

**Bat Call WA** Pty Ltd

ABN 26 146 117 839

ACN 146 117 839

T +61 8 9402 1987

E bullen2@bigpond.com

43 Murray Drive

Hillarys W.A.

6025

AUSTRALIA

20 March 2020

Monica Goggin

Acting Manager - LAHA

Atlas Iron P/L,

Level 17,

300 Murray St.

Perth, 6000,

Western Australia

## SUMMARY

Atlas identified the presence of Ghost bats and caves during their 2019 survey of the Miralga Creek Project area. The Ghost bat is listed as *Vulnerable* under both federal and state legislation and a Matter of National Environmental Significance (MNES). Key findings relevant to impacts to Ghost bats and ghost bat caves within the Miralga Creek Project area include:

1. The permanent bat roost Lalla Rookh lies outside the Miralga Creek Project area and is a confirmed 'Category 1' cave. No impacts to Ghost bats at this roost are expected.
2. Specific impacts to Ghost bat caves from the Miralga Creek Project are determined as:
  - Sandtrax – no long-term impacts to Ghost bats, with possible short-term abandonment.
  - Miralga West – Direct loss of one insignificant cave ('category 4' cave CMRC-02), and unlikely short-term abandonment of nearby caves, including a 'category 2' cave CMRC-06.
  - Miralga East – Presence of a 'category 2' cave (CMRC-15). Short-term abandonment is likely to occur at caves CMRC-13, -14 and -15 during mining, but reoccupation and no long-term impact is expected, contingent on structural integrity of all caves, but specifically cave CMRC-15. No short or long-term impacts are expected to caves CMRC-16, -17 and -18. There is no requirement to protect one insignificant category 4 cave (CMRC-01) due to Ghost bat usage.
3. Any bats exhibiting short-term abandonment from caves within the project area as a result of mining activities are expected to utilise Lalla Rookh as their preferred location.
4. There is no short- or long-term impact on Ghost bat foraging expected.

To support persistence of Ghost bat in the area, the following recommendations are made:

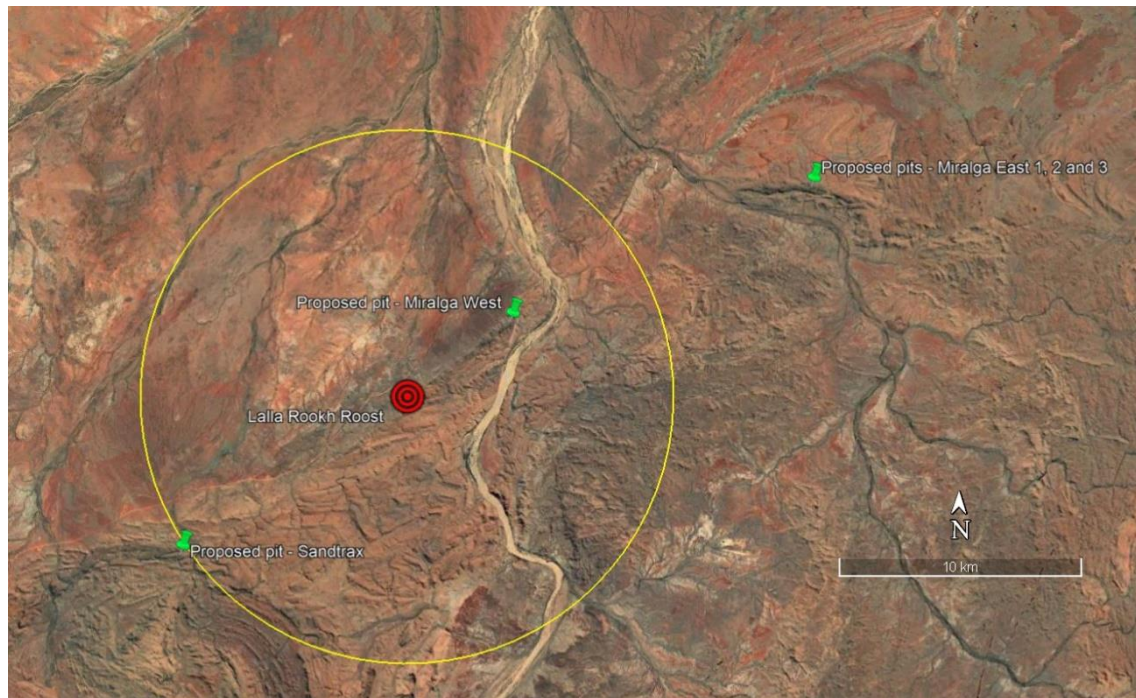
1. Ongoing protection of the ‘category 1’ Lalla Rookh cave from direct interference by Atlas’ operations.
2. Preservation of all caves identified herein as viable Ghost bat roosts, with the exception of caves CMRC-01 and -02, with emphasis placed on the two Category 2 caves (CMRC-06 and -15), and any caves in close proximity to pits.
  - The two category 2 caves (CMRC-06 and -15) together with the groups of caves, shelters and overhangs nearby (CMRC-04, -08, -10, -12, -13, and -14) are recommended for protection by suitable exclusion zones as they make up groupings that are important for the species’ persistence in the area (TSSC 2016a, Bat Call 2017b).
  - The remaining 2 groups (caves CMRC-03, -07, -16, -17, -18, and -19) are also recommended for protection by suitable exclusion zones as the usage by Ghost bat may be more extensive than the single season of monitoring has recorded.
3. Restricting entry of personnel from all category 2 and 3 caves identified herein with the exception of survey activities. Periodic restricting of survey activities in accordance with a disruption protocol (Appendix B) that is aligned to the breeding cycle of the Ghost bat is recommended.
4. Ongoing monitoring of Ghost Bat activity at the category 2 caves in the project area to better understand bat movements and impacts. Timing of monitoring is recommended to be aligned to the project’s development, production and closure schedules.
5. Production blast planning at cave CMRC-15 should follow the recommendations contained in Blast-It (2020) for maximum in-ground vibration limits of 100 mm/s peak particle velocity (PPV) to protect the caves’ ability to remain viable as a category 2 roost (i.e. to ensure that the cave is not destroyed, blocked or a new rear entrance opened) during future mining operations including drill and blast operations and ore removal operations.
6. During the mining operations, monitoring of the in-ground vibration levels and cave conditions should follow the recommendations contained in Blast-It (2020) and be undertaken with feed back to the blasting planning in an adaptive manner to ensure that the caves remain viable as diurnal roosts for the species.

Group	Caves (categories)	Recommended mitigation				Cave may be cleared based on PGb usage
		Avoid disturbing	Entry Protocol	Blast monitoring	PGb usage monitoring	
1	CMRC-03 (3) CMRC-07 (3)	Yes	Yes			
	CMRC-19 (4)	Yes				
2	CMRC-02 (4)					Yes
	CMRC-04 (4)	Yes				
	CMRC-06 (2)	Yes	Yes		Yes	
	CMRC-08 (3) CMRC-10 (3)	Yes	Yes			
	CMRC-12 (4)	Yes				
3	CMRC-01 (4)					Yes
	CMRC-13 (4) CMRC-14 (3)	Yes	Yes	Yes		
	CMRC-15 (2)	Yes	Yes	Yes	Yes	
4	CMRC-16 (4) CMRC-17 (4)	Yes				
	CMRC-18 (3)	Yes	Yes			

In consideration of the above findings and recommendations, it is anticipated that the proposed Miralga Creek Project will not have a significant impact on Ghost bats or Ghost bat caves.

## Miralga Creek Ghost bat review, March 2020.

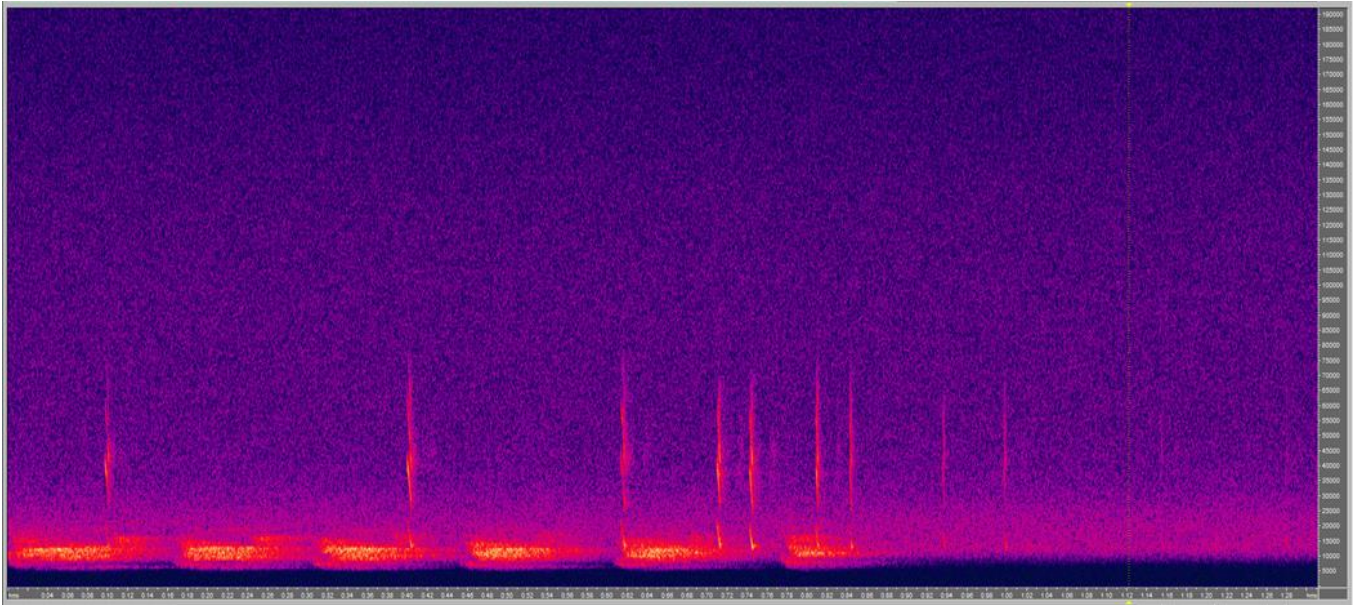
Atlas Iron (Atlas) have recently carried out a series of echolocation surveys for the presence of Ghost bat (*Macroderma gigas*) (PGb) at the proposed Miralga Creek project area in the Pilbara, figure 1. This memorandum summarises the results of those surveys, defines four cave groups important to the species, discusses potential impacts to those caves and provides recommendations for ongoing management of the caves and groups.



**Figure 1: Miralga Creek project. Lalla Rookh is a large Ghost bat roost in an historical underground mine. The three green pins indicate the general locations of proposed pits. The yellow circle indicates the potential nightly foraging range of Ghost bats resident at Lalla Rookh.**

The echolocation surveys were carried out as targeted cave assessments (Biologic 2019) using SM4 ultrasonic bat detectors (Wildlife Acoustics, USA) located at various sites (Bat Call 2019a, 2019b, Biologic 2019). For the surveys, data reduction was carried out using Bat Calls standard review processes for Ghost bat calls, figure 2. Call detections, singly or in groups, made just prior to dawn civil twilight (CT) followed by similar call detection patterns subsequent to dusk CT suggested diurnal roosting of bats at that cave. When these calls were detected in groups over periods of a few to 30 minutes, the number of ultrasonic calls recorded suggested that a similar number of Ghost bat were entering and re-exiting the caves on that day. Audible social calls also confirm presence however these

are not used to indicate numbers present as individual Ghost bats are known to call repeatedly while hanging in the entrance of their roost caves.



**Figure 2: Example of a Ghost Bat audible social and inaudible ultrasonic call sequence**

The Ghost bat is an obligate cave roosting bat that is widespread across the Pilbara (McKenzie and Bullen 2009) where it is under pressure from loss of roosting habitat (TSSC 2016a). The Ghost bat is listed as vulnerable under federal and state legislation. It has been the subject of detailed observations for many years and, more recently, to several mid and long-term monitoring programs including BHP’s programs at Mining Area C / South Flank, and Rio Tinto’s programs at West Angelas and in the Robe Valley. These observations have shown that for roosting, Ghost bats:

- have a small number of cave roosts in the East Pilbara where large numbers are permanently present, and
- are constantly moving between most other available caves in both the East Pilbara and the Hamersley Ranges and adjacent plains.

The evidence from this work shows that the usage of caves falls into four broad categories. These can be described in a similar manner to the categories in TSSC (2016b) suitably modified for Ghost bat usage. Firstly, there are the caves and historical underground mines (adits) that are used continuously as diurnal roosts by large numbers of Ghost bats for long periods of time, “category 1” caves. These are “source” locations (Dunning *et al.* 2018) for other caves in the district that have occasional or “sink” type usage. Secondly there are caves that are used regularly as diurnal roosts by small numbers of Ghost bats but not continuously, “category 2” caves. Thirdly there are caves that are occasionally used as

diurnal roosts and as nocturnal roosts for feeding and resting more frequently, “category 3” caves. And finally, survey work in recent years has shown that virtually any deep overhang, shelter or cave is subject to a nocturnal visit and/or an opportunistic roosting visit, “category 4” sites. Detailed definitions for cave categories are given in Appendix A below.

Ghost bat breeding populations are known from a small number of maternity roosts in the Pilbara and reproduce during the northern wet season with parturition typically occurring in the last week of October or the first week of November (Churchill 2008; authors unpublished observations). The largest of these colonies are in “category 1” abandoned historical gold mines in the East Pilbara and number up to several hundred (Armstrong and Anstee 2000, author’s unpublished observations). Colony sizes at these sites varies over time based on seasonal, climatic and other factors. For example, the counts at Kohinoor Adit in the Northern Territory, a category 1 site, have varied between 300 in 1981, 1,500 in 1990 and then down to 550 in 2013 (TSSC 2016a). At two East Pilbara category 1 sites, variable colony sizes have been recorded. At the Comet mine near Marble Bar, manual counts of exiting bats were 130 in May 2017 rising to 270 in April 2019 (author’s unpublished data). At Klondyke Queen mine, also near Marble Bar, manual counts of exiting bats were 265 in September 2017, 450 in July 2018 and 475 in April 2019 (authors unpublished data). These variations are above those possible based on natural recruitment alone and indicate that bats have congregated at these preferred sites during this period, possibly due to the reduced rainfall received in the east Pilbara between 2017 and 2019. Most other populations across the Pilbara and adjacent Ashburton regions are typically between five and twenty-five individuals in local groups (author’s unpublished data). 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 “category 2” 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, a group numbering 14 including four juveniles at another cave near Mt Robinson in 2015 (Mr. Morgan O’Connell pers. comm.) and a group of 25 including gravid females at another cave near Mt Robinson in 2017 (Mr. Morgan O’Connell pers. comm.). None of these caves are permanently occupied (author’s unpublished observations). 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 the district of their birthplace and that the males can move between districts.

Published information on Ghost bat foraging habitat is sparse. Early published data suggest that the bats use a fairly restricted foraging range (TSSC 2016a). However more recent studies indicate that the bats forage much more widely (~10 km from roost cave, Diete *et al.* 2016), utilise all productive habitats in the Pilbara with the possible exception of treeless spinifex plains (in particular those that have been recently burnt) and forage on a very wide range of prey. Authors unpublished data records regular nightly round trips of up to 25 km in length to a range of foraging sites up to 11 km from the diurnal roost cave and potentially include a total of 38,000 ha over multiple nights. Types of foraging sites regularly visited include cave entrances (where preferred bat species exit), riparian lines, thicker woodlands in productive areas, thin woodlands on plains, thin woodlands on rolling hills with incised gullies and in thin woodlands on the tops of ridge lines (authors unpublished data). Foraging areas are not exclusive and are known to be used by multiple bats (Tidemann *et al.* 1985). In addition, a Ghost bat marked at Klondyke Queen has been recorded arriving at the Comet mine, over 20 km distant (Mr Morgan O'Connell pers comm).

Ghost bat detection at Miralga Creek is shown to be consistent with the year-round presence of Ghost bats in the East Pilbara. Ghost bats and/or scat piles were recorded at ten of the sixteen caves monitored. In addition, there is a confirmed nearby permanent "category 1" colony of over 200 Ghost bats (Bat Call 2017a supplemented by the author in early 2019 by a manual count of exiting bats) at the historical underground Lalla Rookh gold mine. Surveys in 2019 confirmed diurnally roosting bats at four caves (Biologic 2019) and echolocation recordings confirmed diurnal roosting at a fifth (Bat Call 2019b). At any cave apart from Lalla Rookh, the numbers of bats identified as roosting diurnally suggest that a maximum between five and 10 were present during the survey period.

Additional information provided by Atlas for this study are:

- Miralga Creek – Assessment of potential mining activities impact on the structural integrity of the caves. Pells Sullivan Meynick report PSM3754-037L Draft dated 8 January 2020 (herein referred as PSM 2020),

- Miralga Creek project, environmental noise and vibration impact assessment. Talis Consultants P/L report TN19027-1 dated September 2019 (herein referred as Talis 2019).
- Scanned footprints of caves CMRC-13, -14 and -15 relative to MIE Pit 2 boundaries dated January 2020 (herein referred as Atlas 2020a).
- Assessment of blasting at Miralga Creek project, preservation of Ghost bat habitats post mining activities. Blast It Global P/L report dated 5 March 2020 (herein referred as Blast-It 2020).
- Assessment of fauna foraging habitat potentially impacted by the project. Atlas emails dated 19 and 20 March 2020 (herein referred as Atlas 2020b and Atlas 2020c respectively).

This memorandum addresses:

- the potential impact of the project on the broader presence of the species in the area, in particular any impact on the category 1 roost at Lalla Rookh, based on projected sound and vibration analyses provided by Atlas.
- the direct and indirect impacts to four groups containing identified category 2 and 3 caves and provides recommendations for their ongoing management.
- The direct impact on Ghost bat foraging habitat.



**Table 1: Site recording period and location details.**

All data taken from Biologic (2019). Scat age: fresh, recent, old assessed as under 1 month old, 1 to 6 months and over 6 months old respectively.

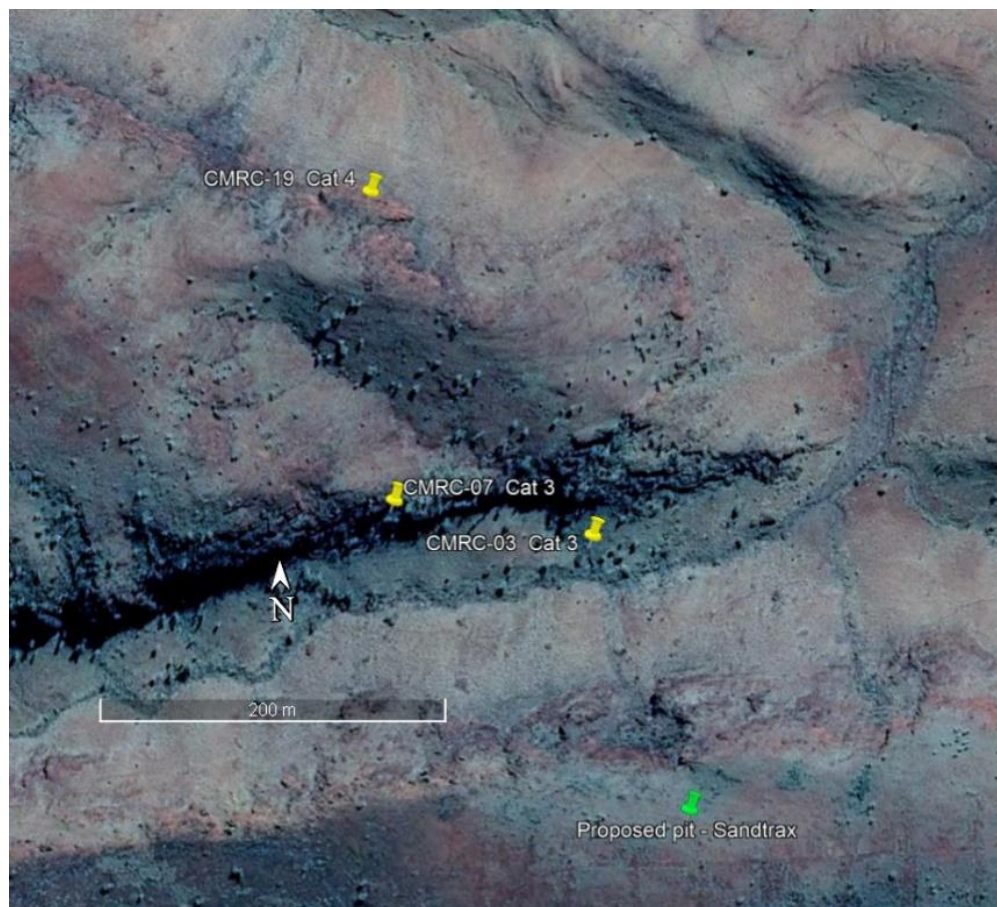
Cave	Lat / Long	Date of assessment	Cave exposure and aspect	Cave depth (m)	Number of chambers	Chamber height (m)	Ghost bats observed or calls recorded.	Ghost bat scats/middens present
CMRC-01	-20.97131, 119.43425	12/05/19	South Semi Exposed	6	1	1	No	3 recent
CMRC-02	-21.0245, 119.3175	14/05/19	South/East Exposed	3	1	1	No	0
CMRC-03	-21.1096, 119.1875	13/05/19	South Sheltered	6	1	1	Calls recorded suggesting diurnal roosting July 2019	~20 recent
CMRC-04	-21.027, 119.3137	14/05/19	South/East Semi Exposed	4	1	1	No	0
CMRC-06	-21.027, 119.313	14/05/19	East Semi Exposed	8	2	2	1 observed	4 recent
CMRC-07	-21.1094, 119.1864	13/05/19	South Sheltered	14	1	1	1 observed	0
CMRC-08	-21.0273, 119.3123	14/05/19	East Semi Exposed	6	1	1	No	~50 fresh
CMRC-10	-21.0269, 119.3133	18/05/19	South/East Semi Exposed	5	2	2	No	0
CMRC-12	-21.0262, 119.3127	18/05/19	East Semi Exposed	2.5	2	2	No	0
CMRC-13	-20.9731, 119.4334	19/05/19	South Semi Exposed	2.5	1	1	No	~70 fresh
CMRC-14	-20.9731, 119.4327	19/05/19	South Semi Exposed	1	1	1	6 observed - flushed into -15 in July 2019	~20 old
CMRC-15	-20.9727, 119.4299	19/05/19	South Semi Exposed	20	1	1	6 flushed from -14 in July 2019. Calls recorded suggesting diurnal roosting July 2019	~4000 fresh scats on midden
CMRC-16	-20.9729, 119.4118	18/05/19	South Semi Exposed	4	1	1	No	0
CMRC-17	-20.9729, 119.413	18/05/19	West Semi Exposed	5	1	1	No	0
CMRC-18	-20.9736, 119.4139	18/05/19	South Semi Exposed	25	1	1	No	~40 recent
CMRC-19	-21.1078, 119.1863	19/05/19	North Exposed	3	1	1	No	~100 fresh

## Miralga Creek Cave Groupings

There are four groups of caves, and two isolated overhangs that have been surveyed during 2019 for Ghost bat usage.

### *Cave Group 1 (Sandtrax).*

Cave group 1 is a group of three caves nearby the proposed Sandtrax pit, figure 3, table 2. There are no Cat 1 or 2 caves in this group. Two caves (CMRC-03 and -07 are category 3 and CMRC-19 is a Cat. 4. The closest is 185 m from the proposed Sandtrax pit boundary and on the opposite side of a deep gully.

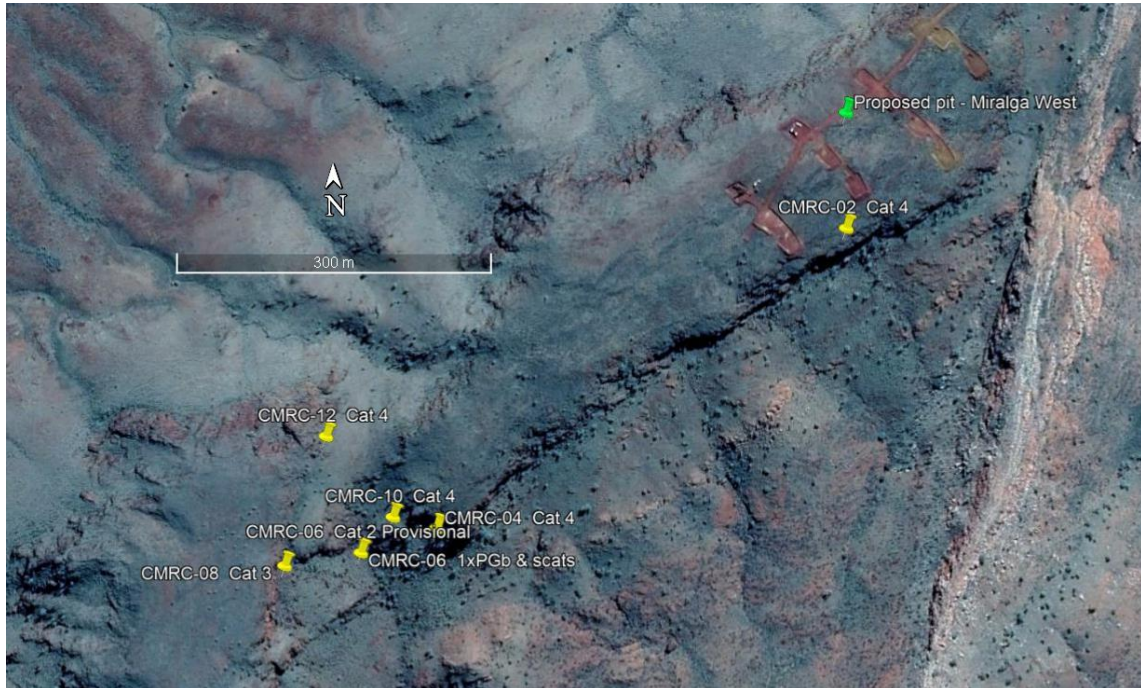


**Figure 3. Miralga Creek Project (Sandtrax). Ghost bat cave group 1.**

### *Cave Group 2 (Miralga West).*

This group comprises five caves approximately 400 m south-west of the proposed Miralga West pit (figure 4, table 2) with one isolated overhang (CMRC-02) adjacent to the pit. One cave, CMRC-06, is a multi-chamber cave with ceiling heights of ~2 m. It is a confirmed diurnal roost cave with a scat pile present. On the basis of the cave geometry together with the 2019 presence observations, it is a category 2 cave. Two caves (CMRC-08 and -10 are category 3 and two (CMRC-04 and -12) are shallow cat. 4

overhangs. The closest is 340 m from the proposed Miralga West pit boundary providing adequate separation from any impact from the mining activities.

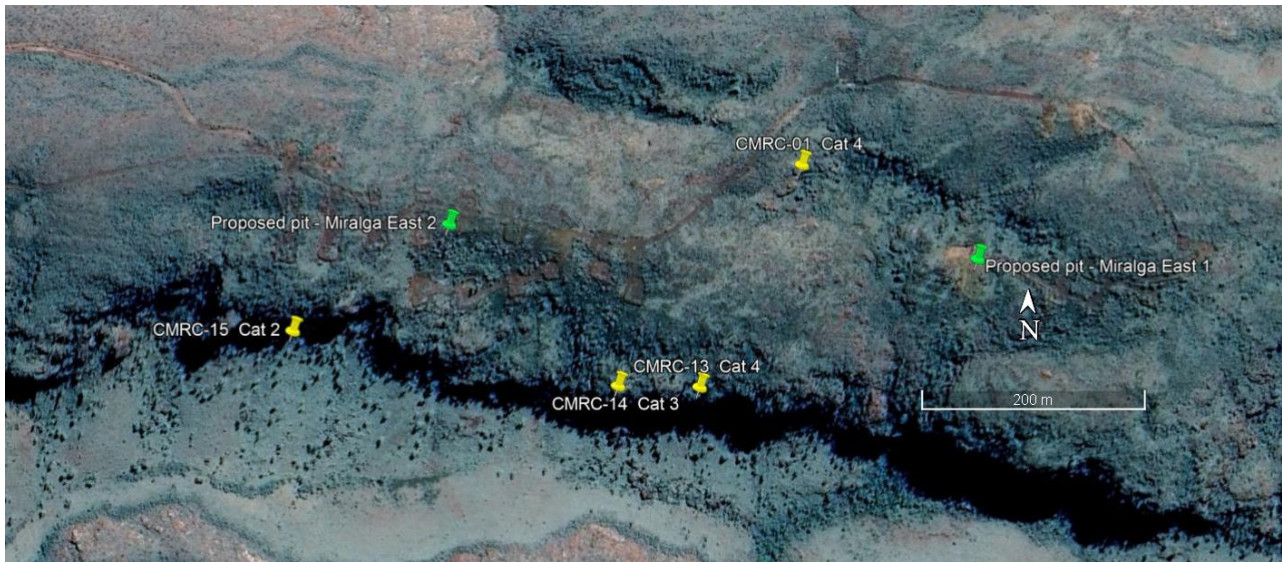


**Figure 4. Miralga Creek Project (Miralga West). Ghost bat cave group 2.**

#### *Cave Group 3 (Miralga East).*

This group comprises a group of three caves between 50 and 120 m south of the proposed Miralga East pit 2 (figure 5, table 2) with one isolated overhang (CMRC-01) nearby the Miralga East 1 pit. One cave, CMRC-15, is at least 20 m deep. It is a confirmed diurnal roost cave with a midden and large scat pile present. On the basis of the cave geometry together with the 2019 presence observations, it is a category 2 cave. Two caves (CMRC-13 and -14) are nocturnally used category 3 based on their proximity to CMRC-15 and the 2019 observation records of occasional diurnal roosting Ghost bat and scat piles. The closest cave to the proposed pit is CMRC-15 whose entrance is 55 m from the pit and whose inner reaches are much closer, approximately 23 m, from the proposed pit boundary. Similarly, CMRC-13 is close to the proposed pit at 95 m.

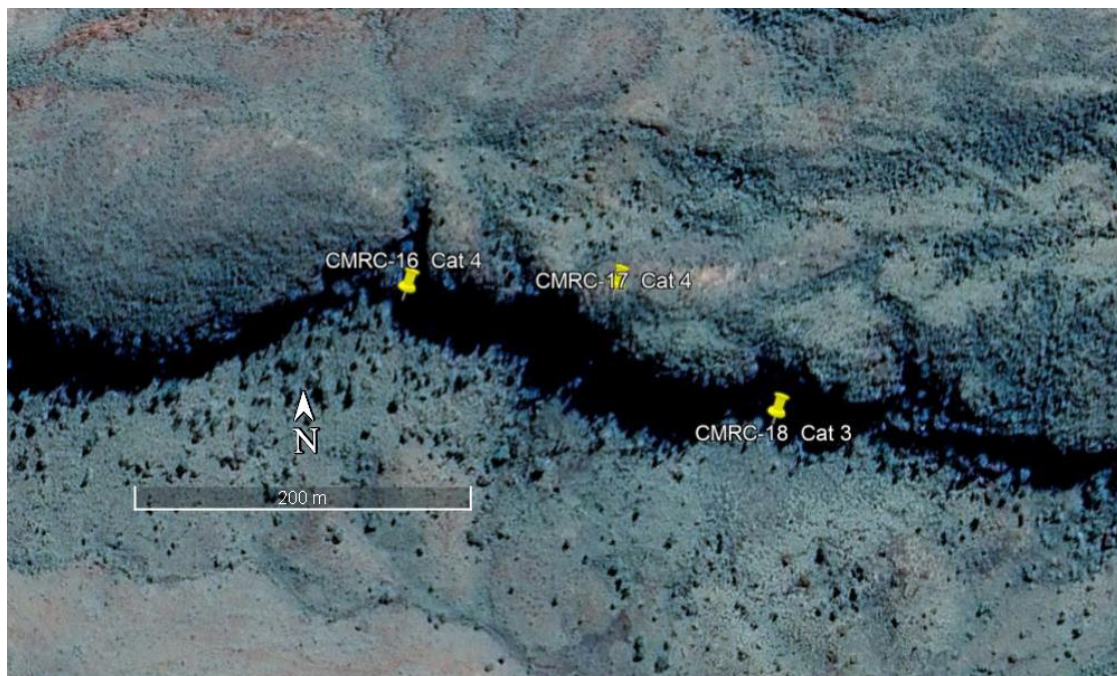




**Figure 5. Miralga Creek Project (Miralga East). Ghost bat cave group 3.**

*Cave Group 4 (Miralga East).*

Cave group 4 is a group of three caves approximately 1 km west of the proposed pits at Miralga East, (figure 6, table 2). There are no cat. 1 or 2 caves in this group. One cave (CMRC-18) is a deep category 3 cave and the other two (CMRC-16 and -17) are shallow cat. 4 overhangs. All three are distant from the proposed pit boundary.



**Figure 6. Miralga Creek Project (Miralga East). Ghost bat cave group 4.**

**Table 2: Cave grouping and categorisation details.**

<b>Cave Group</b>	<b>Distance to Lalla Rookh Cat. 1 roost (km)</b>	<b>Cave</b>	<b>Assessed category</b>	<b>Distance from entrance to nearest proposed pit (m)</b>	<b>Remarks supporting categorisation of cave.</b>
Group 1	11	CMRC-03	Cat 3	185	A shallow single chamber cave with low roof. Diurnal PGB present in July
		CMRC-07	Cat 3	225	A deep single chamber cave with low roof. Diurnal PGB present in July but no other evidence present.
		CMRC-19	Cat 4	385	A deep overhang
Group 2	5	CMRC-02	Cat 4	0	An isolated shallow overhang
		CMRC-04	Cat 4	340	A deep overhang
		CMRC-06	Cat 2	400	A multiple chamber cave with high roof. Diurnal PGB and scats present in July.
		CMRC-08	Cat 3	470	A shallow single chamber cave with low roof. Fresh PGB scats present.
		CMRC-10	Cat 3	450	A shallow multiple chamber cave with high roof. No evidence of PGB usage.
		CMRC-12	Cat 4	340	A shallow multiple chamber cave with high roof. No evidence of PGB usage.
Group 3	19	CMRC-01	Cat 4	50	An isolated deep overhang
		CMRC-13	Cat 4	95	A shallow single chamber cave with low roof. Fresh PGB scats present.
		CMRC-14	Cat 3	117	A shallow overhang. Category based on diurnal presence of PGB and scats and proximity to cave 15.
		CMRC-15	Cat 2	55	A deep single chamber cave with low roof. Diurnal PGB present in July. Large scat pile and midden present.
Group 4	17	CMRC-16	Cat 4	~1000	A shallow overhang
		CMRC-17	Cat 4	~1000	A shallow overhang
		CMRC-18	Cat 3	~1000	A deep single chamber cave with low roof. Scat pile present.

## Potential impact on Miralga Creek Caves

### *Potential Impact on Lalla Rookh cat 1 roost.*

Potential impact mechanisms on the Lalla Rookh roost other than by direct anthropogenic disturbance, can be from airborne dust, sound and in-ground vibration generated by the mining operations. Further a small increase in colony size is expected as bats relocate to Lalla Rookh during mining operations. Lalla Rookh is an historical underground gold mine that lies 700 m south of the unsealed Abydos haul road and 5.25 km south west of the nearest proposed Miralga Creek pit. Regarding impact from dust, bulk road transport of iron ore from Abydos that generated dust had been carried out until recently along the haul road and there has been no impact on the viability of the roost, or the number of bats present, observed during or subsequent to this activity. Miralga Creek transport operations are planned to be of a similar nature and therefore no ongoing impact is foreseen. Regarding sound and vibration from the mining operations, Talis (2020) presents an initial assessment of airborne sound and in ground vibration levels expected at distances from mining operations and in-pit blasting. At distances of over 5 km, all levels projected are below known disturbance thresholds for diurnally roosting Ghost bats (*sensu* Bullen and Creese 2014).

Regarding impact from a possible increase in colony size, available evidence on both roosting habitat and foraging habitat indicate that neither is a limitation. The surveys to date, summarised in table 1, indicate that the maximum number of bats relocating to Lalla Rookh would be approximately 20. This is < 10% of the latest estimate of over 200 bats at Lalla Rookh. While an underground survey of the mine is impossible due to safety concerns, the historical complex includes over 12 shafts and declines over a 450 m length of deposit that are connected underground by a complex of drives at possibly several different levels. Authors observations have confirmed that bats use a number of these shafts for accessing the underground complex indicating that the majority is used for roosting. Within a 12 km radius circle surrounding Lalla Rookh, all but the north west quadrant is dominated by the Shaw River riparian, and the thin woodland covered hills and productive valleys to the north-east, south-east and south-west. The north-west quadrant includes large areas of less productive spinifex covered plain but also includes thin woodlands along ephemeral creek lines that are preferred habitat. The available foraging area for the ghost bats at Lalla Rookh is therefore over 30,000 ha.

### *Potential Impact on Cave Groups 1 and 2*

Impact mechanisms on all caves in the area are similar to those listed above. A short-term abandonment may occur due to sound, vibration and dust when the production is underway at these groups. Re-use is expected following completion of nearby mining operations. Nearby group 2, the isolated Cat. 4

overhang, CMRC-02, is not important to the long-term presence of the Ghost bat locally. No long-term impact on Ghost bat usage of these cave groups is expected from the mining activities based on the distance and demonstrated ability of Ghost bat to use the lower category caves on an occasional basis.

*Potential Impact on Cave Group 3 including CMRC-15 Cat 2 roost*

When production is underway nearby, sound, vibration and dust levels are likely to cause the Ghost bat to abandon caves CMRC-01, -13, -14 and -15 in the short term due to the short distances to the proposed pit boundaries. Cave CMRC-01 is an isolated category 4 overhang and not important to the long-term presence of the Ghost bat locally. If caves CMRC-13, -14 and -15 are managed and remain unblocked by the nearby blasting and associated vibration and if the inner extremities of the caves are not intersected by the pit wall creating new rear entrances or airways that disrupt the internal microclimate, the viability of the caves as diurnal roosts will be maintained and Ghost bats will re-occupy the caves once the disturbance moves away.

Atlas Iron commissioned further investigations in relation to caves CMRC-13, -14 and -15 given their importance to the Ghost bat and proximity to mining. LIDAR scanning of the cave interiors (Atlas 2020a), a geotechnical assessment (PSM 2020) and a blast impact assessment (Blast-It 2020) have all been carried out to better understand the potential effects of mining activities on the caves, particularly given the proximity of cave CMRC-15 to pit 2.

The internal scan of CMRC-15 indicated that the entrance is approximately 30 m and the cave's internal extremities are approximately 23 m from the proposed pit wall below the crest. Further, PSM (2020) indicated that cave CMRC-15 has a *higher risk of structural instability* compared to other nearby caves due to the presence of *a persistent geological structure, a subsidiary fault splay associated with a known nearby regional scale fault line*. In addition, PSM (2020) indicated that cave CMRC-15 has *two adverse blocks* within the cave that are not described in detail. These are interpreted to be smaller structures within the larger roof profile that have the potential to fall to the cave's floor.

The blasting impact assessment (Blast-It 2020) developed a draft blasting plan against a maximum in-ground vibration level at cave CMRC-15 that is projected to retain the primary roof structure and outer and inner chambers intact but not necessarily retain in place any loose ceiling blocks. This is consistent with retaining the caves as viable diurnal roosts. This assessment indicated that a safe set of blast parameters was possible for undertaking drill and blast activities the cave nearest to these activities (cave CMRC-15) and, by inference, all others nearby. This includes the localised effects of in-ground vibration, air-blast, flyrock and block displacement. However, during blasting and other mining



operations in MIE Pit 2, the small distances and high levels of sound and vibration involved indicate that the Ghost bats will temporarily abandon the cave. To achieve the objective of retaining the cave as a viable category 2 roost with a suitable internal microclimate, surrounded by viable lower category caves subsequent to the mining operations, Blast-It (2020) proposed *an over-conservative approach to blast planning* based on:

- Monitoring of in-ground vibration levels at caves during blasting operations,
- blast vibrations less than 100 mm/s peak particle velocity (PPV) at the closest cave to any specific blast,
- all blasts to be designed for less than 85 mm/s PPV,
- cessation of blasting if PPV over 100 mm/s is measured until the cause of the exceedance is identified, a cave inspection is carried out, and steps implemented to prevent reoccurrence.

Prior to and during mining operations, a suitable quarantine zone will be created around the pit that must include cave CMRC-15 to minimise entry and/or inadvertent damage by personnel. During mining and blasting operations in-ground vibration levels, together with the overall cave condition, must be monitored to ensure that the cave remains viable as a category 2 roost. In addition, the development of the pit behind the cave must be carefully monitored to ensure that it does not intersect the inner extremities of the cave.

Caves CMRC-13 and -14, together with nearby CMRC-15 make up a grouping that is important to the ongoing presence of Ghost bats at Miralga Creek. Potential impacts to Ghost bats roosting at caves CMRC-13 and -14 are similar to CMRC-15 indicating that a short-term abandonment from this group is likely, but that the Ghost bats will re-occupy the caves once the disturbance moves away. Internal LIDAR scanning (Atlas 2020a) and geotechnical assessments (PSM 2020) were also carried out at these caves. The LIDAR scans of the caves indicated that their internal extremities are approximately 101 m and 85 m from the closest proposed pit wall below the crest. Further, PSM (2020) indicated that both caves *have low risk of mine induced structural instability due to their distance from the mine, their internal shapes and an apparent lack of persistent geological structure that reduces induced ground vibrations propagating to the caves*. During mining and blasting operations, monitoring the overall cave conditions, together with cave CMRC-15, should be adequate to ensure that the caves remains viable as category 3 roosts. The recommended quarantine zone to be created adjacent to the pit must also include these caves.

The isolated Cat. 4 overhang, CMRC-01, is not important to the long-term presence of the Ghost bat locally.

#### *Potential Impact on Cave Group 4*

No short or long-term impact on Ghost bat usage of these caves is expected from the mining activities based on the distance and demonstrated ability of Ghost bat to use the lower category caves on an occasional basis.

#### **Potential impact on Ghost bat foraging area**

As presented above, Ghost bats will forage in any highly or moderately productive habitat that has suitable perches for its foraging strategy. Atlas have provided an assessment of the areas in several habitat categories that are likely to be impacted by the project (Atlas 2020b, 2020c). High and medium value habitats include gorge/gully, hill crest/ hillslope, major drainage lines and thinly wooded sand plains. For the entire project area, roughly centred on Lalla Rookh, the total Ghost bat habitat (high, medium and low productivity) in the disturbance footprint is 285 ha (Atlas 2020c). Within the eastern area surrounding Cave groups 3 and 4 at Miralga East, high and medium areas up to 64 ha (Atlas 2020b) of the possible foraging area of over 30,000 ha surrounding that site, or 0.2%, approximately half of which overlaps the area surrounding Lalla Rookh. At Sandtrax to the west of Lalla Rookh, no specific figures are available, but the impact area and types of habitats are similar to Miralga East and so a similar area and overlap is assumed. The total area available for foraging by Ghost bats including the areas surrounding Sandtrax, Lalla Rookh and Miralga East is approximately 60,000 ha of which the impact total of 285 ha is 0.48%. There is no short- or long-term impact on Ghost bat foraging expected based on this reduction.

## **Recommendations.**

The results of the 2019 surveys are consistent with the use of the caves within the study areas by Ghost bat, with low numbers confirmed roosting diurnally away from the category 1 colony at Lalla Rookh historical mine during the dry season. Ten caves had evidence of recent foraging visits and five of these had observed presence/call patterns that indicated diurnal roosting. The patterns indicate that four groups of caves are important for the persistence of the species in the area. Two groups are assessed to include category 2 roosts with the probability of supporting reproducing bats.

The recommendations included here-in are from a single season of monitoring, therefore it is expected that the seasonal cycles exposed may not cover the full utilisation of the caves by Ghost bat. Therefore, to support persistence of the bat in the area, the following recommendations are made:

1. Ongoing protection of the ‘category 1’ Lalla Rookh cave from direct interference by Atlas’ operations.
2. Preservation of all caves identified herein as viable Ghost bat roosts, with the exception of caves CMRC-01 and -02, with emphasis placed on the two Category 2 caves (CMRC-06 and -15), and any caves in close proximity to pits.
  - The two category 2 caves (CMRC-06 and -15) together with the groups of caves, shelters and overhangs nearby (CMRC-04, -08, -10, -12, -13, and -14) are recommended for protection by suitable exclusion zones as they make up groupings that are important for the species’ persistence in the area (TSSC 2016a, Bat Call 2017b).
  - The remaining 2 groups (caves CMRC-03, -07, -16, -17, -18, and -19) are also recommended for protection by suitable exclusion zones as the usage by Ghost bats may be more extensive than the single season of monitoring has recorded.
3. Restricting entry of personnel from all category 2 and 3 caves identified herein with the exception of survey activities. Periodic restricting of survey activities in accordance with a disruption protocol (Appendix B) that is aligned to the breeding cycle of the Ghost bat is recommended.
4. Ongoing monitoring of Ghost Bat activity at the category 2 caves in the project area to better understand bat movements and impacts. Timing of monitoring is recommended to be aligned to the project’s development, production and closure schedules.
5. Production blast planning at cave CMRC-15 should follow the recommendations contained in Blast-It (2020) for maximum in-ground vibration limits of 100 mm/s peak particle velocity (PPV) to protect the caves’ ability to remain viable as a category 2 roost (i.e. to ensure that the cave is

not destroyed, blocked or a new rear entrance opened) during future mining operations including drill and blast operations and ore removal operations.

6. During the mining operations, monitoring of the in-ground vibration levels and cave conditions should follow the recommendations contained in Blast-It (2020) and be undertaken with feed back to the blasting planning in an adaptive manner to ensure that the caves remain viable as diurnal roosts for the species.

**Table 3: Summary of recommendations based on Ghost bat usage as they apply to the caves included herein.**

Group	Caves (categories)	Recommended mitigation				Cave may be cleared based on PGb usage
		Avoid disturbing	Entry Protocol	Blast monitoring	PGb usage monitoring	
1	CMRC-03 (3) CMRC-07 (3)	Yes	Yes			
	CMRC-19 (4)	Yes				
2	CMRC-02 (4)					Yes
	CMRC-04 (4)	Yes				
	CMRC-06 (2)	Yes	Yes		Yes	
	CMRC-08 (3) CMRC-10 (3)	Yes	Yes			
	CMRC-12 (4)	Yes				
3	CMRC-01 (4)					Yes
	CMRC-13 (4) CMRC-14 (3)	Yes	Yes	Yes		
	CMRC-15 (2)	Yes	Yes	Yes	Yes	
4	CMRC-16 (4) CMRC-17 (4)	Yes				
	CMRC-18 (3)	Yes	Yes			

In consideration of the above findings and recommendations, it is anticipated that the proposed Miralga Creek Project will not have a significant impact on Ghost bats or Ghost bat caves.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'R Bullen', is centered on the page.

Robert Bullen  
Managing Director and Principal Ecologist

## References.

- Armstrong, K.N. and Anstee, S.D. (2000). The ghost bat in the Pilbara; 100 years on. *Australian Mammalogy* 22(2) 93 – 101.
- Atlas (2020a). Scanned footprints of caves CMRC-13, 14 and 15 relative to MIE Pit 2 boundaries dated January 2020.
- Atlas (2020b). Fauna habitat impact email from David Morley to [bullen2@bigpond.com](mailto:bullen2@bigpond.com) dated 19 March 2020.
- Atlas (2020c). Fauna habitat impact email from David Morley to [bullen2@bigpond.com](mailto:bullen2@bigpond.com) dated 20 March 2020.
- Bat Call (2017a). Atlas Iron Limited Abydos Project, Pilbara WA, July 2017. Echolocation Survey of Pilbara leaf-nosed bat and Ghost bat Activity. Unpublished report for Stantec Australia dated 5 August 2017.
- Bat Call (2017b). 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. Unpublished report for Rio Tinto dated 10 July 2017.
- Bat Call (2019a). Miralga Creek survey bat results; phase 1. Email report to Biologic dated 13 June 2019.
- Bat Call (2019b). Miralga Creek survey bat results; phase 2. Email report to Biologic dated 24 August 2019.
- Biologic (2016). West Angelas Iron Ore Mine – Deposit B and F Ghost bat monitoring 2015. Unpublished report prepared for Rio Tinto dated January 2016.
- Biologic (2019). Miralga Creek Project: Level 2 vertebrate and short-range endemic invertebrate fauna assessment. Unpublished report for Atlas Iron, rev 1 dated September 2019
- Blast-It (2020). Assessment of blasting at Miralga Creek project, preservation of Ghost bat habitats post mining activities. Unpublished report for Atlas Iron dated 5 March 2020.
- Bullen, R.D. and Creese, S. (2014). A note on the impact on Pilbara leaf-nosed and ghost bat activity from cave sound and vibration levels during drilling operations. *The Western Australian Naturalist*, **29**:145-154.
- Churchill, S. (2008). Australian bats, second edition. Allen and Unwin, Australia.

- Diete, R.L., Dixon, K.M. and Barden, P.A., (2016). Predation of pitfall-trapped rodents by the ghost bat, *Macroderma gigas*. *Australian Mammalogy*, 38(2), pp.249-252.
- Dunning, J.B. Jr, Groom, M.J. and Pulliam, R. (2018). Species and landscape approaches to conservation. (Chapter 12 in M.J. Groom, G.K. Meffe and C.R. Carroll; *Principles of conservation biology*, third edition. Sinauer Associates, USA, pp 419 – 465).
- Hamersley Iron (1999). Nammuldi/Silvergrass Exploration Project. Biological Survey Report November 1998 - May 1999. Hamersley Iron Pty. Ltd.
- McKenzie N.L. and Bullen R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum Supplement* **78**: 123-155.
- Ottwell, K, McArthur, S., Van Leeuwen, S. and Byrne, M. (2018). Cave use by Ghost Bat (*Macroderma gigas*) at the West Angelas mine site. WA Department of Biodiversity and Attractions report dated January 2018.
- PSM (2020). Miralga Creek – Assessment of potential mining activities impact on the structural integrity of the caves. Pells Sullivan Meynick unpublished report PSM3754-037L Draft dated 8 January 2020.
- Talis (2019). Miralga Creek project, environmental noise and vibration impact assessment. Talis Consultants P/L unpublished report TN19027-1 dated September 2019.
- Threatened Species Scientific Committee (2016a). Conservation advice, *Macroderma gigas*, Ghost bat. Australian Government Department of Environment, dated 5 May 2016.
- Threatened Species Scientific Committee (2016b). Conservation advice, *Rhinonicteris aurantia* (Pilbara form). Australian Government Department of Environment, dated 10 March 2016.
- Tidemann, C.R., Priddel, D.M., Nelson, J.E. and Pettigrew, J.D. (1985). Foraging behaviour of the Australian ghost bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). *Australian Journal of Zoology*, 33(5), pp.705-713.
- Woinarski, J.C., Burbidge, A.A. and Harrison, P.L. (2014). The action plan for Australian mammals, 2012. CSIRO Publishing: Collingwood, Australia.



## Appendix A: Cave Habitat Classifications

Each cave identified during the survey has been categorised according to the following definitions based on Ghost bat (Ghost bats) usage:

### *Category 1 diurnal roost caves with permanent Ghost bat occupancy.*

There are a number of documented permanent roost caves and underground mines in northern Australia, e.g. Tunnel Creek in the Kimberley and Kohinoor adit in the NT. These tend to have large but variable populations, e.g. Kohinoor's colony has grown from 300+ in 1981 to ~1,500 in 1990 and then reduced to 550 in 2013 (Woinarski *et al.* 2014). In the Pilbara, other than a number of historical underground mines e.g. Comet, Klondyke Queen, Lalla Rookh and Bamboo Creek which do have large populations of over 100 Ghost bats, very few such roosts in natural caves are documented. Those natural caves that may be permanently occupied have been observed with variable populations present. One example is a significant cave with a complex surrounding gully in the Robe Valley south-west of Pannawonica that has had Ghost bats present on most, if not all, survey visits. The colony size at this cave has varied from a few to over 70 recorded in April 2017 (Bat Call 2017b). Where permanent presence at category 1 sites is proven, they must all be assumed to be maternity caves and are critical habitat for the species.

### *Category 2 diurnal roost caves with regular occupancy.*

There are a number of Pilbara caves and adits where Ghost bats have regular, but not continuous, presence over long periods. These tend to be deep caves with ceiling heights in rear chambers of at least 1.5 m allowing multiple roosting opportunities for Ghost bats out of reach of predators. The longest continuous monitoring programs have been at Rio Tinto's West Angelas project and at BHP's Mining Area C and South Flank projects. At all three locations there are a number of caves with roosting Ghost bats records but none of these have had either permanent presence or consistently high numbers present. Numbers have varied between zero and five with very occasional counts of 20 or more (author's unpublished data). Based on recent monitoring of caves using ultrasonic call detectors, these caves have Ghost bats present for 25 to 75% of nights for mid to long periods but then may be abandoned for periods. There is insufficient data at present to see if there are any seasonal trends in these occupancy rates. These caves typically have a number of other caves, shelters and overhangs within a few hundred meters. Together they make up an "apartment block" grouping (TSSC 2016, Bat Call 2017b) that supports the ongoing presence of the bats.

Recent analysis at West Angelas based on genetic sampling at five monitored caves in 2015 and 2017 (Ottwell *et al.* 2018) suggests that some Ghost bats tend to use particular caves regularly over a season

or year, but others move between caves in the same period. Their analysis identifies 34 unique individuals at caves over those two years and indicated that the “genetic effective population size” was twelve. Two of the five caves have been shown by the long-term observations to have regular occupancy (Biologic 2016). In all surveys undertaken, Ghost bats have been either roosting in low numbers or there was evidence of recent roosting at the former and, with the exception of one survey, at the latter. The genetic analysis also supports this conclusion with presence of multiple bats over the two years of that study at these caves. Similar occupancy patterns have been recorded at several caves at the BHP projects. There are an increasing number of observations becoming available of pregnant Ghost bats or Ghost bats carrying pups at some of these caves, plus others (e.g. Silvergrass East cave SG-1, Hamersley Iron 1999) although again there is insufficient data to identify any trends other than to say that any cave that has regular occupancy must be assumed to be capable of supporting one or more reproducing females and their offspring. These caves are critical habitat for the species. There are two caves at Miralga Creek that fall into this category.

*Category 3 roost caves with occasional occupancy.*

There are a large number of caves and adits where Ghost bats roost occasionally or rarely in small numbers of one to a few. Surveys in recent years have identified numerous caves that have Ghost bats scats or small food middens present but either no evidence of roosting bats or with rarely repeated presence observations, e.g. five of the seven monitored caves at West Angelas (Biologic 2016) show such a pattern with occasional Ghost bats present and/or intermittent evidence of recent occupancy. Reproducing females have been reported from at least two caves at West Angelas that ongoing observations indicate fall into this category, but no firm evidence exists that such caves are necessary for successful reproduction. These caves are important habitat for the long-term preservation of the species in the area.

*Category 4 nocturnal roost caves, opportunistic usage.*

Numerous observations suggest that the majority of caves and adits in the Pilbara are used in at least an opportunistic manner by itinerant Ghost bats. This may be anything from a single foraging visit to a longer visit with a resting period or possibly a feeding session. Evidence of such visits is the widespread presence of small numbers of scats found or occasional echolocation calls recorded during surveys. These visits may or may not be repeated depending whether the bat is passing through a district or is a more permanent resident nearby. These caves are not important habitat for the long-term preservation of the species in the area.

## **Appendix B: Recommended Cave Disruption Protocol.**

A conservative protocol is recommended to protect the reproducing females and their young during the most important part of their reproductive cycle. This covers the periods when:

- Gravid females are subject to premature birth due to either capture and handling or repeated flushing the bats from their diurnal roost caves.
- Females carrying newborns are subject to dropping them due to capture or disturbance.
- Non volant young in nurseries are subject to abandonment due to repeated disturbance of the mothers
- Newly volant young during the early adolescent period are subject to premature abandonment due to repeated disturbance of the mothers and/or young.

For Ghost bat category 1 (see Appendix A for definitions), category 2, and category 3 roost caves that are part of an important cave grouping, it is recommended that restrictions tighter than Governmental licencing limitations be enforced:

1. Successful survey sessions, i.e. when Ghost bats are captured or are present and disturbed, be limited to once per cave during August, September and January,
2. Multiple survey entries per cave are allowed in August, September and January. The surveys should be done by one ecologist working quietly to minimise stressing the bats present and hopefully not flushing them. If a Ghost bat(s) is disturbed and flushed, the caves and their entrance areas be vacated allow the bat(s) to return and settle. Restrictions per 1. above then apply.
3. No cave entries should be carried out from October to December inclusive. Damage assessments during blasting operations should be carried out from the entrance.
4. Survey entries in accordance with Governmental licencing limitations be allowed outside these periods.

For Ghost bat category 3 caves that are isolated and not part of an important grouping, and category 4 caves, it is recommended that normal survey activity in accordance with Governmental licencing limitations be allowed year-round including entries as appropriate.