Robe Valley Mesas A and C, Ghost bat roost cave assessment, April 2017

Prepared for Rio Tinto

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C	25 May 2017	Third draft incorporating additional client reviews
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Executive Summary

Rio Tinto commissioned Bat Call WA (Bat Call) to undertake a targeted assessment of bat conservation values of three caves at Mesas A and C. These resources are located in the lower Robe River valley at and to the east of the Mesa A mine, in the Pilbara region of Western Australia.

Previous fauna surveys have been conducted in the area, most recently by Bat Call and Rio Tinto internal ecologists in 2016. Two bat species of conservation significance have been recorded within the area, namely Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) (Pilbara form of the Orange leaf-nosed bat) (PLNb) and Ghost bat (*Macroderma gigas*), both listed as Vulnerable under federal and state legislation. A detailed assessment of caves on Mesas B and C for use by Ghost bats was carried out in July 2016 (Bat Call 2016a). That survey identified a Ghost bat maternity roost cave on Mesa B and a diurnal/maternal cave candidate on Mesa C. Previous surveys had identified caves on Mesa A to also be diurnal/maternity roost candidates. PLNb have been assessed as using the mesas for foraging while originating from a yet to be discovered roost probably on Mesa D or E to the south of Mesa C and west of Mesa F (Bat Call 2016b, 2016c, 2017).

This survey was designed to provide an assessment of the conservation value of caves on Mesa A associated with the presence of Ghost bats and to confirm the assessment of the candidate roost cave on Mesa C.

A visual assessment of cave environments and a search for Ghost bat presence, including roosting bats, was carried out. Ghost bat presence, in the form of guano and middens, was recorded at the cave on Mesa C, MCC-02, but a video and ultrasonic record of the bats exiting and re-entering the cave confirmed that the Ghost bats were foraging outside the cave during the survey and not roosting within it. It was therefore assessed as a confirmed nocturnal feeding roost but remains a possible diurnal roost. Two cave sites were assessed on Mesa A in a gully excised from the mine plan and retained. One cave, A5, was determined to be a shelter with a low roof and assessed to be a nocturnal feeding site. The second cave, MAI06-SH17, was not approached as it was adjacent to a cliff collapse that appeared to be recent. It is characterised as a nocturnal roost based on measurements taken previously and confirmed by an external visual inspection. A number of additional overhangs nearby the caves and shelters were also assessed for signs of Ghost bat use but none were found.

1.0 Introduction.

1.1 Project Background

Rio Tinto commissioned Bat Call to undertake a targeted assessment of bat conservation values of three caves at the Mesas A and C deposits. These are located at, and east of, the Mesa A mine in the lower Robe River valley, in the Pilbara region of Western Australia (WA) (figure 1). Rio Tinto is considering sustaining its Mesa A operations by including the mining of additional deposits. In summary, the planned mining operation would involve the following main components and activities in addition to the existing approved operations:

- progressive open pit mining of ore and overburden from both Mesa B and Mesa C deposits using similar open pit mining techniques to those currently used at Mesa A. These operations are planned to remove the inner core of the mesa while leaving the rocky face of the perimeter intact except where cuts are required for access,
- placement of overburden in out-of-pit overburden storage Areas (OSA) adjacent to the mesas, 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, (Bat Call 2016b, 2017). Locating that roost is the subject of a separate study and will not be considered further herein. Multiple Ghost bat records including echolocation recordings, visual observations and cave middens have been detected within and adjacent to the study area (e.g. Bat Call 2010, Biota 2011; Bat Call 2016a, Astron 2017).

The purpose of this survey was to assess the conservation values of three caves potentially associated with Ghost bats at Mesas A and C that had been previously identified by environmental surveys and internal Rio Tinto heritage and fauna assessments. This involved a visual assessment of cave geometry and environments and a search for Ghost bat presence, including roosting bats and/or middens. The study area is shown in figure 1.

1.2 Existing Environment at Robe Valley Mesas and Surrounds

Topography

The Robe River Valley mesas cover an extensive area beginning at Mesa A and running approximately 100 km upstream. Mesas A to C extend approximately 10 km along, and stand approximately 50 m higher than, a flat plain that is crossed by the Robe River. Mesa C lies immediately adjacent to that river riparian zone. Mesa A is 5 km south of the Robe River riparian zone.

Geology

Both Mesas A and C are tertiary Robe Pisolite iron ore deposits (known as Channel Iron Deposits or CIDs) that are incised with deep gullies around their perimeter. Both have overhangs, shelters and caves along extensive lengths of their perimeters, e.g. plate 1.

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. They 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 additional rear chamber(s) separated from the entrance by a constriction point(s). Those chambers that have ceiling heights of over 2.5m 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. If their cavities are almost fully enclosed, have entrance cracks large enough, and can retain high levels of humidity they provide roosting opportunities for PLNb and Ghost bats.

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.

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

Mesas A and C, their gullies and the surrounding gravelly plains are elements of the Robe Land System. They are low limonite mesas that support spinifex grasslands and scattered Snappy Gums. The lower slopes and adjacent gravelly plains support spinifex grasslands with sparse Acacia and Eucalypt shrubs with low trees that sometimes form thickets.

The adjacent Robe River riparian 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

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 immediate area are associated with ephemeral gullies on the perimeters of the mesas that run into the Robe River drainage system. That riparian zone has a number of permanent and ephemeral pools along its length.

Plate 1. Example of the presence of overhangs and shelters along the perimeters and within the incised gullies on Mesas A and C. (Image by Emma Carroll).

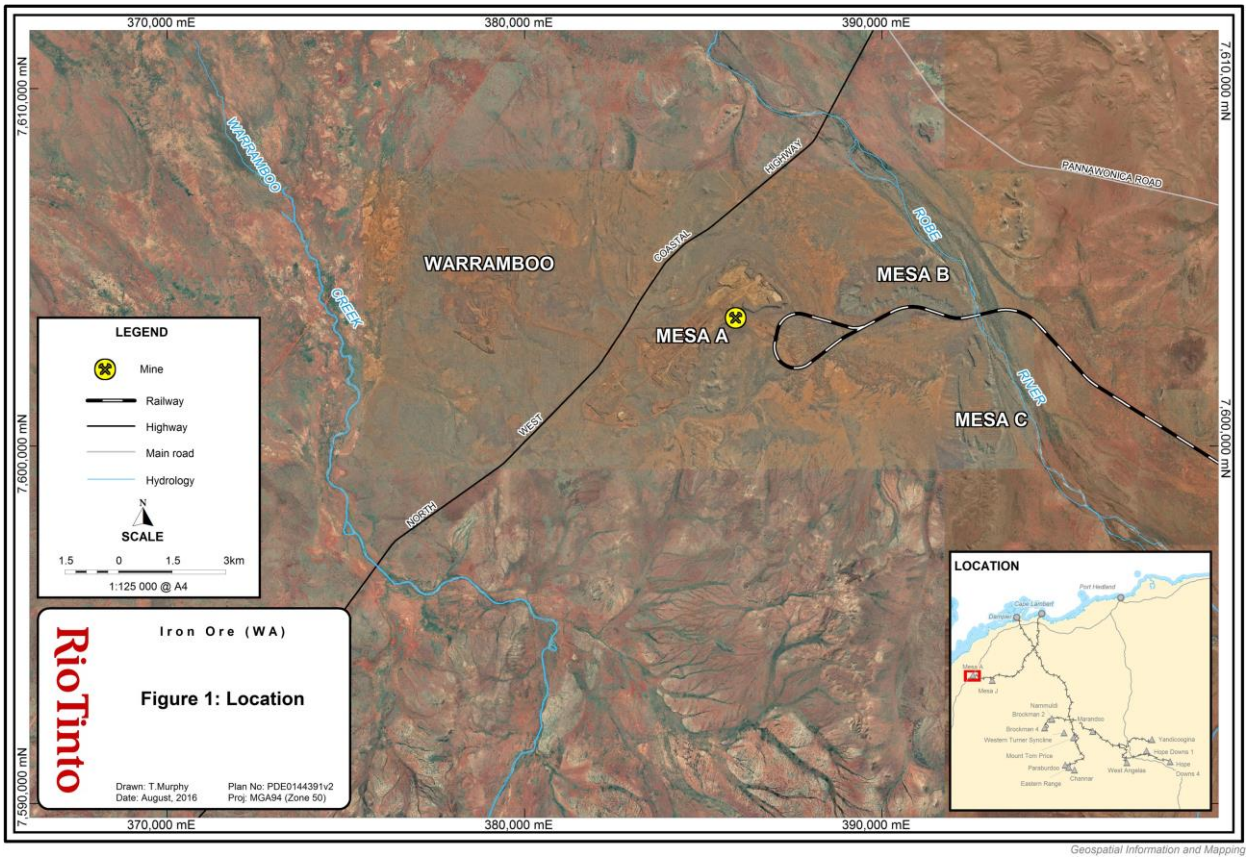

Figure 1. General Arrangement of Lower Robe Valley mining area.

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 lower Robe River 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 Bat Call and 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*).

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 Pilbara's Ghost bat and PLNb populations are isolated from Australia's other populations by 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 PLNb has been detected foraging across the Mesas in the Robe valley. A roost has not been identified in Mesa A, B or C and echolocation records indicate that it lies to the south or east on Mesa D or E and so is not considered further in this study. The Ghost bat has also been detected within the study area and one or more caves are maternity roost candidates.

Ghost bat (*Macroderma gigas*)

The Ghost bat is a large (130 g) carnivorous predator. It's foraging strategy and high trophic niche, as a top night-time carnivorous predator, is unique in Australian microbats. It 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)). It has a conservation status of Vulnerable under the federal 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). The listing is 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)).

Ghost bats hunt their prey in two primary ways. They hunt birds and bats "air-to-air" at cave entrances and elsewhere 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. One Ghost bat carcass was found recently entangled in a barbed wire fence over 12 km from the nearest roosting opportunity in cave forming rocky strata.

Along the lower Robe River valley multiple Ghost bat records including visual observations and the presence of cave middens have been detected on the various mesas within and adjacent to the study area (table 1).

Ghost bat breeding colonies 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). The Hamersley Range populations typically occur in local groups between 5 and 25 individuals (author's unpublished database). 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 productive set of gullies and gorges locally, 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 base). 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 at Durba Springs by W.H. Butler 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 and/or varieties of "dung beetle" that are known to forage on the scats (author's unpublished observation).

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 suitable conditions to form during the period when reproductive females and pups are present.

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

1.4 Summary of Previous Bat Surveys

Prior to 2017 a number of the fauna surveys commissioned by Rio Tinto in the lower Robe River valley included microbat species listings. These found that both significant species were foraging

across the area (e.g. Biota 2010; Bat Call 2010). The 2015 and 2016 surveys, summarised in table 1 below, indicated that the Ghost bat has a maternity colony on Mesa B and may include a diurnal colony at Mesa C.

Table 1. Summary of Fauna Surveys that Include Ghost Bat records in the Mesa A to C District

Date	Reference	Ghost bat activity detected.
2006	Biota 2006	• Observations of Ghost bats, middens or scats at Mesa A cave MAI06-SH17
October 2010	Biota (2010), Bat Call (2010)	• Group of 20 Ghost bats observed at Mesa F cave MF01 and calls detected at Mesas D and F
September 2015	Bat Call (2015)	• Ghost bat echolocation calls detected at Mesa B
May 2016	Bat Call (2016b)	• Ghost bat echolocation calls detected at Mesas B and F
July 2016	Bat Call (2016a)	• Ghost bat cave assessment at Mesas B and C. Maternity roost identified on Mesa B at cave MBC-05. Possible diurnal roost identified on Mesa C at cave MCC-02.
2017	RTIO internal ecologists	• Ghost bat social calls heard at Mesa F at cave MF-01. Cave MAI06-SH17 was measured and a Ghost bat scat found.

2.0 Survey and Assessment Methods

A survey consisting of two days field work was completed in April 2017 (11th to 12th April) on Mesas A and C. Three sites were assessed plus nearby overhangs and shallow shelters. The fieldwork focussed on the assessment of habitat of Ghost bat that previous surveys had indicated were important for this species. Cave names were taken from the relevant Rio Tinto GIS layers.

2.1 Survey Team, Timing and Weather

The survey team consisted of two experienced ecologists. Ms Tenielle Brown (Rio Tinto) was team leader and Mr Robert Bullen (Bat Call) acted as principal ecologist.

The northern wet season of 2016-17 was wetter than average in the Pilbara region. Heavy rain fell in the district in the three months prior to the survey, with 535 mm being recorded at the Bureau of Meteorology station at Pannawonica (Bureau of Meteorology station No 5069) between January and March. This rain continued until a week prior to the survey. The weather during the assessment was typical late wet season conditions, being hot and dry with temperatures between 20 and 40^{O}C.

Sunset and sunrise were at 18:07 and 06:27 during the survey while dusk and dawn civil twilight were at 18:30 and 06:05 respectively. The moon phase was full.

2.2 Survey Techniques

The survey was designed to further assess the list of potential Ghost bat maternity roost caves by considering cave morphology, geology and internal conditions. In particular, cave MCC-02 was assessed using electronic equipment (see below) to determine its status as a nocturnal or diurnal roost. These visits were completed during daylight hours. Caves and shelters were entered after a rigorous safety inspection that reviewed potential hazardous rock structures. Each was then measured for height, width and depth using a hand held laser (Bosch model PLR-50). All caves and gorges had been surveyed earlier by Biota, Bat Call and/or Rio Tinto internal ecologists and evidence of Ghost bat activity including the presence of middens and scats recorded and/or calls recorded.

The regular presence of Ghost bat was confirmed by either of the following observations:

- Visual observation of a large pale bat entering or departing the cave. Note that the Ghost bat is distinctive in being much larger than any other cave dwelling bat in the region, or

- Detection of Ghost bat scats or middens on the floor of the caves or shelters entered, see plate 2.

Plate 2. Typical Ghost bat midden containing scats and feathers on the floor of a cave (image by R. Bullen)

Caves and Shelters were then classified as maternal, diurnal, nocturnal or "not used" based on the cave characteristics and evidence found. The "not used" classification was applied when there is unsuitable characteristics such as low ceilings (typically <1.5 m) and/or shallow depth (typically < 5 m) with no physical evidence or other record such as a sighting or echolocation recording.

Observations of bat species other than the Ghost bat were not recorded during this assessment.

2.3 Survey Effort

Three sites previously identified, figure 2, were approached from the plain below, scanned visually for the presence of bats and assessed for Ghost bat presence. The caves were approached and assessed for safe entry. For two of the three caves, one ecologist entered the cave following agreed Rio Tinto health and safety guidelines covering personal protective equipment (PPE), access limitations and communication strategies. The cave interior was searched for evidence of Ghost bat roosting including the presence of adult Ghost bats and/or middens. The team's second member remained at the entrance to observe any Ghost bat that might depart the cave behind the lead ecologist inside, a common behaviour of this species. Any Ghost bats that departed and/or

entered the caves or were seen flying close to the entrance were thereby recorded visually. Any that departed could be tracked visually to record the alternative cave or shelter that they re-entered. The third cave, MAI06-SH17 was not entered. It was immediately adjacent to a major rock fall and was not closely approached. It was assessed from a distance.

Figure 2 Mesa A and C with locations of caves and shelters assessed during the survey.

At Cave MCC-02 on Mesa C that contains areas that cannot be assessed visually, three electronic systems were located in the mouth of the roost cave to record the movement of any Ghost bats present, figure 3. These were:

1. A full spectrum ultrasonic bat detector (SM2BAT 384 kHz model Wildlife Acoustics, USA) with SMX-US microphone fitted was placed at in the mouth of the cave to record movement of bats present. The SM2 was aligned between the two entrances with the microphone vertically up to record the bats moving in and out of the roost cave. Ghost bat presence was confirmed by recording of distinctive diagnostic ultrasonic and social calls. As the Ghost bat individual pulses and social calls are unique, calls with one or two ultrasonic pulses or audible call are easily identified.
2. Two high-definition video cameras (HandyCam model HDR-PJ790, Sony, Japan, equipped with nightshot and infra-red (IR) lighting were used as the primary data collection method. The cameras were aligned to give a full-frame view of the two constricted entrances to the roost. Bats passing out of the roost and re-entering could be counted manually from the video to confirm minimum colony size.

The SM2BAT recordings, once reformatted as .wav files, were reviewed using COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.). This software displayed each call sequence providing information on the number and timing of calls.

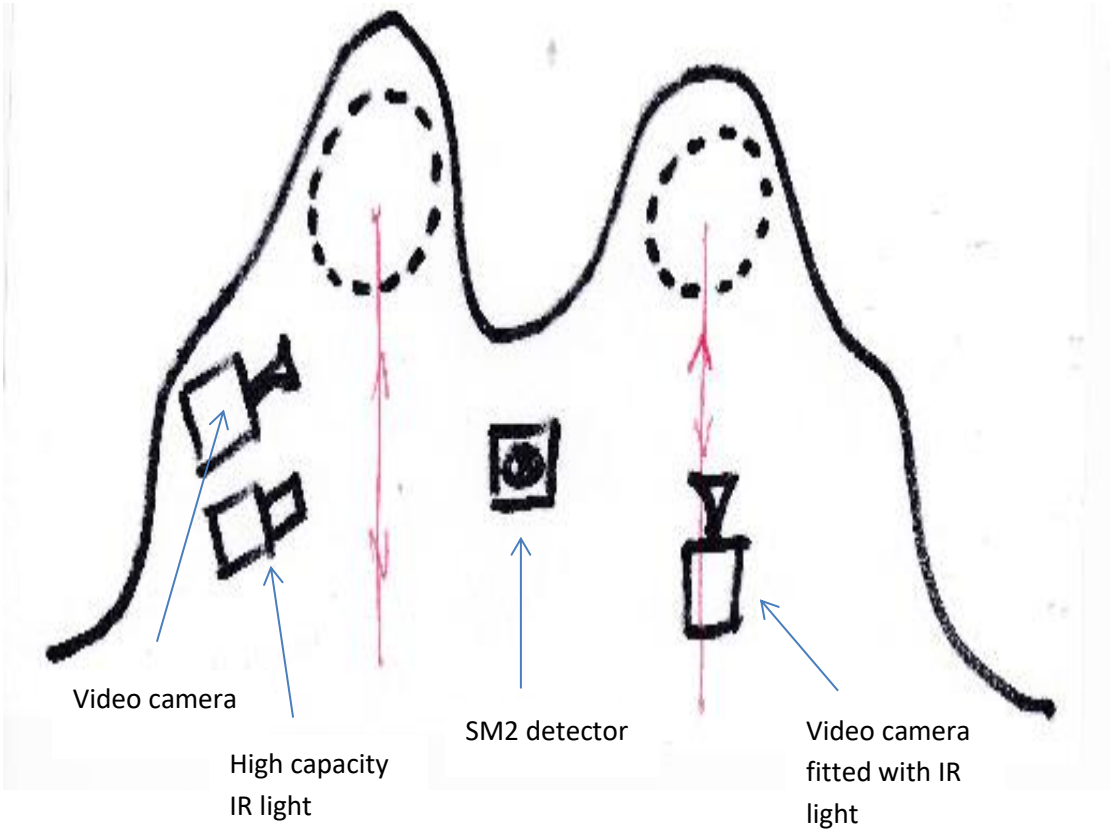

Figure 3. A diagrammatic representation of the cave MCC-02 entrance floor plan showing the location of the detecting devices and the flight paths of the bats (red) entering and departing the entrances as seen on the video.

2.4 Survey Limitations

The primary objective of the survey was the characterisation of Ghost bat activity at three caves on Mesas A and C. All aspects of the survey including site access using 4WD, team make-up and experience levels, equipment used, logistics and safety support provided by Rio Tinto were suitable for the task.

No activities were undertaken that could cause harm to the bats present.

Detailed internal dimensions of a cave and its daytime use by bats cannot be reliably determined from the entrance or by the size of the entrance. Entry of candidate caves was therefore required to confirm internal characteristics including the bat species present. (Note that distinctive Ghost bat social calls heard from the entrance or Ghost bats seen departing caves in daylight serve to confirm the presence of Ghost bats but not their numbers or maternity status).

Detailed interior searches of caves were carried out under the guidelines of the Rio Tinto safety procedures. These prohibited 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. 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.

Cave MAI06-SH17 was not approached as it was immediately adjacent to a major rock fall that appeared to be recent and therefore potentially unstable. Subsequent review of aerial photographs by Emma Carroll (RTIO) indicated that the fall was visible in 2001 before any mining or works were undertaken and so scat presence and dimensions for that cave are reproduced from previous work.

3.0 Results

3.1 Ghost bat

Ghost bat usage at the three caves is summarised in table 2 and detailed characteristics are given in Attachment A.

Table 2. Summary of caves visited on Mesas A and C and assessed for Ghost bat usage.

Cave	Easting	Northing	Observations	Assessed Ghost Bat roost type
Mesa A				
MAI06-SH17	386067	7603893	Ghost bat activity reported by Biota 2006. Cave assessed unsafe to approach due to a nearby rock fall. Measurements and the presence of scat(s) from a previous visit indicate it is a nocturnal feeding roost (Emma Carroll, pers comm)	Nocturnal feeding roost,
A5	386122	7604019	Cave with low roof and upper level tunnels. No Ghost bat guano present. Additional overhangs nearby and on opposite side of gully with no Ghost bat evidence	Nocturnal feeding roost
Mesa C				
MCC-02	392439	7602769	Ghost bat middens present in July 2016 (Bat Call 2016a). Main shelter and upper cave are part of a complex of shelters and overhangs with some interconnection possible. Video and Ultrasonic recordings made to assess Ghost bat current activity. Foraging Ghost bats detected	Nocturnal feeding roost confirmed, possible diurnal roost.

Note: All coordinates are zone 50K.

3.1.1 Mesa A

This study, in conjunction with the earlier data, confirm that the gully excised from the mining plan on Mesa A contains two caves suitable for use by Ghost bats on nocturnal visits, table 2.

Two sites in one deeply incised gully were assessed for current use by Ghost bats including one reported cave and one reported nocturnal roost shelter. Cave A5 was found to be over 10 m deep and to have upper level tunnels with the characteristics of a nocturnal roost although no evidence of current habitation was found. Shelter MAI06-SH17 was assessed as a nocturnal feeding site during an earlier visit (Emma Carroll pers comm). It was not re-entered as a rock fall immediately adjacent to the area included potentially unstable loose rock, plate 3.

Plate 3. Rock fall at site of cave MAI06-SH17. The cave is behind the vegetation just outside the lower right hand corner of the image.

3.1.2 Mesa C

This study also confirmed an ongoing Ghost bat presence at cave MCC-02. Ghost bat middens present in July 2016 (Bat Call 2016a) indicated that the cave was in use by the species. The main shelter and upper cave are part of a complex of shelters and overhangs with some interconnection possible. Ultrasonic recordings made to assess current Ghost bat activity detected calls at the cave's entrance across the night, figure 4, but no pattern of calls consistent with roosting or correlation with the video records of bats entering or departing the cave

entrances was found. The calls were therefore assessed as Ghost bats foraging outside the cave entrance that had originated from one of the other roosts on Mesa B or F.

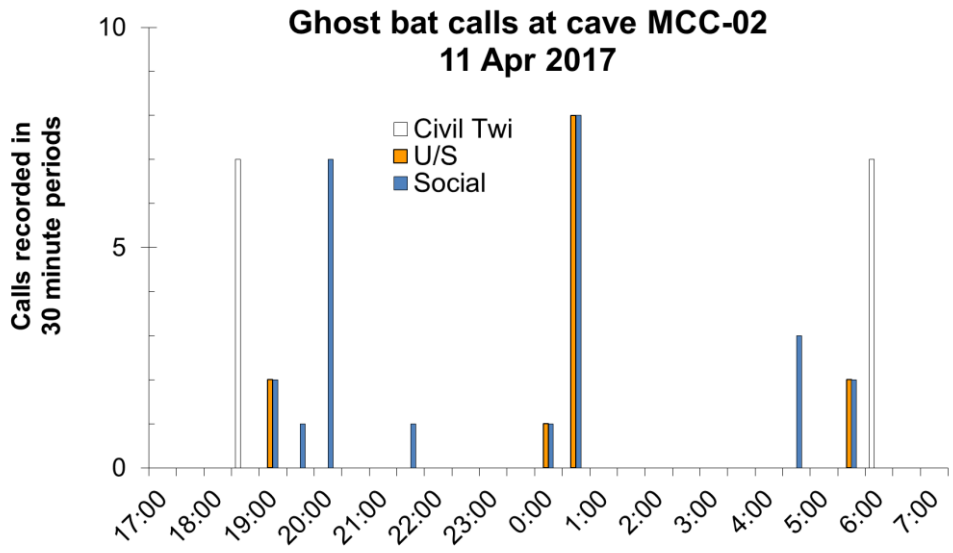

Figure 4. Temporal pattern of Ghost bat calls detected at cave MCC-02

The cave remains a potential diurnal roost due to the unknown depth of its upper chamber(s).

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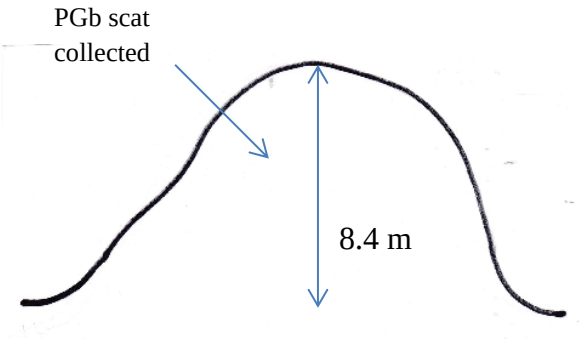
Attachment A: Characteristics of caves examined during this study.

Note that unboxed dimensions indicate cave/shelter width and depth and boxed or "dome height" (solid circles) dimensions indicate ceiling heights. Dotted ellipses indicate the locations of Ghost bat middens or scat piles.

Mesa A Site MAI06-SH17:

Assessed Ghost bat usage: Nocturnal shelter with a scat present (Emma Carroll (RTIO) pers comm	**Coordinates:** 50K 386082 7603878
Entrance safe or unsafe to approach: Unsafe due to adjacent loose rock	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Single wide entrance 9.3 x 2.8 m.	**Entrance Orientation:** South east
Cave Grouping: Cave is a part of a complex of shelters and overhangs in a deeply incised gully.	**Insulation from surface above:** Middle of local landscape
Cave Type: Cave 8 m deep with low roof.	**Internal domed chamber:** None visible
Rear passages that may have roosts: None visible.	**Internal temp. and relative humidity:** Ambient in main chamber
Local foraging opportunities: Good, Mesa A is 5km from the Robe River riparian zone.	**Current distance to disturbance:** Mesa A mine is immediately behind the cave. Active mining continues within 150 m of the cave entrance.

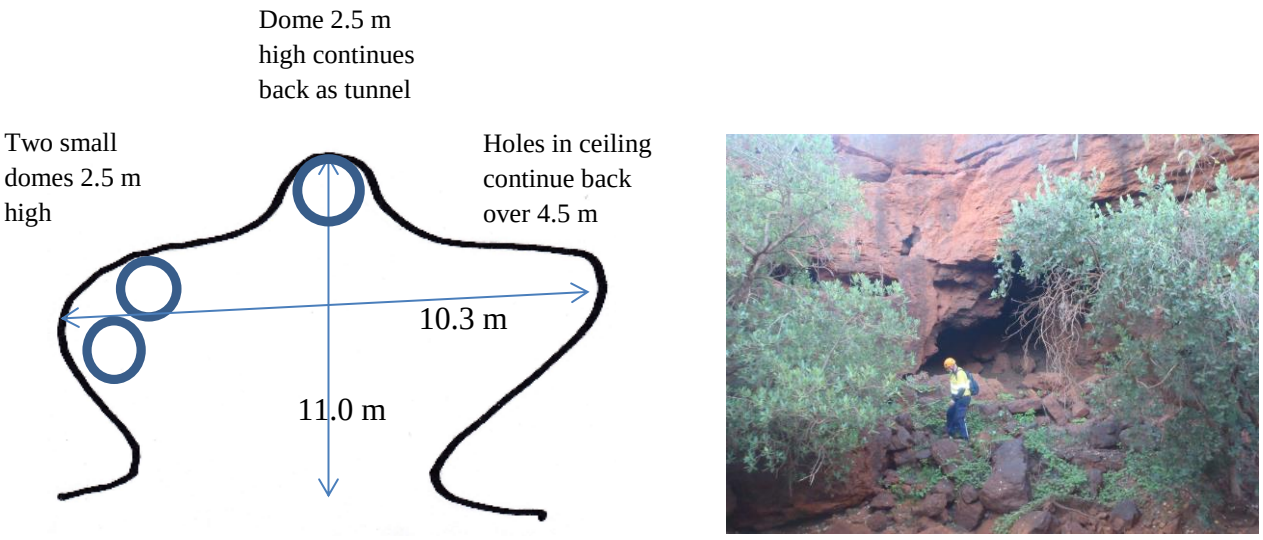
Cave floorplan and entrance photo:



Mesa A Cave A5:

Assessed Ghost bat usage: Nocturnal shelter without Ghost bat scats.	**Coordinates:** 50K 386122 7604019
Entrance safe or unsafe to approach: Assessed safe	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Single wide entrance 5.3 x 3.6 m.	**Entrance Orientation:** South east
Cave Grouping: Cave is a part of a complex of shelters and overhangs in a deeply incised gully.	**Insulation from surface above:** Middle of local landscape
Cave Type: Cave 11 m deep with low roof and three domes.	**Internal domed chamber:** Yes. 2.5 m to 4.5 m high
Rear passages that may have roosts: Cave has rear tunnels and ceiling holes that continue back an unknown distance.	**Internal temp. and relative humidity:** Ambient in main chamber
Local foraging opportunities: Good, Mesa A is 5km from the Robe River riparian zone.	**Current distance to disturbance:** Mesa A mine is immediately behind the cave. Active mining continues within 150 m of the cave entrance.

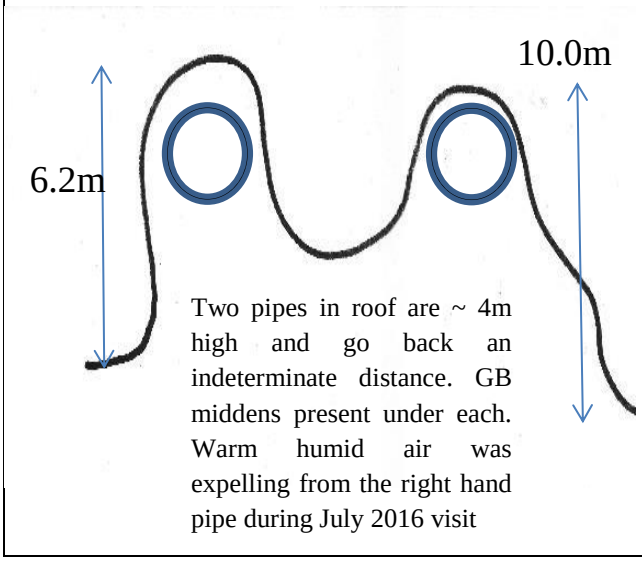
Cave floorplan and entrance photo:



Mesa C Cave MCC-02:

Assessed Ghost bat usage: Two GB middens present in July 2016, upper chamber assessed as possible diurnal roost	**Coordinates:** 50K 392439 7602769
Entrance safe or unsafe to approach: Entrance chamber assessed safe, upper chamber not entered.	**Basic Geology: Land system at site** Robe Pisolite mesa: Robe
Entrance type and dims – WxH (m): Single entrance, 13.0 x 3.0	**Entrance Orientation:** Northwest
Cave Grouping: Loose grouping of caves and shelters	**Insulation from surface above:** Top of landscape
Cave Type: Cave 10.0 m deep with upper chamber ~ 4.0m high	**Internal domed chamber:** Unknown in upper chamber.
Rear passages that may have roosts: Yes, upper chamber is of indeterminate depth and has adequate height for a possible diurnal roost	**Internal temp. and relative humidity:** Ambient in lower chamber, unknown in upper chamber
Local foraging opportunities: Excellent, Mesa C is adjacent to Robe River riparian zone.	**Current distance to disturbance:** Mesa A is 6 km distant. Resource eval. drilling nearby on mesa top.

Cave floorplan and entrance photo:



Two pipes in roof are ~ 4m high and go back an indeterminate distance. GB middens present under each. Warm humid air was expelling from the right hand pipe during July 2016 visit