Northern Resource
CONSULTANTS

# Spring Hill

## Significant Impact Assessment

**February2018**

prepared for

PC Gold

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# Contents

# Assessment of significant impact

An assessment of threatened species and ecological communities at Spring Hill was incorporated into the 'Flora and Fauna Technical Report' included as Appendix C to the EPBC referral.

The Matters of National Environmental Significance – Significant Impact Guidelines 1.1 (the Guidelines) also include 'significant impact criteria'. The 'significant impact criteria', set out for each matter of national environmental significance, are intended to assist in determining whether the impacts a proposed action on any matter of national environmental significance are likely to be significant impacts.

The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. Different criteria are applied depending on the species, or conservation status. For a species listed as 'vulnerable' under the EPBC, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

Of the 21 EPBC-listed fauna species predicted to occur on site, only two were recorded – the Partridge Pigeon and the Ghost Bat. Comments / responses are provided in relation to each of these significant impact criteria below.

## 1. Partridge Pigeon (Vulnerable)

Spring Hill does not have an 'important population' of Partridge Pigeons as defined under the EPBC Significant Impact Guidelines (DoE 2013). Spring Hill is not near the limit of the species range. Habitat is contiguous with other nearby areas with known populations, so it is unlikely that population is genetically important for maintaining the genetic diversity of the species. With an estimated NT population of 1500 individual and the numerous known locations for this species in the broader Pine Creek region, the 30 birds observed at the southern dam do not represent a key source population either for breeding or dispersal.

The proposed action will not impact on the most critical habitat for this species, which is a dam located approximately 800m southwest of the project area. As Partridge Pigeons require daily access to water, the dam is likely to be the centre focus of their distribution in the Spring Hill area. Although a flock of 30 individuals were observed at the dam, no individuals were detected during targeted surveys of the proposed footprint area or surrounding ridge top habitats and it is likely that they primarily utilise foraging habitat close to the dam. The most likely potential negative impact is through haul road traffic on the in the lower terrain. This will be managed with the following mitigation strategies outlined in the MMP:

- Enforce speed limits on site access roads and the haul road.
- Ensure roadside vegetation is cut back and maintained to increase visibility.
- Require an incident report to be completed for all interactions.
- Restrict driving to mine management roads unless otherwise authorised.

By adopting these recommended management and mitigation strategies should reduce the likelihood of a significant impact to 'Low'.

## 2. Ghost Bat (Vulnerable)

The Spring Hill population of Ghost Bats should be considered to be an 'important population' as defined under the EPBC Significant Impact Guidelines.

**Important Population**: Spring Hill is not near the limit of the species range. Although there are numerous records from the Pine Creek region (Atlas of Living Australia), it is known that Ghost Bat populations are highly structured, show little movement between geographically separated sites, and are known to be genetically distinct at both regional and local scales (Worthington Wilmer et al. 1994, TSSC 2016). It is therefore possible that the population at Spring Hill is genetically important for maintaining the genetic diversity of the species, however, no genetic testing has been undertaken.

The Spring Hill ghost bat population is likely to represent a key source population either for breeding or dispersal of the species. Advice from the Sally Strohmayr (NT Department of Environment and Natural Resources) is that the Spring Hill roosting population may be the fourth largest currently known population in the Northern Territory. Populations in Kakadu National Park are believed to have declined by over 90% since the arrival of cane toads in

2001, having declined from approximately 1010-1100 individuals to an estimated 100 individuals (TSSC 2016). Additionally, one of the other important populations in the Pine Creek area are roosting in an adit that is in danger of collapse (TSSC 2016). With a recent count of 103 individuals, the Spring Hill population therefore is a regionally important population that has persisted while other important populations have completely disappeared. This is particularly the case if stope 13 at Spring Hill is a maternal roost, as the loss of such sites has the potential to reduce the area of occupancy and population size significantly (TSSC 2016). Subpopulations are unlikely to be recolonised if a local extinction occurs (Qld DEHP 2015).

**Monitoring**: It is proposed that prior to any further disturbance of mining activities on the site, that we will undertake non-intrusive monitoring of bats on the site using acoustic and night vision video techniques that will commence once the Mine Management Plan (MMP) is accepted, and will continue for two years post-mining (see attached Monitoring Plan Appendix A). The purpose of the monitoring programme will be to provide baseline data for developing and monitoring appropriate disturbance thresholds and responses to ensure that no significant disturbance of the Ghost Bats occurs. The monitoring programme will be divided into four distinct phases, each with separate aims and objectives as shown in Table 1 below:

Table 1 Objectives and details of different monitoring phases

| MONITORING PHASE | OBJECTIVES AND DETAILS |
|---|---|
| Pre-mining phase | - establish baseline levels and variation of noise, vibration and bat activity<br>- determine utilisation of different stopes, including species composition and counts of Ghost Bats<br>- determine reproductive status of threatened bat species |
| early mining | - Monitor vibration and airblast at pre-determined blast events<br>- developing thresholds of vibration, airblast and bat responses<br>- Simultaneously monitor bat behaviour in response to blasts and adjust blast design and resulting vibration as necessary<br>- A maximum of two blasts per day for the first five days until threshold levels of vibration disturbance is reliably established. |
| operational | - confirm that the airblast and ground vibration levels, and bat behavioural responses do not exceed the criteria specified.<br>- develop and implement appropriate and adequate responses that delivers a desired outcome<br>- monitoring effectiveness of management treatment |

| MONITORING PHASE | OBJECTIVES AND DETAILS |
|---|---|
| Post mining | - monitoring the composition, function and changes to bat populations over time after cessation of mining<br>- record important autecological information relating to cave dwelling bats at Spring Hill, including populations studies, breeding times, roosting and foraging behaviour<br>- assessing the importance of the Spring Hill threatened bat populations and its relationship with other populations using genetic studies |

Without mitigation, it is possible that the proposed action will have a significant impact of MNES, particularly the threatened Ghost Bat. However, the application of these mitigation measures outlined in Section 5 and Appendix A of this referral will ensure that these impacts can either be avoided or reduced to an acceptable level, and that the associated monitoring component of the project (see attached Monitoring Plan Appendix A) will facilitate and enhance the protection, knowledge and management of the species in the future. Therefore, it is not expected that the proposed action will have a significant impact on any MNES.

## 2.1 Significant Impact Criteria:

To determine the potential significance of any impact of the proposed action, and to calculate residual impacts following implementation of mitigation measures, it is necessary to address the 'significant impact criteria' set out under Matters of National Environmental Significance – Significant Impact Guidelines 1.1 (DoE 2013). These criteria are intended to assist in determining whether the impacts of a proposed action on a nationally threatened species are likely to be significant impacts.

Potential impacts on Ghost Bats at Spring Hill are assessed on the basis that it is an important population, and assessed against the EPBC guidelines for a vulnerable species. Comments and responses are provided in relation to each of the significant impact criteria below.

### Lead to a long-term decrease in the size of an important population of a species

The important population of Ghost Bats at Spring Hill is dependent on disused mine stopes, particularly stopes that had horizontal workings or microhabitat features that provide the completely dark roost area required by Ghost Bats. Deep stopes can provide stable temperatures and help maintain humidity levels, both of which are important criteria (Churchill 2008; TSSC 2016). Of the stopes visually assessed during the field survey program at Spring Hill, three were determined to have low habitat potential, six had moderate habitat potential and ten contained at least one bat species. Ghost Bats were confirmed in three stopes: #13, #62 and #30, noting that #62 is only one entrance from a larger stope, with stopes #57 and #58 representing alternative entrances to the same stope. Other stopes may also provide important roost sites but had been disturbed by vandalism immediately prior to the bat survey. In the interim period, all stopes are regarded as being potential roost sites. The stopes are old and

potentially dangerous, so none of the stopes have been explored. The depth and habitat complexity of some of the stopes can be inferred by the species of bat that occupy them, as per the microhabitat selection diagram provided by Churchill (2008).

Ghost bats are sensitive to disturbance and may abandon sites where disturbance occurs. Minor disturbances may include approaching people and vehicles, resulting in bats relocating to alternative roosts (TSSC 2016). During the breeding season, young may be dislodged by adults in rapid take-offs and may not return to the roost site (Woinarski *et al*., 2014). This may result in, and constitute a long-term decrease in the size of an important population of a species.

It is not expected that a long-term decrease in this important population is likely to occur as a result of the action. Mitigation strategies developed to avoid this outcome are avoidance of known occupation sites and provision of buffers from mining activities. Areas where mine stopes exist have been removed from the proposed mining footprint, and a minimum buffer distance of 85 m established from the nearest pits, and a buffer of 140m from the most active stope (Figure 1). The proposed buffer zone is based on a study by Armstrong (2010), who reported on a study of the short-term effect of exploration drilling on a Ghost bat colony in Western Australia. The study did not identify any correlations between the drilling program and roost occupancy or colony size for Ghost bats. Armstrong (2010) identified that significant impacts were unlikely for short-term disturbance from drilling further than 25m from a roost entrance and 85m from the roost location within the mine. Impacts from other mining activities such as blasting, excavation and construction of an open pit mine may also impact Ghost Bats. Ghost Bats have been recorded persisting in the vicinity of iron ore mines in the Pilbara region (Biologic 2014), including at Cattle Gorge mine where Ghost Bats persist in caves within 2km of an open cut mine and are presumed to overfly the mine.

There are very few available studies on noise and vibration tolerances from Ghost Bats. Studies by Bullen and Creese (2014) have shown that noise levels up to 70dB are unlikely to result in Ghost Bats leaving their roost. This noise level if equivalent to that of a vacuum cleaner and is almost certainly an underestimate of noise tolerance, considering that Ghost Bats have persisted in stopes at Spring Hill despite the obvious noise and vibration levels of previous disturbance removing old mullock heaps from adjacent to stope entrances. However, a maximum noise threshold of 70dB at mine stope entrances will be adopted for this project.

Biologic (2016) assessed the potential for mining to impact on Ghost Bats at a site approximately 100km north west of Newman in the Pilbara region. Quoting bat call specialist Robert Bullen, they suggested that Ghost Bats would tolerate vibrations of up to 15mm/sec, however, they acknowledged that no specific research had been undertaken to support this. In direct discussion with Robert Bullen, he advised that considerable work on determining blast vibration thresholds for Ghost Bats was ongoing. Recent unpublished studies including undertaking a series of blasts at incrementally smaller distances towards Ghost Bat roosts. That research identified a vibration level of 15mm/sec was where Ghost Bats exhibited signs of disturbance, and that a threshold of 10mm/sec was being adopted as the acceptable limit. In managing Orange Leaf-nosed Bats at the Koodaideri bat colony, Rio Tinto also uses a limit of 10mm/sec as their acceptable threshold (Bullen 2013), and this species has a similar tolerance level to Ghost Bats (R. Bullen pers. comm.).

However, it is proposed that vibration levels be increased in small increments from 2mm/sec until a threshold of acceptable disturbance can be objectively identified. The previous highest

vibration that did not cause disturbance to the bats will have a buffer applied and be set as the maximum allowable threshold against which all subsequent blast events must not exceed. If it is determined during the early mining monitoring phase that an unacceptable negative reaction from the bats is occurring at a level below the nominated threshold of 10mm/sec, then the new buffered threshold will be established and maintained (see attached Monitoring Plan Appendix A to the referral).

The vibration threshold can be adhered to through specialised blast designs (Boucher 2017). Initial predictions have provided guidelines for the bench height, quantity of explosive and buffer distance to achieve compliance with the anticipated vibration thresholds (see blast vibration prediction report, Boucher 2017 in Appendix D), however, on-site testing will be required during the early mining monitoring phase to test predicted rock vibration attenuation characteristics and predicted vibration levels as current confidence levels in those parameters are low (Boucher 2017). Restrictions and conditions limiting dust, noise and vibration will be implemented via the 'dust, noise and vibration management plan' provided in Appendix F of this referral and incorporated into the MMP.

Impacts to Ghost Bats will be reduced by timing and sequencing of actions. Pit development will be sequenced to minimise disturbance to the roost habitat areas, so any disturbance associated with pit development will be coming from only a single direction. Activities will be timed in consideration of daily activity cycles (as determined from a monitoring programme) to minimise disturbance (e.g. when roosts are unoccupied). Although mining in the first year will continue until October, mine development activities with high-risk impacts (e.g. blasting) that generate noise and vibration will be timed to occur primarily before July, with the only blasting to be carried out between July and October 2018 limited to deep within the Hong Kong 1 Pit, which is separated from the bat exclusion zone by a valley with low potential for transmission of vibration. Limitations on times of blasting are cognisant of the July-February period when Ghost Bats have dependant young.

The potential to reopen collapsed stopes to allow recolonization by Ghost Bats (see 'Offsets' in Section 5 below) may actually lead to a long-term increase in the size of this population.

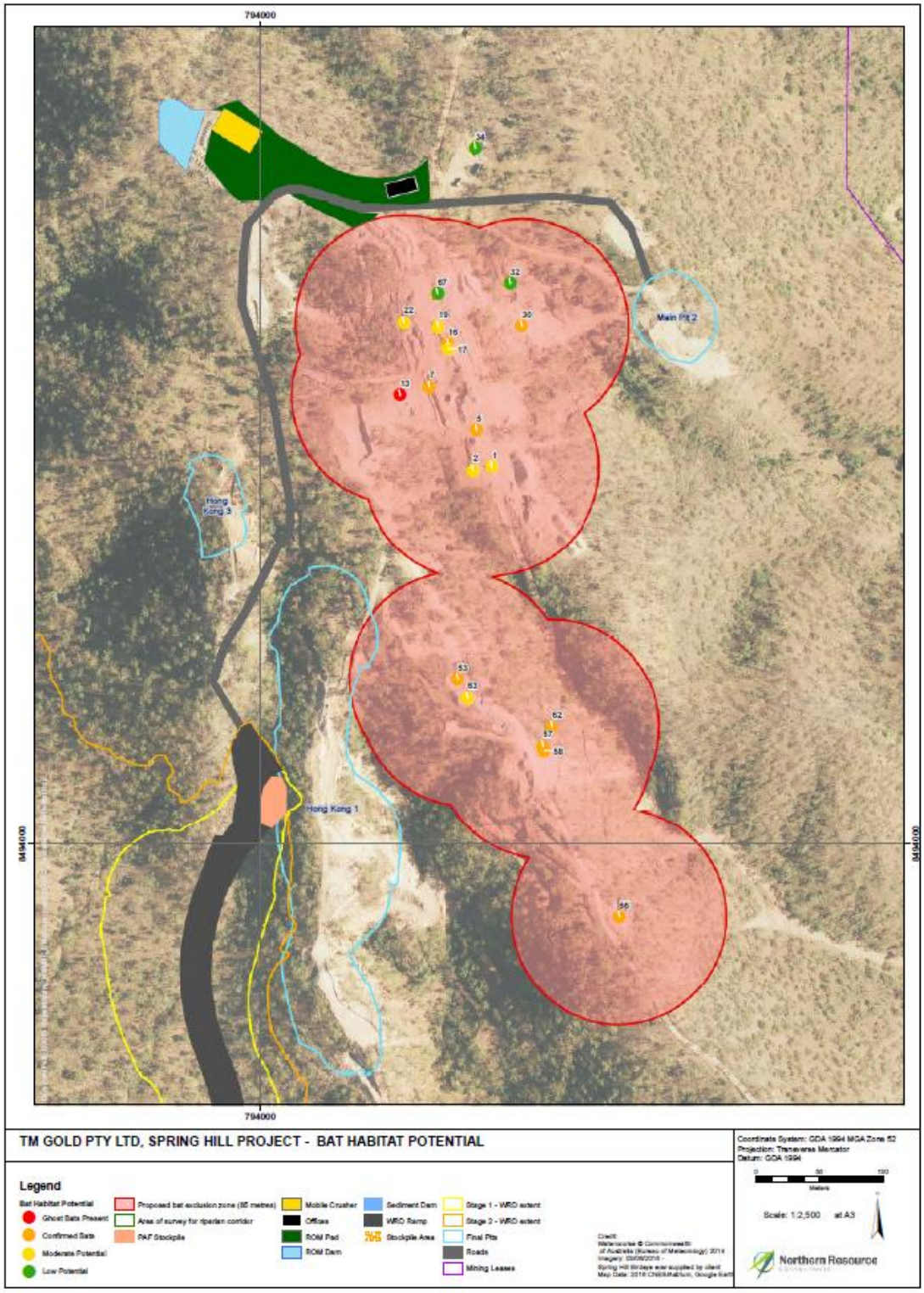


Figure 1: Bat exclusion zone in relation to bat habitat and proposed mine infrastructure

## Reduce the area of occupancy of an important population

The Spring Hill Ghost bat population has been determined to be an important population, and populations in the Pine Creek region are potentially genetically distinct from the Kakadu population as Ghost Bats are often genetically distinct at both a local and regional scale (TSSC 2016). A high degree of philopatry (remaining in, or returning to, an individual's birthplace) has been recorded in this species and this likely emphasises regionalism between populations. As a result, loss of sites containing breeding females has the potential to reduce the area of occupancy and population size of this species dramatically (TSSC 2016).

he key threat to the ghost bat is habitat loss and degradation due to mining activities. Habitat loss through the destruction or degradation of roosting habitat at Spring Hill through mining activities may result in the reduction of occupancy of this important population. Mitigation measures will be required to prevent the destruction or abandonment of roost sites and are outlined in the referral.

he estimated project footprint of 17ha does not include any areas with stopes that may provide roosting habitat for Ghost Bats. A minimum buffer distance of 85 m established from the nearest pits, and a buffer of 140m from the most active stope. Blasting and excavation activities will be minimised to limit noise and vibration to thresholds that will be determined during the early mining phase to limit disturbance to cave dwelling bats.
Following mine closure and rehabilitation, it is anticipated that ghost bat occupancy may increase if the offset measures proposed in the referral are undertaken.

## Fragment an existing important population into two or more populations

It is not known if the Spring Hill populations interacts with other known populations in the Pine Creek region, though considering their relatively small home ranges (61ha) and strong tendency to remain close to their birthplace, it may be concluded that such interactions may be uncommon. The proposed action does not sever connectivity between the known Spring Hill Ghost Bat roost sites and adjacent vegetation that is contiguous with extensive areas or remnant vegetation and locations of other known Ghost Bat sightings (Atlas of Living Australia). Adjacent areas of vegetation have broader strong connectivity to other large remnant patches, both through strips of woodland and along riparian corridors, and the area of available habitat with connectivity to the proposed impact area is extensive. There is no severance of remnant vegetation between Spring Hill and the largest population at Kohinoor Adit near Pine Creek or any other previously recorded Ghost Bat populations in the area.

## Adversely affect habitat critical to the survival of a species

The Spring Hill population likely represents one of the more stable Ghost bat metapopulations in the Northern Territory. The sustainability of this metapopulation could be critical for the long-term survival of the species. No maps available that show habitat critical to the survival of the Ghost Bat. Foraging habitat has a mean size of mean size of foraging areas was 61 ha and

tagged bats generally returned to the same areas each night. (TSSC 2016). Most of the proposed disturbance area is highly disturbed by vehicle tracks, clearing and vegetation thinning, so it is likely that the primary foraging areas are outside the proposed mine footprint. Some areas of foraging habitat will be removed to incorporate mine infrastructure, the largest of which will be the waste rock dump that covers 11.63ha (Figure 1). This area will be revegetated post-mining as per the Revegetation Management Plan included in Appendix G of this referral and included in the MMP. However, important foraging areas will remain undisturbed immediately adjacent to the occupied mining stopes. Ideal foraging habitat consists of areas within 5km of diurnal roost sites that is a gully or gorge system that opens onto a plain or riparian line (TSSC 2016). Considering the very high frequency of fires in the open woodland areas, the best habitat that meets that description within a 5km radius of the site are the drainage lines and associated riparian vegetation running westerly from the project area to a broader open plain, which are outside the proposed mine footprint. Ecological assessments of this area in October 2016 (see 'Flora and Fauna Technical Report in Appendix C of the referral) identified a broad diversity of potential vertebrate prey items in the area including 42 bird species, 4 mammal species, 10 bat species, 13 reptile species and 5 amphibian species within the study area. Several bat species known to be prey items for Ghost Bats were identified in the mine stopes, so important foraging areas may be the areas immediately around the mine stopes themselves. Areas to the north and east of the proposed action will remain as foraging habitat. It is likely that the mine pits will not act as a barrier to Ghost Bat movement as evidence from the Pilbara suggests that it is likely that Ghost Bats overfly active mine sites (Biologic 2014, 2016). The proposed 17ha footprint of the mine occupies only 0.2165% of the 5km radius area surrounding the roost sites, while the 39.4ha area nominated as the project boundary in this referral occupies only 0.5017% of the 5km radius area. Aerial photo interpretation identifies that 9.76ha (24.77%) of the area covered by this referral is in a cleared or highly degraded state (Figure 2).

In this broader area of remnant woodland vegetation, areas of suitable roosting habitat are likely to be significantly constrained in comparison to foraging habitat and the mine stopes would represent habitat critical to the survival of this important population. The project design avoids impact to areas of suitable roosting habitat and provides necessary buffers to prevent damage or unnecessary disturbance. The monitoring plan described in Section 5 and provided in Appendix A describes how bats will be carefully monitored for response to incrementally increased noise and vibration levels until a conservation threshold can be established that avoids bats being unduly disturbed and abandoning the mine stopes. These mitigation measures will ensure that the critical roosting habitat at Spring Hill will not be adversely impacted by the proposed action.

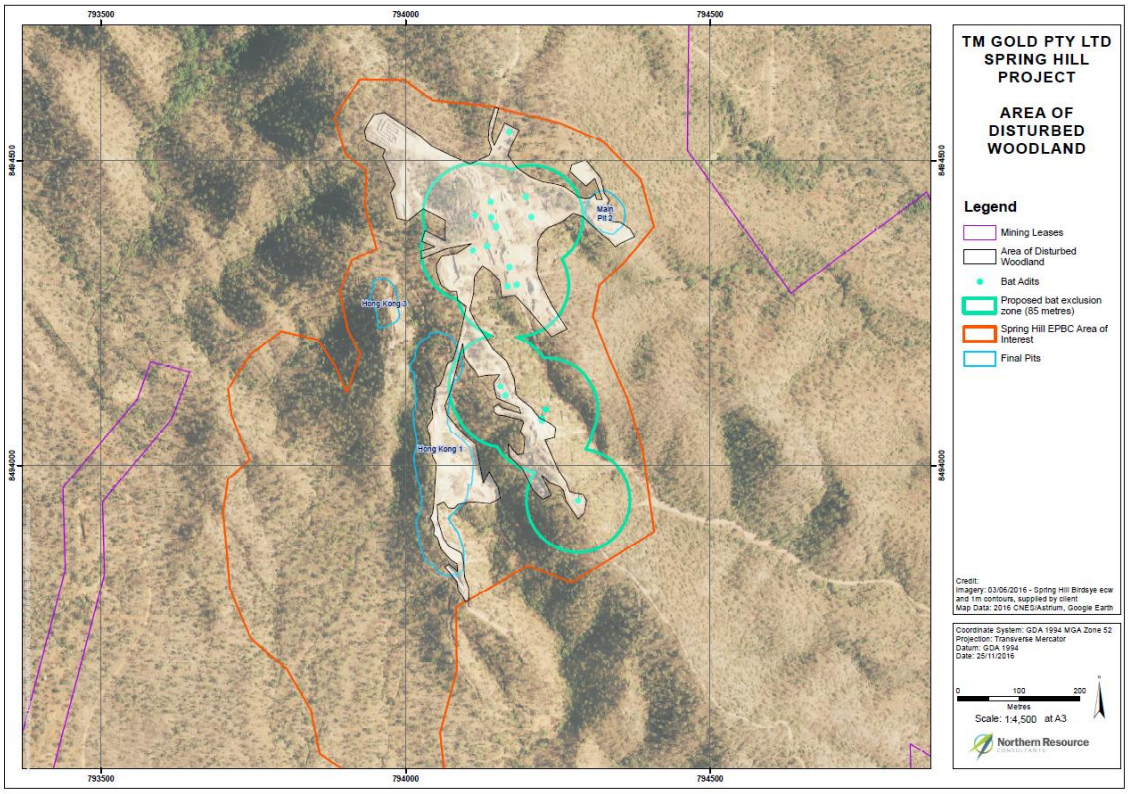


Figure 2: Location of highly degraded areas within the referral area

## Disrupt the breeding cycle of an important population.

As previously mentioned, the Spring Hill Ghost Bat population is an important population, however, the status of the site as a maternal breeding place has not been established. Disruption to the breeding cycle could occur if significant disturbance of a breeding site resulted in the loss of pups and/or abandonment of roost sites (TSSC 2016).

Breeding times are known to vary across their geographic range. A general mating time of April-May is given by Churchill (2008), while Queensland populations are known to mate in July-August (Curtis *et al* 2012). Ghost bats disperse widely when not breeding, but are known to concentrate in important roost sites when breeding (TSSC 2016). Females are known to give birth in late October to early November in both Rockhampton (Hoyle *et al* 2001); and in the Pilbara region (WA) (Churchill 2008), however, Ghost Bats at Pine Creek are noted giving birth in late July-early August (Pettigrew *et al*. 1986). Young are carried by the mother for the first four weeks, capable of flight after 7 weeks, flying with their mothers by the end of January, fully grown by mid-February and weaned during March (Hoyle *et al* 2001).

Due to the discrepancy in the published dates for Ghost Bats giving birth, this action will take the precautionary principle until on-site research and monitoring can provide more detailed dates for breeding. The proposed action will be timed to avoid where possible potentially high-disturbance activities such as land clearing or initial mine development during the period of July-

late February when there is the potential for dependant young to occur in the adits. The use of acoustic and visual surveys using night vision video cameras as described in the Monitoring Plan will provide precise information on the life cycle and breeding status of the Ghost Bats at important periods during the annual cycle and will be used to better inform the mining operations. If monitoring identifies that births have occurred earlier than predicted, then blasting operations will cease.

### Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

There will be permanent changes to the landscape following mining, including the residual voids of the mine pits totalling 3.3ha, and a waste rock dump (WRD) 11.63ha in size. The WRD will be revegetated post mining, incorporating a stable design, contoured bench slopes, rock-lined drains, topsoiled and revegetated surface and placement of fallen timber stockpiled following clearing. Revegetation monitoring will ensure that the site has nutrient cycling and vegetation indices equal to or above those of the control transect within the analogue site. Consequently, it is anticipated that the revegetated WRD will provide habitat for a range of fauna species and provide suitable foraging habitat for Ghost Bats. Revegetation and rehabilitation of the site is described in the 'Revegetation Management Plan' included as Appendix G of this referral.

As previously mentioned in Section 4 above, the proposed action is limited to a footprint of approximately 17ha, which occupies only 0.2165% of the 5km radius area surrounding the roost sites, suggested by the TSSC (2016) as the area of ideal foraging habitat. Within the 39.4ha area nominated as the project boundary in this referral, aerial photo interpretation identifies that 9.76ha (24.77%) of the area covered by this referral is in a cleared or highly degraded state. The mapped historic fire record indicates there have been fires at Spring Hill in 10 out of the last 10 years, and this unnatural fire regime is having ongoing impacts on flora and fauna in the region, which is discussed further in the Flora and Fauna Technical Report provided in Appendix C.

The areas of disturbance are a very small proportion of the area within the 5km radius considered to be the area of ideal foraging habitat. Ghost Bats have a mean foraging area size of 61ha (TSSC 2016) and there are areas of undisturbed contiguous foraging habitat in excess of 7,800ha within 5km of the bat exclusion zone at Spring Hill.

Therefore, it is unlikely that the proposed action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the Ghost Bat population at Spring Hill is likely to decline.

### Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A 'Pest and Weed Management Plan' is included as Appendix H to this referral. The stated objective of this plan is "to ensure there is no increase in the abundance or distribution of pest flora or fauna species because of the Spring Hill project"

The weeds present on site include *Mesosphaerum suaveolens* (Hyptis), *Cenchrus polystachios* (Perennial Mission Grass), *Melinis repens* (Red Natal Grass) and *Passiflora foetida* (Stinking Passion Fruit) (LES 2013, NRC 2017). Of these, Perennial Mission Grass represents the greatest threat to biodiversity and site management, and is listed by the Commonwealth Department of Environment and Energy as a key threatening process. Under the Northern Territory's Weeds Management Act 2001, it is a declared Class B/C weed, which requires landholders to control its growth and prevent spread. Perennial Mission Grass was identified as a key factor in the failure of post-mining revegetation at Nabarlek Mine in the Northern Territory, due the very high biomass limiting native tree recruitment and contributing to high fuel loads that allowed destructive uncontrolled fires to cause significant damage to revegetation plots (Bayliss *et al*. 2016). Other introduced grasses such as Gamba Grass are not present on site, but their introduction would pose a significant threat to revegetation success and long-term sustainability of woodland habitats that support the Ghost Bats and other cave-dwelling bat species at Spring Hill.

Implementation of the 'Pest and Weed Management Plan' outlined in Appendix H and adopting the control measures outlined in Section 5 below, including enforced weed hygiene measures, routine weed inspections, and the monitoring and management of revegetation sites to prevent sites becoming dominated by high biomass introduced grasses. A policy of early detection and eradication of all new weed species not currently occurring on site will be implemented. For example, Spring Hill is within the Zone B Declaration zone for Gamba Grass which requires Gamba grass to be controlled, however, due to its absence at this particular site, a policy of eradication will be adopted. These items will be incorporated as components of the Planning and Construction Environmental Management Plan (EMP) for Spring Hill.

Cane Toads have been strongly implicated in the decline of Ghost Bats at Riversleigh and Boodjamulla National Park (QLD) and from other sites in the Northern Territory since their arrival in 2001, with declines of over 90% recorded from sites in Kakadu, including the loss of major breeding sites (TSSC 2016). It has been observed that remaining colonies are typically in areas remote from waterholes (TSSC 2016). Cane Toads are a significant threat to Ghost Bat colonies, and although Cane Toads have been recorded on site, an action that results in increased cane Toad abundance at a site could be considered a significant impact under this criteria.

Cane toads will be managed at Spring Hill by limiting potential breeding sites, and through regular monitoring and management. A 'Groundwater Technical Report' included as Appendix I of this referral shows none of the proposed pits will intersect with groundwater.

The following measures will be undertaken to avoid any increase in toad populations at the project site:

- allow sediment ponds to dry out during the dry season
- undertake routine toad inspection and control
- remove sediment pond during rehabilitation
- Efforts will be made to back fill voids with waste rock where possible, thereby significantly reducing the potential of the voids as toad breeding areas.

Implementation of the Spring Hill 'Pest and Weed Management Plan' (Appendix H) will ensure that invasive species that are harmful to Ghost Bats will not become established.

## Introduce disease that may cause the species to decline

There are no diseases with the potential to be introduced to Ghost Bats as a result of the proposed action. The proposed action is unlikely to introduce either the Hendra or Australian Bat Lyssavirus (ABLV) diseases, since these are not thought to be carried by humans, soil or machinery, and ABLV has not been detected in Ghost Bats.

Whitenose Syndrome Fungus (WNS) (*Pseudogymnoascus destructans*) is decimating microbats in the USA and Canada and has also been recorded in China and Europe (Wildlife Health Australia 2017). Humans have been implicated in its spread, as the fungal spores can be carried into caves on boots, clothing and caving equipment by cavers, researchers or tourists (Wildlife Health Australia 2017). However, this disease is not considered a potential threat to Ghost Bats at Spring Hill because:

- it has not been identified in Australia
- it is a psychrophilic (cold-growing) fungus that thrives at cold temperatures below 15oC and ceases to grow above 20oC which are significantly lower temperatures than the relatively stable temperature of 27°−29°C preferred by Ghost Bats (Churchill 2008)
- WNS impacts hibernating insectivorous bats (the fungus requires low body temperature to grow on the skin), however, Ghost Bats are incapable of going into torpor (Leitner & Nelson 1967)

## Interfere substantially with the recovery of the species.

The Threatened Species Scientific Committee recommended that there should be a recovery plan for the Ghost Bat (TSSC 2016), however, only five threatened bat species are covered under a recovery plan made or adopted under the EPBC Act, and Ghost bats are not included, having only been included as a threatened species under the EPBC Act since 05 May 2016.

The proposed action is consistent with the recommendations of the TSSC which are listed and addressed under the following tables and addressed in greater detail in the referral.

Table 2: Primary Conservation Actions

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Protect roost sites from mining, human disturbance and collapse | Mine footprint revised to avoid impact to mine stopes<br>Buffer established between mine activities and mine stopes<br>Noise and vibration thresholds established through monitoring program<br>Site fenced to prevent unauthorised human disturbance to stopes |
| Replace the top strands of barbed wire in fences near roost sites with single-strand wire | Fencing will not use barbed wire and top strand will be easily visible and avoidable by Ghost Bats |

Table 3: Conservation and Management Actions

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Protect land with significant colonies | The ridge with mine stopes occupied by Ghost Bats and other cave-dwelling bats will be incorporated into the buffer zone |
| In barbed wire fences close to roost sites, replace the top strand with single-strand wire, and put a metal disc (around 10x10cm) between the top and second strands. | Fencing will not use barbed wire and top strand will be easily visible and avoidable by Ghost Bats |
| Protect roost sites and surrounding foraging areas from disturbance, including the loss of habitat quality due to changes to fire and grazing regimes. | Post mine landscape will include mine pits totalling 3.3ha, and a revegetated waste rock dump (WRD) 11.63ha in size<br>A ‘Pest and Weed Management Plan’ will be implemented to manage or prevent weeds that will alter fire regimes<br>The site is not proposed to be grazed |
| Where appropriate, modify roost site areas to reduce risks of collapse, and ensure mine-adits that are known roost sites for ghost bats are maintained following the cessation of mining activities. | mine stopes occupied by Ghost Bats and other cave-dwelling bats will be incorporated into the buffer zone<br>mine stopes that currently have collapsed entrances will be investigated for opening post-mining |
| Educate people not to disturb roost sites | All personnel, staff and contractors must participate in a site-specific induction that includes education on Ghost Bats and exclusion areas |

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Where there are known roosts in proximity to mining or other activities, ensure disturbance is minimised by undertaking environmental assessment, considering alternative locations for works and impact mitigation measures. | mine stopes occupied by Ghost Bats and other cave-dwelling bats will be incorporated into the buffer zone<br>vibration and noise will be maintained at levels lower than level at which bats are disturbed (see Monitoring Plan Appendix A)<br>no mining will occur at night or during the period where dependant young are present<br>Mitigation measures to avoid, reduce, manage or offset other mine related activities are described in Section 5 below |

Table 4: Survey and Monitoring Priorities

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Assess population size (and significance) of all known subpopulations. | Population size and significance of local population (via DNA) will be assessed in the Monitoring Plan (Appendix A) |
| Monitor populations at key sites and where impacts from mining are occurring or likely. | Extensive monitoring to occur before, during and for 2 years post-mining |
| Develop cost-effective monitoring protocols (e.g. thermal tracking software) at a set of standardised sites that contain most of the known population | Acoustic and visual survey methods have been identified and described in the Monitoring Plan |

Table 5: Information and research priorities

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Assess impacts of disturbance of breeding sites and identify appropriate buffer zones for specific activities around roost sites so mining and other activities do not lead to abandonment. | Objectives of the monitoring plan at commencement of mining is to:<br>Monitor vibration and airblast at pre-determined blast events<br>developing thresholds of vibration, airblast and bat responses<br>Simultaneously monitor bat behaviour in response to blasts and adjust blast design and resulting vibration as necessary |

| RELEVANT RECOMMENDED ACTION | COMPLIANCE |
|---|---|
| Assess options for establishment of new/artificial roost sites (as a last resort only), and mitigation options to reduce impacts of mining. Evaluate the success of such actions. | Offset options being considered include<br>potential to re-open several stopes that have collapsed entrances, particularly 'Main Adit' on south eastern side of the main ridge whose entrance collapsed in 2011 (See 'offset' in Section 5 below) |
| Assess proximity to roosts of foraging habitats used by lactating females compared to other adults. | Objectives of the monitoring plan during post-mining includes:<br>record important autecological information relating to cave dwelling bats at Spring Hill, including populations studies, breeding times, roosting and foraging behaviour |

The recommended mitigation measures listed in the Appendices to the referral, particularly Monitoring Plan (Appendix A), and blast vibration modelling report (Appendix D) will be adopted to minimise these impacts

# 3. Listed migratory species

## 3.1 Description

The desktop assessment identified 17 listed migratory species that have the potential to occur within 30km of the study area (See Flora and Fauna Technical Report in Appendix C). These are individually assessed below:

Table 6: Assessment of likely impacts on migratory species

| SPECIES | COMMON NAME | HABITAT | LIKELIHOOD OF IMPACT |
|---|---|---|---|
| *Pandion haliaetus* | Eastern Osprey | The Eastern Osprey is a large bird of prey commonly found along the north Australian coastline, particularly on rocky shorelines, islands and reefs. They often favour the mouths of large rivers, lagoons and lakes where they specialise in catching fish over clear, open water. They usually nest high in dead trees, tally rocky outcrops or artificial structures, usually within one kilometre of the sea | Low - Although this species has a moderate chance of occurring on site, primarily for fly-over purposes, the project site does not represent important foraging areas or roosting habitat. |
| *Charadrius leschenaultii* | Greater Sand Plover (V) | This species prefers sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks. They seldom occur at shallow freshwater wetlands (DoEE, 2016b). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site |

| SPECIES | COMMON NAME | HABITAT | LIKELIHOOD OF IMPACT |
|---|---|---|---|
| *Apus pacificus* | Fork-tailed Swift | The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (Higgins 1999). The species is almost exclusively aerial, and mostly occur over inland plains, over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They also occur over settled areas, including towns, urban areas and cities (Pizzey & Knight 2007). | Low - Although this species has a moderate chance of occurring on site, primarily for fly-over purposes, the project site does not represent important foraging areas or roosting habitat. |
| *Charadrius veredus* | Oriental Plover | Occurs on open plains; bare, rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare clay pans; margins of coastal marshes; grassy airfields, sports-fields and lawns (Pizzey and Knight, 2007). | Low - Although this species has a moderate chance of occurring on site, the project site does not represent important foraging areas or roosting habitat. |
| *Pluvialis squatarola* | Grey Plover | Occurs on mudflats, saltmarsh, tidal reefs and estuaries, and only rarely inland ((Pizzey & Knight 1997). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |
| *Cuculus optatus* | Oriental Cuckoo | Occurs in monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangrove islands (Pizzey and Knight, 2003). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |

| SPECIES | COMMON NAME | HABITAT | LIKELIHOOD OF IMPACT |
|---|---|---|---|
| *Glareola maldivarum* | Oriental Pratincole | Occurs on plains; shallow, wet and dry edges of open bare wetlands; tidal mudflats and beaches (Pizzey and Knight, 2003). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |
| *Hirundo rustica* | Barn Swallow | Occurs in open country, agricultural land especially near water, railyards, towns and overhead wires (Pizzey & Knight 1997). | Low – Although the proposed site is on the edge of the possible predicted distribution for the species (Atlas of Living Australia), the project site does not represent important foraging areas or roosting habitat. |
| *Cecropis daurica* | Red-rumped Swallow | Occurs in open country, on overhead wires, and in swamps, grasslands and the coast (Pizzey & Knight 2007). | Low - This species is unlikely to occur, so no impact considered likely. This species is an uncommon vagrant to Australia and suitable habitat does not occur on site |
| *Motacilla cinerea* | Grey Wagtail | Occurs near running water in disused quarries, sandy, rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2007). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |

| SPECIES | COMMON NAME | HABITAT | LIKELIHOOD OF IMPACT |
|---|---|---|---|
| *Motacilla flava* | Yellow Wagtail | The Yellow Wagtail is a rare summer migrant to Australia. Although regularly seen between Darwin and Broome, there is one record from south of Pine Creek (Atlas of Living Australia). They are known to utilise a range of habitats including but not limited to short grass and bare ground, swamp margins, sewage ponds, saltmarshes, and ploughed land (Pizzey & Knight 2007). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |
| *Rhipidura rufifrons* | Rufous Fantail | The Rufous Fantail is found throughout coastal eastern Australia and coastal islands (Pizzey & Knight 2007). It inhabits the understorey of rainforest, wetter eucalypt forest, thickly wooded gullies, monsoon forest, paperbarks, sub-inland and coastal scrubs, and vegetation along watercourses (Pizzey & Knight 2007). | Low – The proposed site is outside the predicted distribution for the species (Atlas of Living Australia), there are no nearby records, and vegetation on the site is considered too open and dry to be suitable. |
| *Calidris ferruginea* | Curlew Sandpiper | This species prefers intertidal mudflats in sheltered coastal areas but can also be found around non-tidal swamps, ephemeral and permanent lakes and lagoons. | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |

| SPECIES | COMMON NAME | HABITAT | LIKELIHOOD OF IMPACT |
|---|---|---|---|
| *Numenius madagascariensis* | Eastern Curlew | Habitats include intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays with sea grass beds (DoEE, 2016b). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site. |
| *Acrocephalus orientalis* | Oriental reed-warbler | Occurs in dense reeds, cumbungi, over and near water (Pizzey & Knight 2007). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site |
| *Crocodylus porosus* | Estuarine Crocodile | The Estuarine crocodile inhabits coastal rivers and swamps and extends inland along major drainage systems. It is also occasionally observed in the open ocean (Wilson & Swan 2010). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site |
| *Pristis pristis* | Largetooth Sawfish | Occurs primarily in the main channels of large rivers (DoEE, 2016b). | Low - This species is unlikely to occur, so no impact considered likely. Suitable habitat does not occur on site |

## 3.2 Nature and extent of likely impact

Of the 17 migratory species assessed above, three species were considered to have a moderate likelihood of occurring within the study area; however, the proposed project is considered to have a low likelihood of impact on all predicted migratory species as the site does not represent likely or important habitat for any of the species. The site is unlikely to support a population of any of the listed migratory species.

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