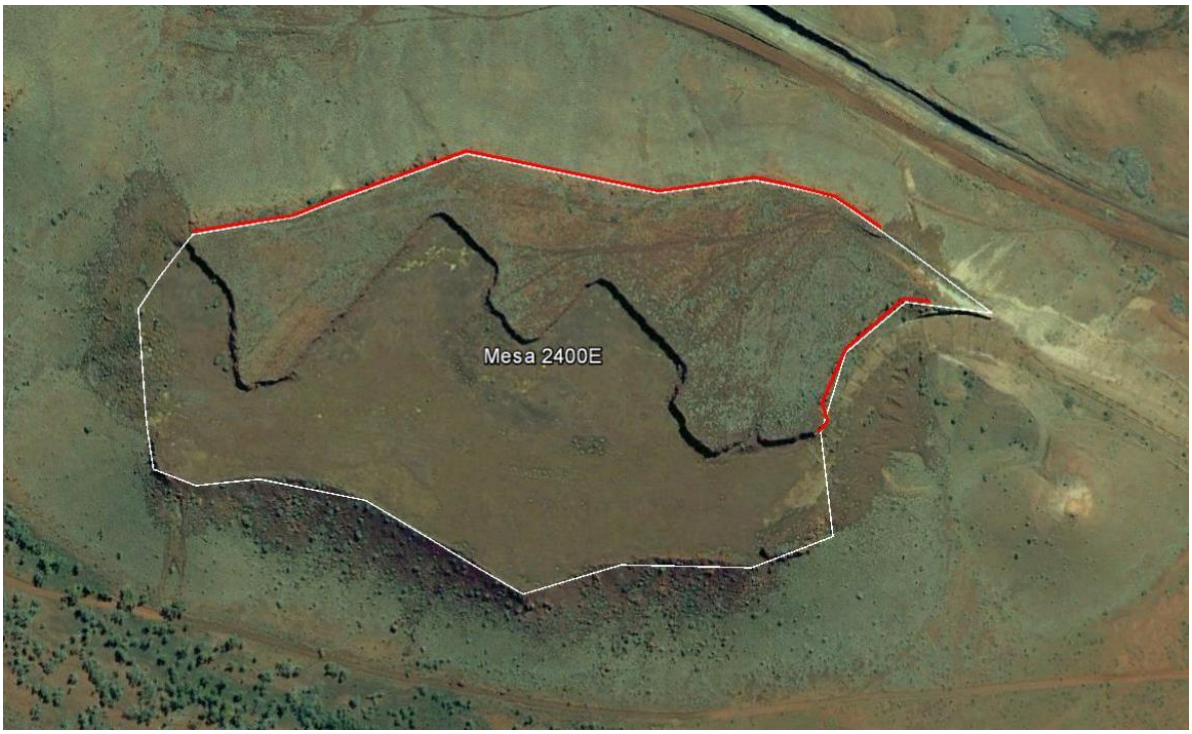

Figure 3. An example of the assessment of the size, perimeter length and state of preservation of the original mesa escarpment; Mesa 2400E in the Mid Robe valley. The white polygon surrounds the original mesa top cap. The red lines indicate the extent of the retained original perimeter containing caves, shelters and overhangs. The extent of the perimeter removed by mining is indicated by the visible overburden dumped along its length (dark brown scree outside polygon). The retained perimeter with original talus or abandoned haul track below is the light colour areas immediately outside the polygon.

Each mesa was then categorised for the extent of mining operations carried out. These operations covered:

- Mesa in original state.
- Initial resource evaluation including track building and skeletal drilling.
- Resource evaluation drilling on close grid patterns down to 50 m spacing.

- Overburden removal and resource mining operations including the building of access haul tracks through the perimeter.

- Post mining rehabilitation.

2.2 Density of caves and deep shelters on mesa rims

The locations of the deep caves and shelters around the complete perimeters were available from surveys completed on Mesas B, C, G and H (Rio Tinto data base). The number of sites was counted and the lengths of the facades including these were measured. Sites that included complexes or groups of caves/shelters/deep overhangs in close proximity, typically separated by less than 25 m, were counted as a single site.

2.3 Observation of current Ghost bat presence and usage.

Results from surveys included in this study were collected over a number of years using a variety of techniques. The majority of observations are recent dating from 2014 to 2017 and result from visual assessments of caves and shelters made on foot. These were supplemented by harp trap, mist net and echolocation detector records from the years since 2006.

The most recent fieldwork focussed on the assessment of habitat of Ghost bats at all mesas between A and 2403E by Astron, Bat Call and RTIO internal ecologists. In 2015 and 2016, Astron completed assessments of the mesas from the East Deepdale and Middle Robe areas. In July 2016 and April 2017 Bat Call and RTIO completed detailed assessments of all identified caves and shelters on Mesas B, C, F, G and H. Characterisation of significant caves on Mesas F and G are included in attachment A herein. In April 2017 a visual assessment was made of the state of preservation the mesas east of Mesa J to allow correlation with the Ghost bat presence records from the earlier surveys and to ground truth the aerial photography assessments.

2.4 Survey Team

The July 2016 and April 2017 survey teams consisted of two experienced ecologists on each survey. In 2016 and 2017, Ms Emma Carroll (Rio Tinto) and Ms Tenielle Brown (Rio Tinto) were team leaders respectively. Mr Robert Bullen (Bat Call) acted as principal ecologist for both surveys. In April 2017, Ms Melinda Brand (Rio Tinto) accompanied the assessments of Mesa H and those further to the east.

2.5 Inclusion of sites nearby Robe River in study

Ghost bat presence records from five sites within 10 km of the river but not on the named CID mesas were included in the study for context. These sites are all locations were Ghost bats have been sighted during daytime survey activities and are therefore possible diurnal roost candidates.

2.6 Survey Limitations

Detailed interior searches of caves were carried out under the guidelines of the Rio Tinto safety procedures. Prior to July 2016 entry by fauna surveyors into caves and shelters was prohibited. Post July 2016, entry into any cave that was deemed to have an unstable ceiling as characterised by loose rocks overhead or around the entrance, heavy cracking or the presence of fresh slab like roof material fallen to the floor continued to be prohibited. These procedures also prohibited entry into any chamber that required sliding on stomach or back or that required climbing or descending 2 m using rock-climbing techniques. The rear areas of some caves could therefore not be searched completely and the possible presence and number of Ghost bats in such caves was therefore not confirmed absolutely.

Complete perimeter searches for caves and deep shelters greater than 10 m depth have only been completed on mesas A, B, C, G and H. Incomplete searches that identified only the most visible caves and shelters have been completed on the rest of the mesas.

3.0 Results

3.1 Cave Characterisations at Mesas F and G

Mesa F

During this study an ongoing Ghost bat presence at cave MF-01 on Mesa F was confirmed. Ghost bats had been reported at this site by a number of earlier visits (e.g. Biota 2010 and Rio Tinto internal ecologists 2017). On entering the first chamber of the cave, audible social calls were heard originating at the rear of the cave. Almost immediately over 70 Ghost bats emerged at high speed along the rear tunnel, flew past the author and observer, and departed the main entrance, plates 3 and 4. A number roosted under overhangs beside the cave, plates 5 and 6, and then re-entered once the observers had departed. Additionally, as the main group was exiting the cave the observer at the entrance saw a number flying above the entrance that appeared to be originating from a secondary entrance higher up the cliff directly above. Following the departure of the main group, the rear tunnel was found to have a very large and high second chamber where the bats had been roosting, attachment A. During the assessment, the floor of the cave was found to have Ghost bats scats along its full length. The characteristics of this cave supported by the multiple observations of roosting bats, the extensive scat carpet and the presence of a large number of "dung beetles" are consistent with its use as a permanent diurnal/maternity cave.

Plates 3 and 4. Ghost bats departing cave MF-01.

Plates 5 and 6. Ghost bats roosting temporarily under overhangs outside the entrance of cave MF-01.

Due to the speed of their departure from the cave, no observations regarding their gender or apparent age could be made.

Mesa G

During this study a group of caves on the southern face of Mesa G was assessed. In conjunction with the earlier data, a Ghost bat presence at Mesa G was confirmed, figure 4.

Figure 4. Mesa G caves and shelters where Ghost bat observations were made. The red dot denotes the diurnal cave G02 at the eastern end of the mesa. The yellow dot denotes a nocturnal feeding shelter at G03. The white dot denotes one location where Ghost bats have been reported (Biota 2009) but no other indication of a roost cave or activity was observed during this survey.

Two sites in one deeply incised gully were assessed as being in possible current use by Ghost bats including one diurnal roost cave and one nocturnal roost shelter. Assessments of each cave and observations of Ghost bat activity are provided below, attachment A, with detailed characteristics of the caves including floorplans and dimensions. Cave G02 was found to be over 20 m deep and to have the characteristics of a diurnal roost although no evidence of current habitation was found.

The eastern gully on the south face containing caves G02 and G03 was assessed as the most significant areas on Mesa G. Cave G02 (50K 411740 7595774) being a part of a complex of caves, shelters and overhangs, and the gully containing it, has all of the characteristics required by Ghost bats for this to be considered a possible maternity roost. These characteristics include an internal shape adequately deep and dark along with a high domed chamber at the rear shaped to trap warm humid air, multiple nocturnal roost opportunities, multiple daytime refuge opportunities, multiple early evening observation sites and a major productive riparian zone within 5 km. No evidence of Ghost bat presence was found within this complex during this survey although a small midden containing scats and *Taphozous* sp. wing bones, the age which could not be determined, was found in cave G03 (50K 411727 7595625) nearby.

3.2 Unmined mesas, density of caves and shelters.

There are nine mesas with no mining activity evident, attachment B. These are Mesas D, E, I, L2, 2400A, 2400B, 2400C, 2400D and 2402B. A view representative of the rim of an unmined mesa is presented in plate 7.

The density of caves and shelters greater than 10 m deep on unmined mesas was assessed from the data available from Mesas B, C, G and H that have 100% of their original perimeters intact, are presented in table 2. A density of up to 2 caves/shelters per km of unmined facade was found to be typical of the mesas west of Pannawonica. The visual review of the mesas east of Pannawonica undertaken suggests that this figure is also applicable in the East Deepdale and Middle Robe areas. Ghost bats have been found to be present on Mesas B, C, G and H for both roosting and foraging. The current Ghost bats presence records for Mesas B, C and H are presented in detail in Bat Call (2016a, 2017c, 2017d). These data are supplemented with Mesa G data herein. Diurnal roosts classified as maternal have been identified at caves on Mesas B (MBC-05) and F (MF-01). Five diurnal roosts candidates have been identified on Mesas C, G, H and 2402B. A summary of the results and the available data from the other unmined mesas is

given in attachment B. A summary of the available data from the unmined supplementary sites within 10 km of the river is in attachment C.

Plate 7. A view of the unmined central gully and eastern face of Mesa H showing the upper rim, the cliff face with caves and shelters present and the lower talus slope. This view is representative of the condition of the unmined mesas along the valley.

Table 2. Density of caves and deep shelters on unmined Robe River mesas.

Mesa	Number of sites with caves and/or deep shelters	Perimeter of mesa facade containing the sites	Density of caves and shelters deeper than 10m
B	16	9.6	~1.7 / km
C	21	10.5	~2 / km
G	12	6.0	~2 / km
H	46	25	~1.9 / km

3.3 Mesas with initial resource evaluation activities or resource evaluation drilling.

An assessment of the impact of resource evaluation drilling on the caves and shelters potentially in use by Ghost bats has shown that skeletal resource assessment drilling programs do not impact the mesa facades and therefore do not impact the caves and shelters, figure 5. A minor length of facade is lost when access tracks are cut through the face but these lengths are typically very short, i.e. 25 to 50 m. An example is given in figure 6. There are three mesas that have an initial, drilling (or equivalent) program with only skeletal tracks and pads present, Mesas F, L1 and 2405A.

Figure 5. View of the top of an unnamed mesa west of the Buckland Hills showing a recent skeletal drilling pattern retaining an unaffected perimeter at least 50 m wide.

Figure 6. View of the top of the northern end of Mesa C access track to the top of the mesa that has removed approximately 25 m of the lower cliff and 20 m of the upper cliff.

In early decades facade retention was not prioritised and the pattern of resource evaluation disturbance continued to within 10m of the rim edge, figure 7. This is evident on Mesa 2403E. This suggests that some limited loss of habitat due to localised rim collapse was possible on these mesas prior to mining operations beginning. More detailed resource evaluation drilling patterns in recent years have maintained an approximately 50 m standoff from the rim of the mesa cap, figure 8. There are four mesas with this type of pattern, Mesas B, C, G and H. This has ensured that all but the very deepest caves have remained unaffected by drilling programs on mesas between B and H.

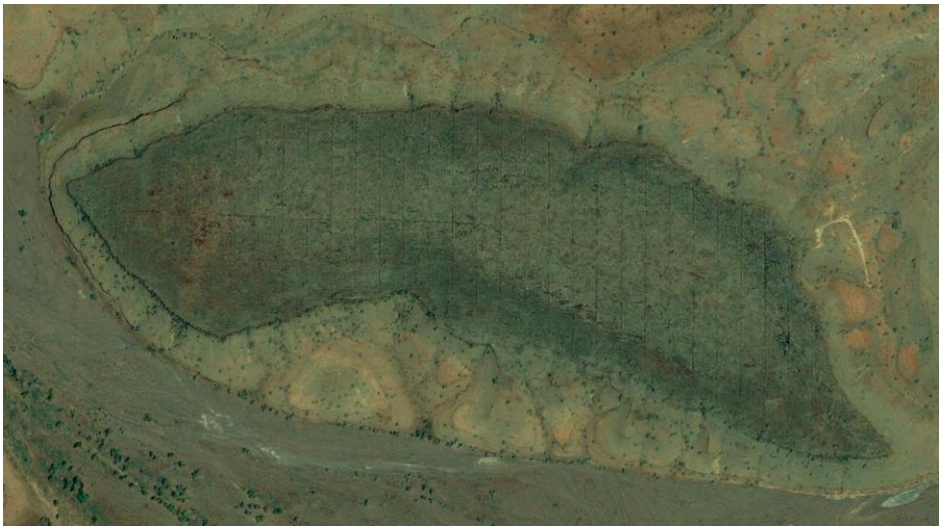

Figure 7. View of the top of Mesa 2403E showing a resource evaluation work pattern dating from several decades ago that extends to the mesa perimeter (facade) potentially impacting sites on the cliff below.

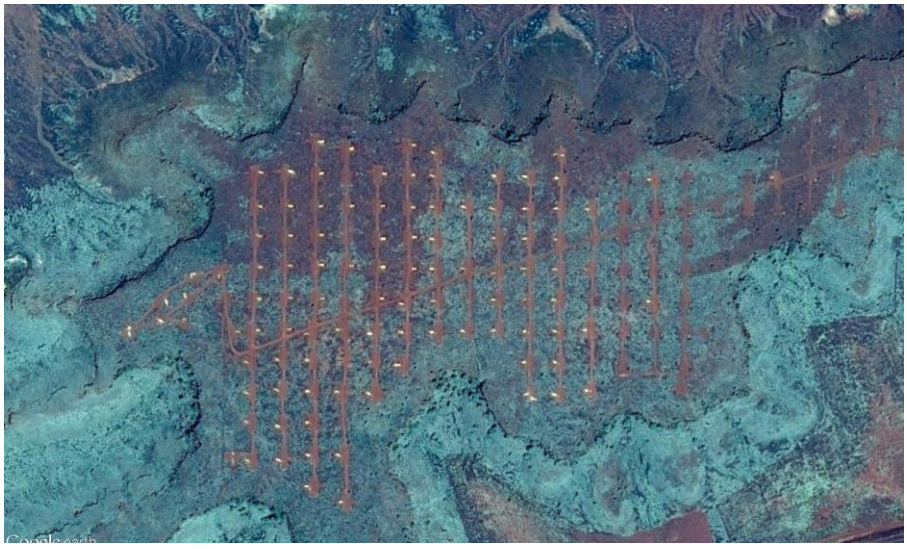

Figure 8. View of the top of the western end of Mesa B showing a recent drilling pattern retaining an unaffected facade at least 50 m wide.

3.4 Mesas with current overburden and/or open-cut resource extraction operations.

There are two mesas with current mining operations. These are A and J, attachment B. Mining at Mesa A has been in progress since 2010 and the operations now cover the majority of the original mesa. Mesa A does not have an escarpment on its southwestern side. Almost 100% of the original escarpment of the northern half of the mesa has been retained to a width of 50 to over 100 m, figure 9. This retained length includes an area in the north-eastern corner that surrounds a deeply incised gully to a width of 150 m. Cave MAI06-SH17 was assessed in September 2016 as a nocturnal roost and a single scat was found by an internal Rio Tinto ecologist (Emma Carroll pers. comm.). Cave A5 was assessed in April 2017 to be a nocturnal roost candidate with no current evidence of Ghost bat presence. No other current evidence indicating Ghost bat presence has been recorded on the mesa in recent years however minimal surveying has been completed in this period.

Figure 9. View of the top of Mesa A showing the extent of the mining operations and the retained perimeter. Caves MA-05 and MA-06 are shown in the retained north-eastern gully.

Mining at Mesa J began in 1994 and the operations also cover the majority of the original mesa. The majority, 88%, of the original perimeter that was an escarpment, i.e. the northern half of the mesa, (see attachment B) has been retained to a width of 50 to over 100 m, figure 10. Similar to Mesa A, minimal surveying has been completed in recent years at this mesa, the only current Ghost bat record at Mesa J is a single site with scats on the north-western bluff opposite the Robe River. This site is behind a retained facade of over 500 m width locally.

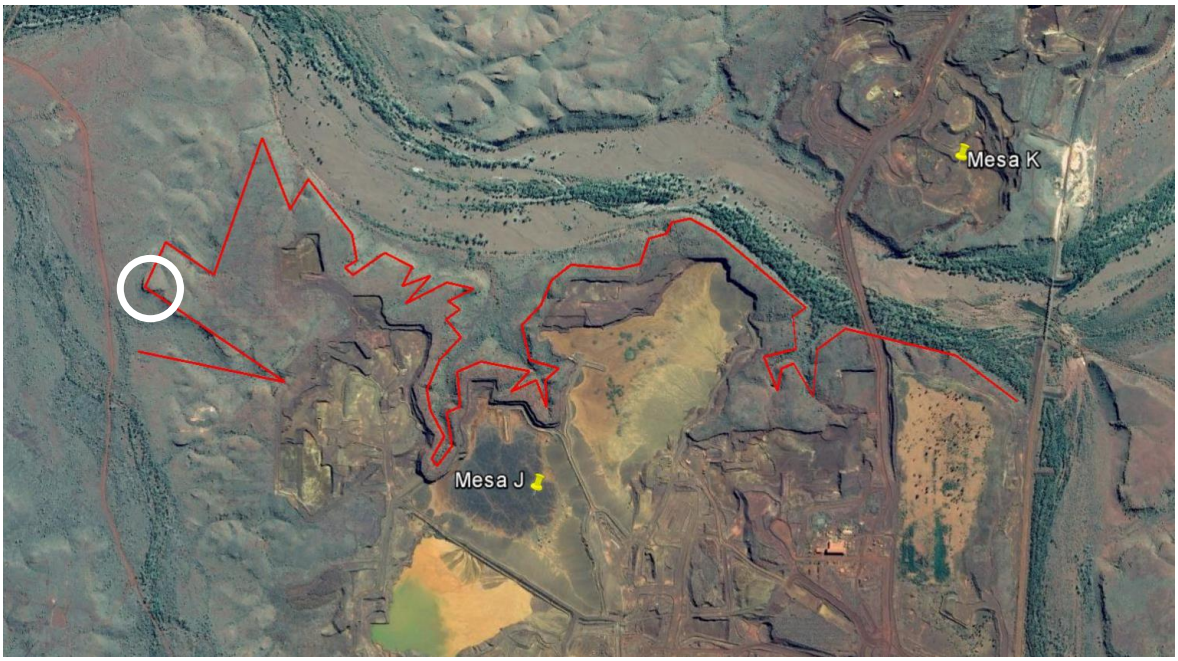

Figure 10. View of the top of Mesa J showing the mining operations and the retained perimeter (red line). Ghost bat scats have been recorded at the bluff on the retained north-western corner (circled).

While limited, the available evidence suggests that while there are caves and shelters available on the retained perimeter of a mesa with active mining, Ghost bats are generally not roosting in numbers where blasting, crushing and hauling operations are underway behind a facade of 20 to 50 m. This is likely to be the result of disturbance by sound, vibration and/or airborne dust. The evidence also suggests that with perimeters of such width, Ghost bats are foraging occasionally on the facades.

3.5 Mesas with historical mining operations.

There are thirteen mesas with historical mining operations. These are Mesas K, L, M, N, 2400E, 2400F, 2400G, 2401A, 2402A, 2402C, 2402E, 2403ABC and 2403D, attachment B, all of which were mined in the early decades of the Robe valley operations. The extent of the retained perimeters is 0% on N, 2402A and 2402C and is generally less than 50% on the others. Only Mesa 2403D has retained the majority of its original facade at 93%. Examples of the extent of perimeter removal are given in figures 3 and 11. Figure 3 shows Mesa 2400E that has 50% of its perimeter retained. The disturbance to the other 50% where overburden has been dumped is evident. Figure 11 shows Mesa 2402C which has no original perimeter retained. A side view of a mesa with its perimeter destroyed by dumped overburden is given in plate 8. There is no retention of any of the original cliff line or its cave/shelter features. On mesas where parts of the original perimeter have been retained, the original caves and shelters are in general in good

condition, plate 9. The available evidence detailed in attachment A, and summarised below, shows that Ghost bats have recolonised these undamaged perimeters following the completion of mining and are roosting in appropriate caves.

Figure 11. Aerial view of Mesa 2402C that was mined in the early decades and has had all of its original facade removed. The extent of dumping overburden over the side and covering the talus is clearly visible as darker brown scree flowing over the lighter original material.

Plate 8. Image of the side of a mesa that has had overburden dumped on the original façade. This is typical of the condition of the current state of the majority of the perimeters of the mesas mined in the 1970s.

Plate 9. Image of the side of a mesa that has had a portion of its original façade retained. This indicates that caves and shelters on those portions of facade remain as viable Ghost bat habitat.

3.6 Summary of Ghost bat records on the Robe River mesas.

There are twenty mesas of the thirty four, including Pannawonica Hill, on the Robe River system that have recent Ghost bat records. In addition there are five other sites within 10 km of the river where Ghost bat activity has been recently recorded. These are detailed in attachments B and C.

There are eighteen mesas that have not been mined. Of these, three have had skeletal drilling on their caps (Mesas F, L1 and 2405A) and four (Mesas B, C, G and H) have had extensive resource evaluation drilling programs, all of which have a retained facade of 50 m. Of the unmined eighteen, twelve mesas that have been surveyed for Ghost bat activity in recent years have evidence of activity. Of these, there are maternity roosts identified on Mesas B and F plus diurnal roosts, some of which may be utilised as maternity sites, on Mesas C, G, H and 2402B, plus three of the supplementary sites, attachments B and C. Of the supplementary sites, three have current evidence in the form of sites with scats or with recorded calls. Of the six unmined mesas without current evidence (Mesas E, L1, 2400B, 2400C, 2403E and 2405A) insufficient survey activity has been carried out and evidence of Ghost bat usage may be present.

This result shows unequivocally that the escarpments of the mesas that have not been mined including those that have had intense drilling programs on their caps remain as confirmed Ghost

bat habitat and the caves and deep shelters continue to offer diurnal and maternity roost opportunities for the species.

There are two mesas where current large scale open cut resource extraction activities are underway, A and J. Neither of these currently has a known diurnal presence of Ghost bats although this is speculative due to a lack of survey data on the mesas from recent years. The available data suggests that it is possible that the species does use the perimeters for foraging on an occasional basis as a single scat has been identified on Mesa A (cave MA06) and scats have been recorded on the facade of Mesa J (cave Opp02). Based on data from other Pilbara iron ore mine sites (e.g. West Angelas and others; author's unpublished data), the lack of diurnal presence is thought to be due to the disturbance from the sound, vibration and airborne dust generated by the blasting, crushing and hauling operations nearby.

There are thirteen mesas where mining has been completed. Of these, three have had their caps completely removed and none of their perimeters retained. There is no current evidence of Ghost bat usage on these three although it is possible that occasional foraging visits are made. Of the remaining ten, the percentage of retained perimeter varies from 16% on Mesa 2402E to 93% on 2403D. The six that have been recently surveyed all have current evidence of Ghost bat usage, one of which, Mesa 2400E, has a site that has been identified as a possible diurnal roost, attachment A. This result shows unequivocally that the perimeters that have been retained on the mesas that have been mined remain as Ghost bat habitat and the protected caves and deep shelters continue to offer nocturnal and diurnal roost opportunities for the species. It is also possible that the retained deepest caves and shelters are used as maternity sites although no evidence of this is available at this time.

An assessment of impact of iron ore mining on the Ghost bat species in the Robe valley mesas therefore was made by reviewing the lengths of the perimeters that are retained to a width that protects the deepest caves and shelters that are available for nocturnal and diurnal roosting. The total original escarpment length of the mesas between Mesa A and Mesa 2405A is approximately 275 km. Of this, approximately 227 km, or 83% has been retained or is in place on mesas not yet mined. Virtually all is in good condition although there have been some localised collapses such as one noted at Mesa A adjacent to cave MAI06-SH17 (note that this collapse occurred prior to 2001 before mining began nearby). By applying the 2 caves/km ratio from above to the undisturbed perimeter it is possible that there are up to 400 deep shelters and caves suitable for Ghost bat usage remaining on the mesas.

For the 48 km of perimeter that have been removed or destroyed, potentially up to 100 caves and shelters may have been removed. This quantity may have had an impact on the total number of Ghost bats present although this is speculative as the numbers may be limited by availability of prey, see section 1.3 above. Based on the observations since 2014 of Ghost bats and/or their scats and middens at the supplementary sites that are in the upland areas nearby the Robe River and its mesas stretching from Sugarloaf Hill in the west to the bluff opposite Mesa 2403D in the east, Attachment C, it is also apparent that the areas surrounding the mesas have retained all of their Ghost bat population. With a current estimate of 150 Ghost bats in the Robe valley, from above, and recognising that the number will vary with the quality of the seasons, the loss of bats due to the loss of roosting habitat that has already occurred is estimated to be less than 20 individuals. For current and future mining operations, retaining a facade of greater than 20 m around the mesa perimeters and providing particular protection to significant diurnal/maternal roost caves will result in no further loss of Ghost bats in the valley due to roost destruction.

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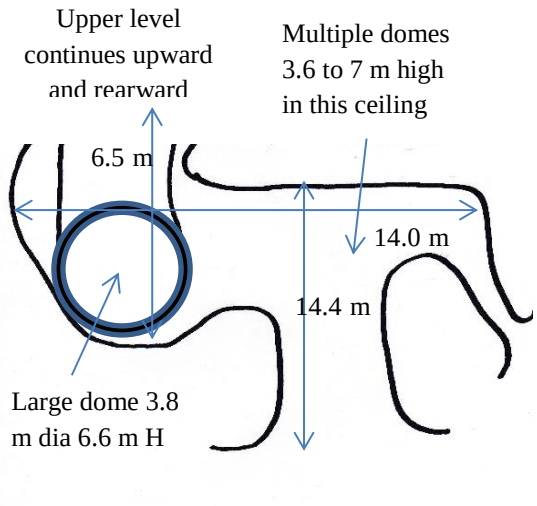
Attachment A: Characteristics of caves examined during this study.

Unboxed dimensions indicate cave/shelter width and depth and boxed or "dome height" (solid circles) dimensions indicate ceiling heights.

Mesa F Cave MF01:

Assessed Ghost bat usage: Permanent maternity roost. 70 present.	**Coordinates:** 50K 398218 7591036
Entrance safe or unsafe to approach: Assessed safe	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Cave has two entrances opening into a mid-size chamber. Left 6 x 7 m. Right 0.8 x 0.5 m.	**Entrance Orientation:** East
Cave Grouping: Other overhangs along gully sides outside entrance.	**Insulation from surface above:** Middle of local landscape
Cave Type: First chamber 15 m deep with four high domes. Second chamber is 5.0 x 6.5 m with a 6.6 m high dome and a higher level.	**Internal domed chamber:** Yes. Multiple between 2.5 and 7.0 m high.
Rear passages that may have roosts: Second chamber has an upper level going back an unknown distance.	**Internal temp. and relative humidity:** Ambient to second chamber then hot and humid behind.
Local foraging opportunities: Excellent, Mesa F is adjacent to Robe River riparian zone.	**Current distance to disturbance:** Mesa A mine is >17 km distant. Resource evaluation drilling nearby on mesa top.



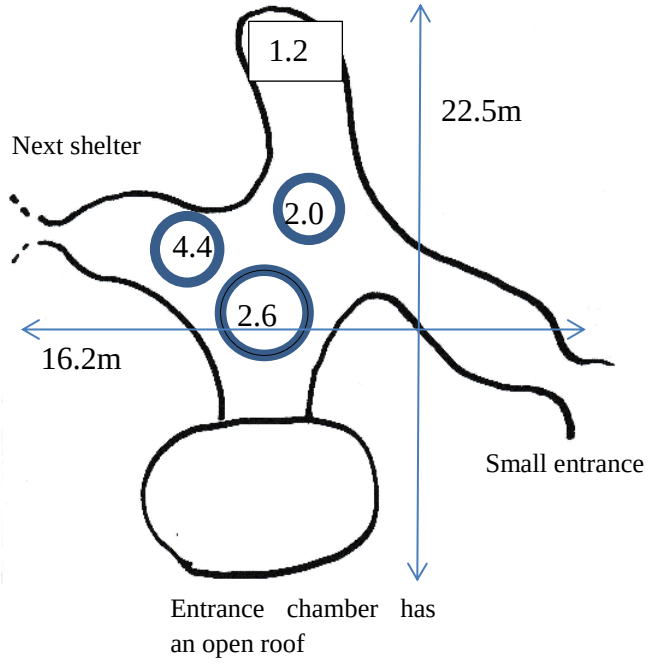
Mesa G Site G01:

Assessed Ghost bat usage: Shallow overhangs and semipermanent pool nearby coordinates. Ghost bats trapped in 2009. No deep cave found in April 2017. Probable foraging site.	**Coordinates:** 50K 410531 7595661
Entrance safe or unsafe to approach: Assessed safe	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): N/A	**Entrance Orientation:** N/A
Cave Grouping: Group of overhangs and shallow shelters along a gully.	**Insulation from surface above:** Middle to Top of local landscape
Cave Type: N/A.	**Internal domed chamber:** N/A
Rear passages that may have roosts: N/A.	**Internal temp. and relative humidity:** Ambient
Local foraging opportunities: Excellent, Mesa G is adjacent to Robe River riparian zone.	**Current distance to disturbance:** Mesa J mine is >10 km distant. Resource evaluation drilling nearby on mesa top.
Cave floorplan and entrance photo:	

Mesa G Cave G02:

Assessed Ghost bat usage: Diurnal Roost although no Ghost bats present in April 2017	**Coordinates:** 50K 411740 7595774
Entrance safe or unsafe to approach: Assessed safe	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Entrance chamber has a large open roof.	**Entrance Orientation:** South
Cave Grouping: Cave is a part of a complex of shelters and overhangs with some internal connection.	**Insulation from surface above:** Middle of local landscape
Cave Type: Cave 22.5 m deep with low roof and three domes.	**Internal domed chamber:** Yes. 2.0 m to 4.4 m high
Rear passages that may have roosts: Side chambers interconnect to other shelters along the gully.	**Internal temp. and relative humidity:** Ambient
Local foraging opportunities: Excellent, Mesa G is adjacent to Robe River riparian zone.	**Current distance to disturbance:** Mesa J mine is >10 km distant. Resource evaluation drilling nearby on mesa top.

Cave floorplan and entrance photo:

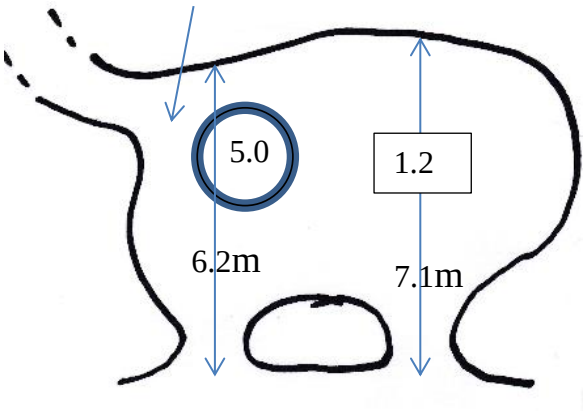


Mesa G Shelter G03:

Assessed Ghost bat usage: Nocturnal shelter with a Ghost bat midden.	**Coordinates:** 50K 411727 7595625
Entrance safe or unsafe to approach: Assessed safe	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Cave has two entrances opening into a mid-size shelter. Left 1.2 x 2.5m. Right 2.8 x 2.6m.	**Entrance Orientation:** West
Cave Grouping: Other overhangs along gully side to the north.	**Insulation from surface above:** Middle of local landscape
Cave Type: Cave 7.0 m deep with low roof, a dome and a tight rear tunnel.	**Internal domed chamber:** Yes. 5.0 m high
Rear passages that may have roosts: One rear sinuous tunnel continues on the left side. It has as small Ghost bat midden under its entrance.	**Internal temp. and relative humidity:** Ambient
Local foraging opportunities: Excellent, Mesa G is adjacent to Robe River riparian zone.	**Current distance to disturbance:** Mesa J mine is >10 km distant. Resource evaluation drilling nearby on mesa top.

Cave floorplan and entrance photo:

Small PGb midden with *Taphozous* sp. wing bones



Attachment B. Data on Robe River mesas including records of recent Ghost bat presence.

Note 1: Perimeter lengths of Mesas A and J indicate the original escarpment lengths that only partially encircled the mesas.

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
A	8.6	10.1 Note 1	Robe	N/A	Underway	10.0	99%	Yes - Incomplete	Yes Minimal current activity, one scat found (MAI06-SH17) 200 m from pit.	Bat Call 2017c
B	1.9	9.6	Robe	Yes	Not begun	9.6	100%	Yes	Yes Maternity roost (MBC-03 with 16 PGb present) plus >10 nocturnal "caves" with scats and middens	Bat Call 2016a
C	2.3	11	Robe	Yes	Not begun	11	100%	Yes	Yes Potential diurnal roost (MCC-02) plus 8 “caves” with scats and middens	Bat Call 2016a
D	1.3	9.7	Robe	No	Not begun	9.7	100%	Yes - Incomplete	Yes One site (cave Opp) with calls on southern facade	Biota 2010 Bat Call 2010
E	1.1	11	Robe	No	Not begun	11	100%	No		

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
F	17.2	39	Robe	Initial assessment only	Not begun	39	100%	Yes - Incomplete	Yes Maternity roost (MF01 with over 70 PGb present) plus multi shelters and overhangs present nearby.	This study
G	11.6	32	Robe	Yes	Not begun	32	100%	Yes	Yes Diurnal roost (Cave G02) plus >10 nocturnal "caves" with scats and middens	Biota 2009, Astron 2017, This study
H	10.3	35	Robe	Yes	Not begun	35	100%	Yes	Yes Two diurnal roosts (Caves MH16-34, AC-04) plus >9 nocturnal "caves" with scats and middens	Bat Call 2017d
I	1.4	8.7	Robe	No	No	8.7	100%	Yes	Yes One breakaway site with echolocation calls recorded	Astron 2016
J	15.3	14.0 Note 1	Robe	N/A	Underway	12.3	88%	Yes - Incomplete	Yes One breakaway site with scats on retained facade, 500 m from pit	Astron 2016
K	3.3	9.5	Robe	N/A	Finished	4.3	45%	Yes	Yes One site (SM12) with calls on retained facade	Astron2015, Bat Call 2015

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
L	2.1	11.4	Robe	N/A	Finished	2.5	22%	Yes	Yes One site (Opp-01) with scats on retained facade	Astron 2015
L1	0.3	4.3	Robe	Initial assessment only	No	4.3	100%	No		
L2	0.1	2.6	Robe	No	No	2.6	100%	Yes	Yes One site (Opp-07) with scats on retained facade	Astron 2015
M	0.7	3.9	Robe	N/A	Finished	1.8	46%	No		
N	0.1	0.1	Robe	N/A	Finished	0	0%	Yes - Incomplete		
2400A	0.04	1	Robe	No	No	1	100%	Yes	Yes One site (HA06) with scats on retained facade	Astron 2015
2400B	0.1	1.2	Robe	No	No	1.2	100%	Yes - Incomplete		
2400C	0.02	0.8	Robe	No	No	0.8	100%	Yes - Incomplete		

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
2400D	0.02	0.8	Robe	No	No	0.8	100%	Yes	Yes One site (HA07) with scats on retained facade	Astron 2015
2400E	0.3	2.4	Robe	N/A	Finished	1.0	42%	Yes	Yes One site (SM10) with calls on retained facade, assessed by Astron as possible diurnal roost	Astron2015 Bat Call 2015
2400F	0.2	2.3	Robe	N/A	Finished	0.65	28%	Yes	Yes One site (Opp06) with scats on retained facade	Astron 2015
2400G	0.2	2.2	Robe	N/A	Finished	0.65	30%	Yes - Incomplete		
2401A	2	13	Robe	N/A	Finished	5.7	44%	Yes	Yes One site (SM14) with calls and four with scats on retained facade	Astron2015 Bat Call 2015
2402A	0.3	2.5	Robe	N/A	Finished	0	0%	No		
2402B	0.05	1	Robe	No	No	1	100%	Yes	Yes One possible diurnal roost (Opp04 - PGb present) plus two sites (HA12, Opp05) with scats on retained facade	Astron 2015

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
2402C	0.3	2.8	Robe	N/A	Finished	0	0%	No		
2402D	0.3	2.7	Robe	No	No	2.7	100%	Yes	Yes One site (Opp03) with scats on retained facade	Astron 2015
2402E	0.8	6.8	Robe	N/A	Finished	1.1	16%	Yes - Incomplete		
2403ABC	1.3	9.3	Robe	N/A	Finished	2	22%	Yes - Incomplete		
2403D	1.2	6.9	Robe	N/A	Finished	6.4	93%	Yes	Yes One site (HA13) with scats on retained facade	Astron 2015
2403E	0.7	4.1	Robe	Yes but old	No	4.1	100%	No		
2405A	0.3	3.4	Robe	Initial assessment only	No	3.4	100%	No		

Attachment C. Data on Supplementary sites within 10 km of Robe River including records of recent Ghost bat presence.

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
Pannawonica Hill	0.001	0.1	Robe	No	No	0.1	100%	No		
Unnamed Bluff facing Robe River near Mesa 2403E	N/A	N/A	McKay	No	No	N/A	100%	Yes	Yes One site with two nearby caves. Multi PGb seen (SF13, SF14) and calls recorded, assessed as diurnal/maternal roost due to high number of calls detected	Astron 2015 Bat Call 2015
Unnamed bluff near Jimmawurrada Creek (1.25 km from Ck, 9 km from Robe)	N/A	N/A	Newman	No	No	N/A	100%	Yes	Yes One diurnal roost (MJmar17-09 >20 PGb present 2017). Maternity roost candidate	RTIO internal survey March 2017
Major unnamed gorge system SW of Mesa J (6km from Robe)	N/A	N/A	Newman	No	No	N/A	100%	Yes	Yes One probable maternity roost (Bat04) plus two diurnal roosts (DRML01/02 - both with PGb present 2016). Additional sites with scats and calls nearby	Astron 2016 Bat Call 2016c

Mesa	Approx. Area km^2	Perimeter length km	Land System	Drilled for resource evaluation?	Mining status	Retained perimeter length km	Retained perimeter %	Recent survey including Ghost bats?	Ghost bat usage - Summary of current evidence	Reference
Cave system in gully on unnamed mesa on west side of Buckland Hills (7 km from Robe)	0.7	4.9	Robe	Initial assessment only	No	4.9	100%	Yes	Yes One possible diurnal roost (PGb present 2014)	Biologic 2014
Cave system on Sugarloaf Hill on North side of Robe River, north of Mesa B (1.5 km from Robe)	0.15	1.9	Robe	No	No	1.9	100%	Yes	Yes One site (Bat07) with calls detected on facade and scats present.	Astron 2016 Bat Call 2016c