Independent expert advice on the likely impacts of the proposed

Cloudbreak Iron Ore Expansion Project

(EPBC 2010/5696)

on the EPBC Act listed endangered and migratory

Night Parrot (*Pezoporus occidentalis*)

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for

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Scope of consultancy

To provide expert independent advice on the likely impacts of the proposed Cloudbreak Mine Expansion on the EPBC Act Listed endangered and migratory Night Parrot.

The advice must take account of the following information sources:

- *The draft and final PER documents, which includes the proponent's Response to Public Submissions document, the annual Night Parrot survey reports (PER Appendix C) and proposed avoidance, mitigation and management measures; and*
- *Public submissions on the Night Parrot*

The advice may take account of the following information sources:

- *Journal papers, other available scientific information, information provided by other threatened species experts and any other information deemed relevant by the person preparing the advice.*

1) *<u>Suitable Habitat of the Night Parrot</u>*
   a) *Provide and assessment of the vegetation communities that the Night Parrot may utilise within the vicinity of the proposed sire e.g. for foraging, breeding, refuge, flythrough, roosting etc, including an analysis of uncertainties and assumptions;*
   b) *Provide and assessment of the relative importance of each vegetation community identified in 1a) for the Night Parrot, including an analysis of uncertainties and assumptions;*
   c) *Provide an estimate of the area of impact the proposed action would have on the vegetation communities that provide habitat for the Night Parrot based on the assessment provided for 1a).*
2) *<u>Presence of the Night Parrot</u>*
   a) *Provide an assessment of the suitability of the Night Parrot survey methodology to detect the species;*
   b) *Comment on the effort that has been undertaken to determine presence/absence of the Night Parrot in all habitat types that the species may utilise within the vicinity of the proposed site; and*
   c) *Based on the information provided in the assessment documentation and other relevant information, comment on the importance of the Fortescue Marsh Night Parrot population.*
3) *<u>Impacts on the Night Parrot</u>*
   a) *Provide an assessment of whether the impacts of the proposed action pose a threat of serious or irreversible environmental damage to the Night Parrot. For example a project that will destroy a breeding population of a listed species such that the species may become extinct;*
   b) *If suitable habitat occurs outside the proposed disturbance footprint, provide an assessment on the potential for fragmentation of habitat and the potential for impacts on landscape functionality for the species;*
   c) *Provide an analysis of the scientific certainty in predicting potential or likely impacts of the proposed action on the Night Parrot; and*
   d) *Provide and assessment of the adequacy, effectiveness and risks of the mitigation measures proposed to be implemented for the Night Parrot.*

Summary of analyses

1. There is a history of reasonably reliable Night Parrot sightings in the Pilbara IBRA Bioregion and Fortescue Subregion, including the Minga Well sighting near the proposed Cloudbreak expansion area in 2005.
2. Despite dedicated Night Parrot surveys since the 2005 sighting no further conclusive evidence of Night Parrots has been found in or around the Cloudbreak proposal area. However, this is not surprising given the extremely low probability of detecting Night Parrots even when they are known to be in an area.
3. Enough is known about Night Parrot ecology to map potential habitat within and near the Cloudbreak proposal area. While there is widespread *Triodia* and chenopod habitat in the IBRA sub-region in which Cloudbreak occurs, high resolution vegetation mapping commissioned by FMG has revealed habitat at the fringes of the Fortescue Marshes that could be disproportionately important to Night Parrots given its position in the landscape. The full extent of this habitat type has not been mapped but needs to be in order to interpret the potential impacts in a regional context.
4. The proposed mine disturbance footprint (excluding the water infrastructure envelope) is likely to affect only a small area of Night Parrot habitat directly.
5. Infrastructure and access associated with water injection could impact upon Night Parrot habitat along the fringes of the Fortescue Marshes. More precise details about these activities and their locations are required before an accurate assessment of the potential impacts can be made.
6. There is the potential for predicted changes to groundwater due to dewatering and injection to affect Night Parrot habitat on the fringes of the Fortescue Marshes. It is unclear how altered groundwater will affect such habitat, but should be monitored. The regional significance of potential impacts cannot be assessed because of limited mapping of this habitat type.

Statements about the threats to Night Parrots posed by the Cloudbreak expansion project

1. The IBRA Pilbara Bioregion and Fortescue Subregion area have a history of Night Parrot sightings. Enough is known about the habitats used by Night Parrots to infer that it is the Fortescue Marshes and the vegetation fringing the Marshes that Night Parrots are probably using. The spatial data supplied by FMG show that the proposal will impact these habitats, particularly the water infrastructure envelope and modelled hydrological changes.
2. The proportion of fringing habitat that will be affected cannot be calculated because of incomprehensive mapping. Uncertainty exists about the extent of impacts from the water infrastructure envelope because specific details about the locations and activities within the envelope have not been supplied. Uncertainty also exists because it is not known how modelled changes to hydrology will impact on vegetation.

PART 1

REVIEW OF NIGHT PARROT ECOLOGY

1.1 Specimen-based analysis of habitat associations

Key point:

1. Habitat descriptions associated with specimens, or recorded by authoritative collectors unambiguously list *Triodia* and/or chenopod dominated systems as being the main habitat types used by Night Parrots

The following information about habitat is based on locations where Night Parrot specimens have been collected. There are 24 specimens lodged in institutions worldwide: 22 were collected prior to 1880 (reviewed in Forshaw *et al.* 1976), and two more were found dead in 1990 and 2006 (Boles *et al.* 1994; McDougall *et al.* 2009). Figure 1 shows the locations of 19 specimens for which accurate location data exists. Descriptions of the vegetation at or near each collection locality are given in Table 1. Note that the Bourgoin specimen purportedly collected in 1912 but subsequently lost (Wilson 1937) is excluded from this analysis.

Ten of the specimens were collected from the Western Gawler Ranges in South Australia by F.W. Andrews in the late 1800s. There are no habitat descriptions directly associated with these specimens, although Andrews did state that Night Parrots only occur in *Triodia* areas when large quantities of *Triodia* seed is available (Andrews 1883). Additionally, detailed vegetation surveys have since been conducted in the Western Gawler Ranges (Hudspith *et al.* 2001). 422 sites were surveyed which defined 19 vegetation communities. The six most common communities accounted for 58% of the sites surveyed. Three out of six contain chenopods as dominant species, while one is a hummock (*Triodia*) grassland.

From these analyses, it is unambiguous that Night Parrots are associated with habitats containing one or more species of *Triodia.* They are also unambiguously associated with habitats containing one or more species of chenopod (samphires and saltbushes, Chenopodiaceae). There is some evidence of an association with areas where these two habitat types are juxtaposed, although the evidence is inconclusive. These statements are based on:

- Four instances of chenopods being **directly** associated with specimen (either in habitat description made at the time of collection, or lodged in the bird's feathers), with no mention of *Triodia*.
- Two instances of significant area of chenopods being recorded **near** specimen location, with no mention of *Triodia*.
- 13 instances of both *Triodia* and chenopods being recorded as common **near** specimen location

Figure 1. Location of Night Parrot specimens.

Numbers correspond to specimen ID numbers shown in Table 1.

Table 1. Habitat details associated with Night Parrot specimens

Specimen ID	Year	Habitat notes accompanying specimen or described by collector	Habitat description for specimen location based on other sources	Reliability and comments
1	2006	Sparse shrubland of *Acacia cambagei, Eremophila latrobei, Senna artemisoides*, near head of small creek. Dense & extensive *Triodia* 4km north. In immediate area, approximately 60% of ground was bare; remaining 40% was vegetated with Gidgee, Crimson Turkey Bush, Blunt-leaf Cassia, *Sclerolaena* sp., *Sporobolus actinocladus*, *Ptilotus* sp., *Maireana* sp., *Eragrostis* sp., *Enneapogon* sp., and *Sida* sp. (McDougall *et al.* 2009)		**High-Medium**. Bird killed after hitting fence; may have flown in from elsewhere, although presumably within 10km (can fly up to "*four or five miles*", as noted by Andrews (1883)).
11	1990	Low, sparse *Astrebla, Calotis* and chenopod grassland/herbland; gibber areas. *Sclerolaena* seeds lodged in feathers (Boles *et al.* 1994).		**Medium-High**. Road-killed bird may have fallen from front of car after being hit at a considerable distance. However, *Sclerolaena* seeds lodged in feathers probably indicate activity in a Chenopod shrubland.
23	1872	none	See Table 2	**Medium**. Various habitats described from general collection locality.
24	1872	none	See Table 2	**Medium**. Various habitats described from general collection locality.
25	1872	none	See Table 2	**Medium**. Various habitats described from general collection locality.
26	1880	none	See Table 2	**Medium**. Various habitats described from general collection locality.
28	1873	none	No specific info; 15km SW of ID# 47, so this description applies with some uncertainty	**Low-Medium**. Various habitats described from a site 15km away
29	1880	none	See Table 2	**Medium**. Various habitats described from general collection locality.
30	1873	none	No specific info; 21km NE of ID# 47, so this description applies with some uncertainty	**Low-Medium**. Various habitats described from a site 21km away
31	1854	granite break-away country with fringing saltbush flats (R. Austin in Wilson 1937)	Probably reasonably large areas of *Triodia* and chenopod within 10-20km based on contemporary mapping (AH Burbidge *in litt.*)	**High**. Location derived after the fact by Wilson (1937) who examined Austin's journal. Type specimen.

Specimen ID	Year	Habitat notes accompanying specimen or described by collector	Habitat description for specimen location based on other sources	Reliability and comments
32	1845	"*Samphire, salsolae and mesembryanthemum*" (C. Sturt in Forshaw *et al.* 1976). Note: *Mesembryanthemum* does not occur naturally in Australia. Probably refers to a pigface in the Aizoaceae		**High**. Habitat described at precise location of where bird collected.
46	1875	"*shrubby samphire*" (Andrews 1883)		**High**. Habitat described at precise location of where bird collected.
47	1867	The collector (C. Ryan) passed live specimen to F. von Müller, who sent it to London Zoo with a note that "*it lives in the rocky caves of the ranges…*" (von Müller in Wilson 1937).	Chenopod plains (*Atriplex versicaria, Maireana pyramidata* +/- *M. sedifolia*); Myall Woodland (*Acacia papyrocarpa*); Myall/Mulga Woodland (*A. papyrocarpa* & *A. aneura*); Horse Mulga/Mallee Woodland (*Eucalyptus socialis* & *A. ramulosa* + shrubs); Tall Mallee Woodland (*E. oleosa, E. brachycalyx* & *E. socialis*); Native Pine Woodland (*Callitris columellaris*) (Matthew and Carpenter 1993)	**Medium**. Von Müller's description is not directly associated with the specimen, although it was made by the property lessee (C. Ryan) who collected this specimen alive. Ranges more likely to be dominated by *Triodia* than chenopods. Also, various habitats described from general collection locality (Matthew and Carpenter 1993).
113	1875	none	Spinifex on rocky hilltops; sparse chenopods on upper hill-slopes and low rubble hills, grading to dense formations on lower hill-slopes & plains; sand-sheets & dunes; closely spaced small trees along waterways (Wakelin-King 2009)	**Medium**. Various habitats described from general collection locality (Wakelin-King 2009)
117	1880	none	See Table 2	**Medium**. Various habitats described from general collection locality
118	1875	none	See Table 2	**Medium**. Various habitats described from general collection locality
119	1875	none	See Table 2	**Medium**. Various habitats described from general collection locality
120	1873	none	See Table 2	**Medium**. Various habitats described from general collection locality
121	1873	none	See Table 2	**Medium**. Various habitats described from general collection locality

Specimen institution accession numbers: 1 = QMO32613; 11 = QMO29055; 23 = AM.017831; 24 = AM.017832; 25 = AM.A9308; 26 = HLW.55; 28 = USNM71792; 29 = AM.A9309; 30 = MCZH. 31516; 31 = BM.68.1.27.30; 32 = 640C; 46 = NMV.36256; 47 = BM.1990-7-1; 113 = AMNH.623833; 113 = HLW.54; 118 = B8118; 119 = B24172; 120 = CG1879,679; 121 = CG1879,680

1.2 Night Parrot habitat associations based on unconfirmed observations

Key point:

1. Habitat descriptions associated with unconfirmed observations also list *Triodia* and/or chenopod dominated systems as being the main habitat types used by Night Parrots

Murphy *et al.* (in prep) collated 194 published and unpublished Night Parrot records, spanning the period 1845 to 2007. Excluding the 24 specimens, 99 of the remaining 170 records (58%) contain no specific habitat details. Approximately 32% mention only *Triodia*, 5% mention only chenopods and 4% of records mention both *Triodia* and chenopods as being present nearby. Caution should be used when interpreting these results quantitatively as observers may be more likely to record *Triodia* because (a) it is probably more familiar to most people than are chenopods, (b) there is a widespread belief in the general public that Night Parrots mainly associate with *Triodia* and as such observers may be more likely to notice it, and (c) roads normally avoid low lying chenopod dominated areas, thus introducing the potential for non-random sampling. Nevertheless, in a qualitative sense, these observations support the idea that Night Parrots mainly use *Triodia* and/or chenopod dominated habitats above all other habitat types.

1.3 Analysis of confirmed and unconfirmed Night Parrot observations to determine core distribution and range contraction

Key points:

1. Night Parrots seem to have retracted from the southern portion of their former range.
2. An extant population of Night Parrots exists in south-western QLD, perhaps extending into north-eastern South Australia.
3. A consistent record of Night Parrot sightings provides reasonably strong evidence for a population in the Pilbara region, Western Australia.

The Night Parrot sightings database collated by Murphy *et al.* (in prep) contains 194 records, of which 89 have accurate year and month information, while 182 have accurate location data. A scoring protocol was developed which considered various elements of the observations so that each could be assigned a single score of the likelihood the observation being a Night Parrot (hereafter referred to as “veracity”). This scoring procedure was conducted independently by three people who

have an ornithological background and have a thorough knowledge of the Night Parrot literature. If a record was of a specimen housed in an institution with an accession number, it automatically was given the highest score of 11. To summarise, the scoring parameters considered:

1. Physical description
2. Observer experience
3. Observer pre-disposition
4. Light conditions
5. Distance from observer to bird
6. Duration of observation
7. Habitat and range
8. Behaviour
9. Number of observers in party

A 100 x 100km sample grid was constructed, and statistics about the observations in each cell of this grid were generated. These statistics described: (a) the number of observations in each cell; (b) the maximum veracity score in each cell, and; (c) the year the last observation was made in each cell.

This analysis is presented in Figure 2. Veracity is represented by colour: green = low veracity, grading through to red = high veracity. Transparency is set by the number of observations in each cell. For example, deep red = many high veracity observations; deep green = many low veracity observations; pale red = few high veracity observations; pale green = few low veracity observations. The year the latest observation was made is also shown.

The information presented in Figure 2 can be summarised by region, thus:

1. Southern South Australia had a confirmed population that is now probably extinct.
2. There is a confirmed and extant population in South-western Queensland that may extend into north-eastern South Australia.
3. There is only weak evidence that Night Parrots use southern Northern Territory and northern Western Australia.
4. Compared to southern NT and northern WA, there is comparatively stronger evidence that Night Parrots may more regularly use parts of the Pilbara; however this may be confounded by increased road access and survey effort due to mining activity.

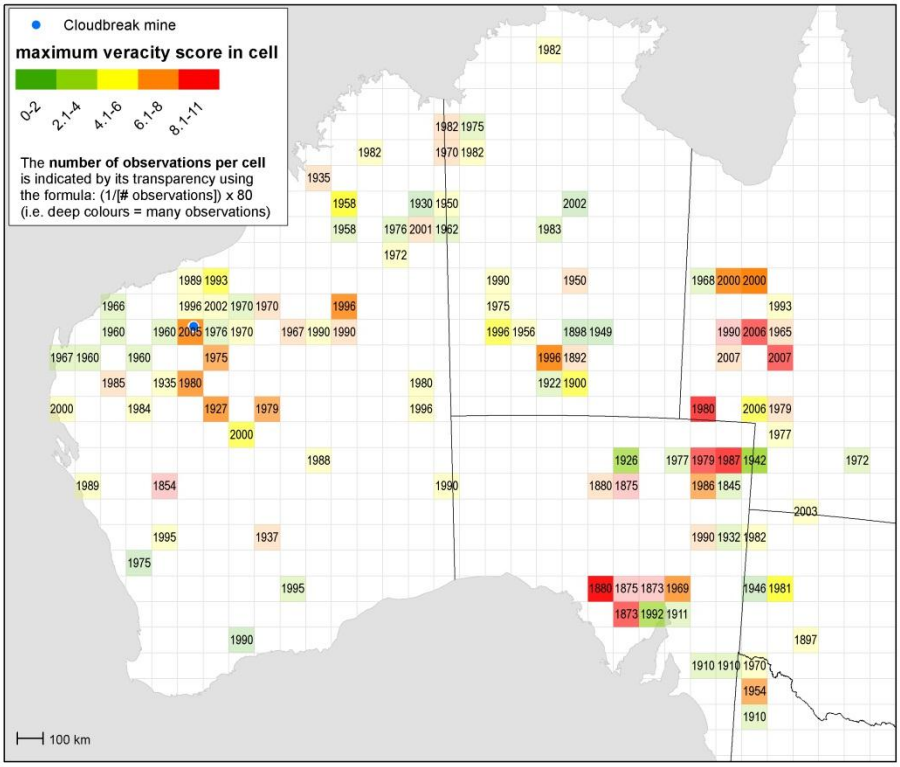

Figure 2. Night Parrot distribution summarised by sighting density, veracity scores and year of last sighting.

1.4 Diet and drinking, as recorded from specimen information or collectors

Key points:

1. The little information about Night Parrot diet lists *Triodia* as being important and other features attest to Night Parrots being primarily granivorous.
2. Authoritative collectors maintain that Night Parrots do drink at waterholes etc., although it is not known if this behaviour is obligatory or facultative, depending on diet.

There is little information about Night Parrot diet tied directly to specimens. What little evidence exists is presented in Table 2.

The best information comes from a statement by Andrews (1883), who was an authoritative collector of Night Parrots. He stated that Night Parrots arrive in areas to feed on *Triodia* seed, although this statement was not directly associated with a specimen (i.e. crop contents etc.). In 1912, M. Bourgoin reportedly analysed the crop contents of a specimen he shot, but the skin was poorly prepared and subsequently lost (Wilson 1937).

Table 2. Night Parrot diet and supporting evidence

Food/other	**Reference**	**Reliability**	**Comments**
Triodia seed	Andrews 1883	High	Statement by authoritative collector of Night Parrots, F.W. Andrews.
"…spinifex seeds and limestone herbage seeds"	Wilson 1937	High-Medium	Based on crop contents of bird shot by Bourgoin in 1912; poorly prepared specimen made but subsequently lost.
prefers green food	Murie 1868	Low	Captive bird in London Zoo; the value of this observation is questionable because (a) non-natural foods would have been offered to the bird, and (b) the post-mortem (Murie 1868) revealed symptoms consistent with inappropriate diet (Dr. Bethany Jackson, BVSc, *in litt*.).
grit & small stones in gizzard	McDougall *et al.* 2009; Murie 1868	High	Based on specimens; confirms that seeds are important.
"*unusually large…fold-like flaps*" inside mouth	Murie 1868	Medium	Described by Murie (1868) during autopsy of specimen BM.1990-7-1; these probably produce amylase and may indicate an adaptation to digest carbohydrates (i.e. seeds) with maximum efficiency (Dr. Bethany Jackson, BVSc, *in litt*.).

Andrews (1883) and Bourgoin (in Wilson 1937), both of whom collected specimens and saw Night Parrots on multiple occasions, give authoritative accounts of Night Parrots coming into drink.

> "*When the dark shades of evening have fairly set in it comes out to feed, but generally flies direct to the nearest water which is often at a considerable distance from its nest; in some instances I have known them to fly a distance of four or five miles.*" (Andrews 1883, p. 29)

> "*When coming into water or leaving, they give a long drawn-out mournful whistle which can be heard for a great distance. … The night has always fallen when they come into water, so that it is too dark to see them without a torch or spotlight. Generally they arrive in pairs, but on one occasion, eight birds came in together. They alight right on the edge of the water, not back like Pigeons, or on trees like other Parrots."* (quoted in Wilson 1937, p. 83-84)

While these observations prove that Night Parrots do drink, it is not clear if their reliance on surface water is related to what they are eating at the time. Andrews states that they nest in *Triodia* and that he only found birds in *Triodia* when it set "*large quantities of seed*". Given that Andrews

observed birds drinking when nesting, it can be reasoned that Night Parrots do drink when feeding on *Triodia*. There are no similar observations of Night Parrots drinking when associating with chenopod areas.

Observations on the closely related Western Ground Parrot (*P. flaviventris*) suggest that they only drink when feeding on dry seeds, and at other times obtain sufficient water from their foods (A.H. Burbidge *in litt.*). Night Parrots may behave in a similar way.

1.5 Landscape-scale movements by Night Parrots

Key point:

1. Anecdotal observations suggest that Night Parrots undertake seasonally-driven, landscape-scale movements.

There is little information about landscape-scale movements of Night Parrots. Anecdotally, Andrews (1883) stated that they arrive in areas after rain to feed on *Triodia*. This idea has been corroborated by comments recorded from Aboriginal informants who also suggested that Night Parrots disappear during dry spells (Cleland 1930; Wilson 1937). Several authors have hypothesised that Night Parrots may move from *Triodia* areas during wet periods into chenopod systems during dry periods (see references in Higgins 1999).

1.6 The importance of each vegetation type to Night Parrots

Key points:

1. There is relatively reliable evidence that Night Parrots rely on *Triodia* systems for feeding, breeding and daytime roosting.
2. By comparison, the reason why Night Parrots use chenopod systems is less certain.

Based on the evidence presented above, there is considerable reliable evidence that Night Parrots rely mainly on *Triodia* and/or chenopod dominated systems, possibly sequentially as environmental conditions change. Table 3 attempts to attribute various behaviours to these two habitat types.

Table 3. Recorded Night Parrot habitats and their suspected importance.

***Triodia* systems**			
Activity	**Importance**	**Reliability**	**Notes and references**
Feeding	high	high-medium	Crop contents of specimen subsequently lost (Wilson 1937); comments by Andrews (1883); anecdotal observations by J. Scarce (in Howe and Tregellas 1914)
Breeding	high	high-medium	Comments by Andrews (1883); Aboriginal informants (Whitlock 1924; Wilson 1937); McDonald (McGilp 1931); RAOU Atlas (Higgins 1999))
Roosting	high	medium	Comments by Andrews (1883); statements by Aboriginal informants (Whitlock 1924; Wilson 1937); anecdotal reports of birds flushed during the day
Chenopod systems			
Feeding	unknown	medium-low	Multiple high veracity anecdotal observations in areas of pure chenopod flats (Andrews 1883; Ellis 1982; Powell 1970)
Breeding	low	medium	Only one authoritative account (McDonald in McGilp 1931)
Roosting	high	medium	Andrews' (1883) commented they "*conceal themselves during the day in the thick patches of shrubby samphire*"; multiple high veracity anecdotal observations of birds being flushed from pure stands of chenopod flats during the day (e.g. Ellis 1982; Powell 1970)

PART 2

THE LIKELY IMPACTS OF THE PROPOSED CLOUBREAK EXPANSION PROJECT ON NIGHT PARROTS

With reference to:

1. **Fortescue Cloudbreak Life of Mine – Public Environmental Review (and appendices) April 2011**
2. **Public Submissions**
3. **FMG Response to Submissions**
4. **Spatial data supplied by FMG via SEWPAC**

2.1 Night Parrots in the Pilbara bioregion and FMG Night Parrot surveys at Cloudbreak

Key points:

1. There have been several Night Parrot sightings in the Pilbara IBRA Bioregion, including one at the Cloudbreak site in 2005.
2. The probability of detecting Night Parrots is extremely low even if they are known to be in an area.
3. Failure to detect Night Parrots cannot be taken as evidence that they don't inhabit an area.
4. A diverse set of standard and innovative survey techniques has been used to detect Night Parrots around the Cloudbreak site, without success.
5. Permanent detection strategies must be used to increase the probability of detection.

2.1.1 Night Parrots in the Pilbara bioregion

There have been no Night Parrot specimens collected in the Pilbara bioregion. The statement on page 202 of the Cloudbreak Public Environmental Review that "*Regional sightings of the Parrot are limited to the single sighting at Minga well …*" is incorrect, although it depends upon the definition of "sighting" and whether or not unpublished accounts were considered. Murphy *et al.* (in prep) collated 15 Night Parrot records in the Pilbara bioregion between 1960 and 2005 (Table 4; Figure 3). Some of these observations had medium-high veracity, including the 2005 Minga Well sighting, which was accepted by the Birds Australia Rarities Committee (Davis and Metcalf 2008).

Table 4. Night Parrot sightings in the Pilbara and its sub-regions.

Area of interest	No. Observations	Veracity* range (& mean)	Year range
Pilbara bioregion	15	1.5-7.9 (4.2)	1960-2005
Fortescue sub-reg.	6	1.5-7.9 (4.9)	1970-2005
Hamersley sub-reg.	3	2.5-7.5 (4.4)	1960-1975
Roeburne sub-reg.	1	2.8	1966
Chichester sub-reg.	5	1.8-4.3 (3.6)	1976-2002

* See Section 1.2 for definition of veracity.

2.1.2 Night Parrot detectability

Almost all accounts of Night Parrots suggest they are extremely difficult to detect, even if they are known to be, or there is a high likelihood of them being in an area. For example, in 1927 Bourgoin failed to find Night Parrots despite searching for two days at the precise location he had observed eight birds three days before (Wilson 1937). In 1923, despite a vigorous active search which included lighting several fires, a group of people failed to locate Night Parrots at a location where fresh tracks had been discovered the previous night by Aboriginal people (Whitlock 1924). A high veracity sighting in 1979 was followed immediately by an organised "beat" of the 200m x 400m wide patch of habitat, which failed to flush the bird (although three birds that were probably Night Parrots were flushed later that afternoon (Ellis 1982)). Similarly, a series of sightings in Western QLD was followed up quickly, without success (Garnett *et al.* 1993), as was the 2005 Minga Well sighting (Davis and Metcalf 2008).

Key aspects of Night Parrot behaviour probably help to explain why they are so undetectable, even when known to be in an area. Several high veracity anecdotal reports (e.g. Ellis 1982; McGilp 1931; Powell 1970; Whitlock 1924) are remarkably consistent with the idea that Night Parrots are extremely furtive; they remain close to the ground and opt to run rapidly between cover rather than fly. It seems that they will take to the wing only when disturbed at a very close range after which they fly only a short distance before disappearing again into thick vegetation. One authoritative observer remarked that "*this is by far the shyest bird I have ever seen and when hiding in suitable cover is almost impossible to find unless nearly trodden on. I have had a horse's hoof within two feet of the bird and a utility wheel about the same, and still the bird would only run"* (Powell 1970 p. 208).

The failure to find Night Parrots at the Cloudbreak mine site and surrounds cannot be taken as evidence that Night Parrots do not use the area. Given their extremely low detectability and furtive behaviour, it is impossible to assume there is neither a transient nor even a sedentary population using the Fortescue Marshes area. As such, statements that appear in the PER, such as "*… it is highly unlikely that the study area is utilised by the Night Parrot"* (page 20, Appendix C) cannot be substantiated.

2.1.3 Cloudbreak Night Parrot surveys – suitability and effort

There have been no confirmed Night Parrot sightings near Cloudbreak since the Minga Well sighting in 2005, although there has been some evidence which has been considered "of interest", such as unidentified bird calls. Of particular interest are the frog-like calls heard on multiple occasions, fitting the authoritative description of Night Parrot calls made by Andrews (1883).

There have been eight surveys for Night Parrots in the Cloudbreak area following (i.e. not including) the Minga Well sighting, with at least one in each year. The duration and number of field staff varied between surveys. In total, there has been approximately 430-person days spent in the field surveying Night Parrots. Temporary deployment of automated recording equipment has also been used, thus further expanding the search effort.

Specific details of the survey methods are provided in Appendix C of the Public Environmental Review. A summary is provided below:

- Survey effort spread over multiple locations within area, representing all potential habitat types (chenopod, *Triodia*, caves).
- Survey effort spread across various seasons and climatic conditions
- A variety of both standard and novel survey techniques has been used. This has included
    - waterhole observations (using observers, and motion sensitive and continuous-recording cameras)
    - daytime active searches (feathers, feeding signs)
    - aural surveys (a proven technique for Ground Parrots)
    - call playback (using Ground Parrot and synthesised calls)
    - spotlighting (vehicle based & on foot)
    - human-chain sweeps
    - trapping (mist nets and modified mammal traps)
    - searching the lining of other birds' nests

While the surveys to date have used an impressive range of both standard and novel techniques, their main limitation has been the total duration of search effort, which has primarily relied upon relatively short-term site visits and the temporary deployment of recording equipment. Given the extremely low detectability of Night Parrots, permanent monitoring equipment and multiple locations are needed to increase the probability of detection. Results of the surveys to date suggest that permanent sound recording stations and camera/drift fence arrays have the highest chance of detecting Night Parrots.

2.1.4 Comments about waterhole-based surveys

Surveys at waterholes can be an effective way to detect birds, although it depends upon the environmental and biological context. On-going annual granivore counts in the Top End and Kimberley show that it is an effective way to detect common sedentary species during dry periods, but that the same species become far less detectable even after small amounts of rain (personal observations). For non-sedentary species, the lack of widespread surface water may be the trigger for dispersal into wetter environments. Authoritative, albeit anecdotal, information about Night Parrots suggests regional movements between habitats depending on rainfall (Andrews 1883; Wilson 1937), which may explain why dedicated waterhole-focussed Night Parrot surveys have failed in the past, both near Cloudbreak and elsewhere (e.g. Blyth and Boles 1999; Blyth *et al.* 1997a; Blyth *et al.* 1997b; Butler 1977; Maher 1995). The available evidence suggests that surveying water points during dry periods is not an effective way to detect Night Parrots systematically. This is not to say that Night Parrots will not be detected at water points (as the observations by Andrews (1883), Bourgoin (in Wilson 1937) and Davis and Metcalf (2008) show), just that it is unlikely to be the most effective strategy, especially given the low level of our understanding of Night Parrot ecology.

2.2 Night Parrot habitats in the vicinity of the Cloudbreak site

Key points:

1. Night Parrot habitat has been mapped and analysed using two vegetation layers: (i) state-wide and coarse scale NVIS data and (ii) high resolution mapping in the vicinity of the Fortescue Marshes, commissioned by FMG.
2. The definition of Night Parrot habitat used in the PER should be expanded to include *Triodia* dominated areas away from the Fortescue Marshes. Such habitat occurs extensively at the sub-regional level, based on NVIS data.
3. Based on the NVIS layer, the Fortescue subregion contains 29% of all potential Night Parrot chenopod habitat in the greater bioregion and it is configured in one discrete block of habitat (Fortescue Marshes).
4. *Triodia* habitat (as defined by FMG mapping) near the edge of the Fortescue Marsh could be disproportionately important to Night Parrots because of inherent protection from fire and increased groundwater availability.
5. The chenopod habitat in the Fortescue Marsh and the fringing areas of *Triodia* could have above average importance for Night Parrots at the state and national level.

2.2.1 The FMG PER definition of Night Parrot habitat

The FMG Public Environmental Review defines Night Parrot habitat as "*dense spinifex and samphire in the vicinity of the marsh*" (page 202) and their subsequent mapping and analyses are based upon this definition combined with vegetation mapping undertaken by Mattiske (2007). It excludes areas dominated by *Triodia* away from the marsh. This is at odds with authoritative and high veracity observations by Andrews (1883), Bourgoin (in Wilson 1937) and statements recorded by Aboriginal people (Whitlock 1924; Wilson 1937). That is, it is almost certain that areas dominated by *Triodia* occurring away from samphire flats do support Night Parrots at particular times.

2.2.2 Independent Night Parrot habitat mapping using NVIS data

National Vegetation Information System (NVIS) Level 6 spatial data for WA (Shepherd 2003; Shepherd *et al.* 2002) was used in this study to define potential Night Parrot habitat in the IBRA Pilbara bioregion. Vegetation descriptions in each NVIS Level were searched using the keywords "*Triodia*" and "spinifex" to define *Triodia* habitat. Chenopod habitat was defined using the keywords "chenopod", "samphire", "*Atriplex*", "*Halosarcia*", "*Maireana*" and "*Sclerolaena*". Only mainland parts of the bioregion were mapped. The resultant map showing potential Night Parrot habitat in the Pilbara bioregion is shown in Figure 3, and the breakdown by subregion is given in Table 5.

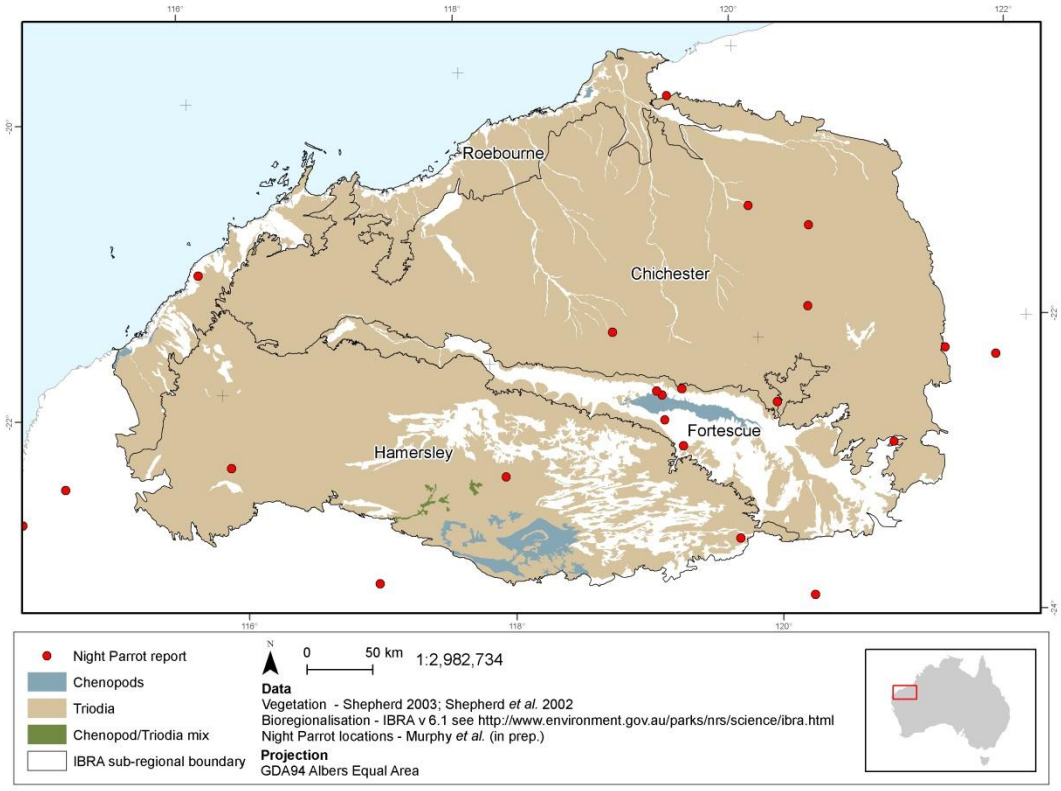

Figure 3. Map of bioregional extent of potential Night Parrot habitat based on NVIS

Table 5. Bioregional extent of potential NVIS-based Night Parrot habitat

Approx. values in hectares.

Area of interest	Total Area (%)	Area *Triodia* (% of total in region)	Area Chenopod (% of total in region)	Area *Triodia*/Chenopod mix (% of total in region)
Pilbara Bioregion	17,821,000	14,941,000	280,000	19,000
Fortescue sub-reg.	1,951,000 (11)	824,000 (6)	82,000 (29)	0 (0)*
Hamersley sub-reg.	5,635,000 (32)	4,567,000 (31)	184,000 (66)	19,000 (100)
Roeburne sub-reg.	1,861,000 (10)	1,389,000 (9)	14,000 (5)	0 (0)
Chichester sub-reg.	8,375,000 (47)	8,161,000 (55)	0 (0)	0 (0)

* while there is no Triodia/Chenopod mix defined by NVIS, mapping by FMG shows significant areas of this habitat immediately adjacent to the Fortescue Marshes.

In the Fortescue subregion, in which Cloudbreak occurs, the extent of potential chenopod habitat is the second highest compared to the other subregions, at 29%. The area of chenopod habitat in Fortescue occurs in one discrete unit (the Fortescue Marshes), compared to that occurring in the Hamersley subregion, which occurs as several discrete patches. The extent of potential *Triodia* Night Parrot habitat in the Fortescue subregion is the lowest compared to the other subregions (6%).

2.2.3 Habitat fringing Fortescue Marshes based on high resolution vegetation mapping

FMG has commissioned vegetation mapping in the proposal area (Mattiske 2007) which was used to define Night Parrot habitat along the edge of the Fortescue Marshes (Fig. 75 in PER). Even though the species growing here are likely to be found elsewhere, their close proximity to the Marshes could mean these areas are disproportionately important to Night Parrots. There are two reasons for this: First, an analysis of 150 Landsat satellite images between 1999 and 2011 showed that almost all of the large fires in the area around Cloudbreak stopped before they reached the edges of the Marsh. Figure 4 shows one of several cases. The implication of this is that *Triodia* growing near the edge of Fortescue Marshes appears to have a degree of inherent protection from fire. Most *Triodia* species are slow to recover biomass after fire, and some take several fire-free years before they set seed (Armstrong and Legge 2011; Westoby *et al.* 1988). Authoritative evidence suggests that Night Parrots require *Triodia* patches that have large biomass for nesting and roosting, and plentiful seeding for feeding (see Section 1.6 The importance of each vegetation type to Night Parrots). Second, *Triodia* plants near the edges of the Fortescue Marshes may be behaving phreatophytically (i.e. responding to groundwater (Geiger 2007)) and consequently may be setting seed more often or

earlier than elsewhere, as was observed on the edges of the Marshes in 2007 (Bamford and Burbidge 2007).

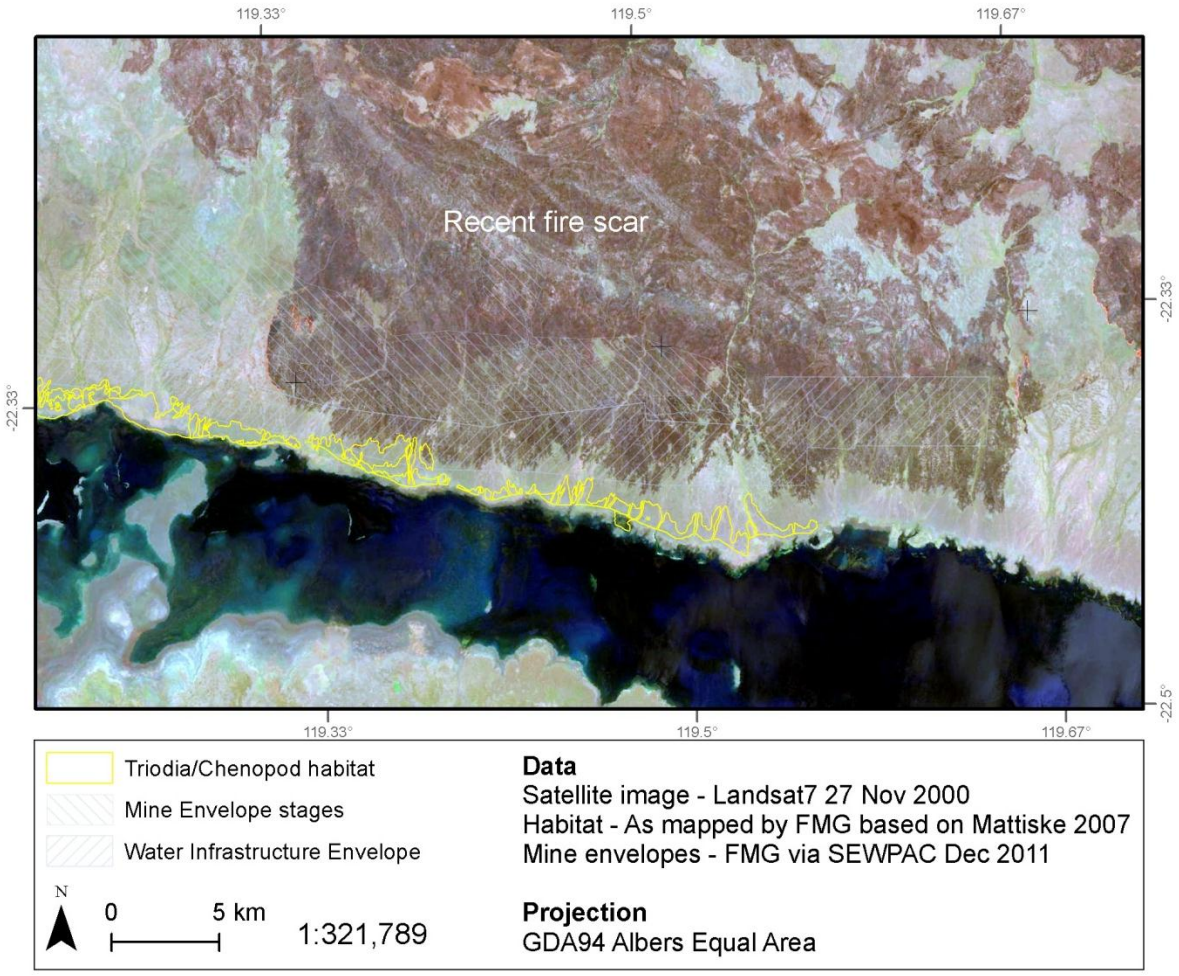

Figure 4. An example of a large fire near fringing *Triodia*/Chenopod habitat.

2.3 Importance of the Fortescue Marshes to Night Parrots

A combination of extensive chenopod habitat and areas of adjacent *Triodia* that are probably phenologically different compared to other areas means that it is likely the Fortescue Marshes and immediate surrounds may have above average importance for Night Parrots in Western Australia and nationally.

2.4 Importance of the Fortescue Marshes Night Parrot population at the national level

Given the lack of ecological understanding about Night Parrots and their extremely low probability of detection even when known to be in an area, it is impossible to say with a high degree of certainty how important any Night Parrot population is at the national level. However, given the history of sightings near the Marshes (Section 2.1.1), the configuration of known habitats (Section 2.2.3) and the national-level analysis showing core distribution and range contraction (Section 1.3), it is possible that the Fortescue Marshes supports a Night Parrot population (at least sporadically) that is of high national importance.

2.5 Impacts of the proposed mining on known Night Parrot habitats

Key points:

1. The direct impacts of the proposed mine expansion will affect 2,909 ha of suitable Night Parrot habitat, as defined by a combination of NVIS and FMG-based vegetation mapping.
2. The indirect impacts of the proposed mine expansion will affect 18,668 ha of suitable Night Parrot habitat, as defined by a combination of NVIS and FMG-based vegetation mapping.
3. The habitat fringing the edges of the Marshes (likely to be disproportionately important and mapped by FMG) will not be directly impacted. However, a relatively large area of this habitat (approx. 1,800 ha) could be indirectly impacted. The proportion of this habitat potentially affected is unknown because of incomprehensive mapping, which should be rectified. Also, the exact locations of injection infrastructure need to be clarified before accurate assessment of these impacts can be determined.

2.5.1 Definitions of direct and indirect impacts and Night Parrot habitat used for analyses

The analyses presented in this section were based on NVIS-defined habitat (Section 2.2.3 of this report), habitat defined by FMG based on Mattiske (2007), and impact envelope polygons supplied as shapefiles by FMG via SEWPAC in December 2011. Each of these datasets are shown in Fig. 5.

The analyses presented in this section are based on the following assumptions:

1. There will be no new impacts from the **existing** approved footprint on Night Parrot habitat, and therefore this area has been removed from all calculations.

2. The impacts associated with proposed mine expansion footprint (Fig. 5) are considered to be **direct**. Spatial analyses for this are based on the unmodified polygon supplied by FMG, via SEWPAC in December 2011.
3. The **indirect** impact area is based on a combination of (i) the water infrastructure envelope (polygon supplied by FMG) and (ii) mounding and drawdown contours for operational and post-mining periods, supplied as shapefiles by FMG via SEWPAC in December 2011. According to the FMG PER, mining activity will lead to lower groundwater levels in some areas at some times (drawdown) and higher levels in other areas at other times (mounding). The magnitude and spatio-temporal dynamics of these impacts have been modelled by FMG for the operational life of the mine and for 40 years post-mining (Figures 20 to 30 in PER). In the analyses presented below, both mounding and drawdown contours for each period were merged to determine the spatial extent of potential changes to groundwater (see Appendix). These were then further merged with the water infrastructure envelope to define an overall area of indirect impact.
4. As discussed in Sections 2.2.1 and 2.2.2, Night Parrot habitat has been defined using two vegetation datasets: (i) relatively coarse NVIS data and (ii) FMG-defined higher resolution data that identifies habitat around the fringes of the Marshes. The latter overlaps the NVIS-define d Chenopod habitat (Fig 5). To calculate the area of habitat potentially affected by direct and indirect impacts, two analyses were conducted. First, both NVIS and FMG-defined habitat were merged into a **single combined habitat layer**. Second, because of the suspected importance of the **habitat fringing the edge** of the Marshes (see Section 2.2.3), a separate impact analysis was performed upon this habitat area alone.

For all analyses, Australian Albers Equal Area Conic projection was used, which is suitable for calculating areas. Spatial unions were performed to define intersects between direct and indirect footprint areas and habitat areas using ArcGIS 9.3.1 (Environmental System Research Institute Inc., Redlands, CA, USA).

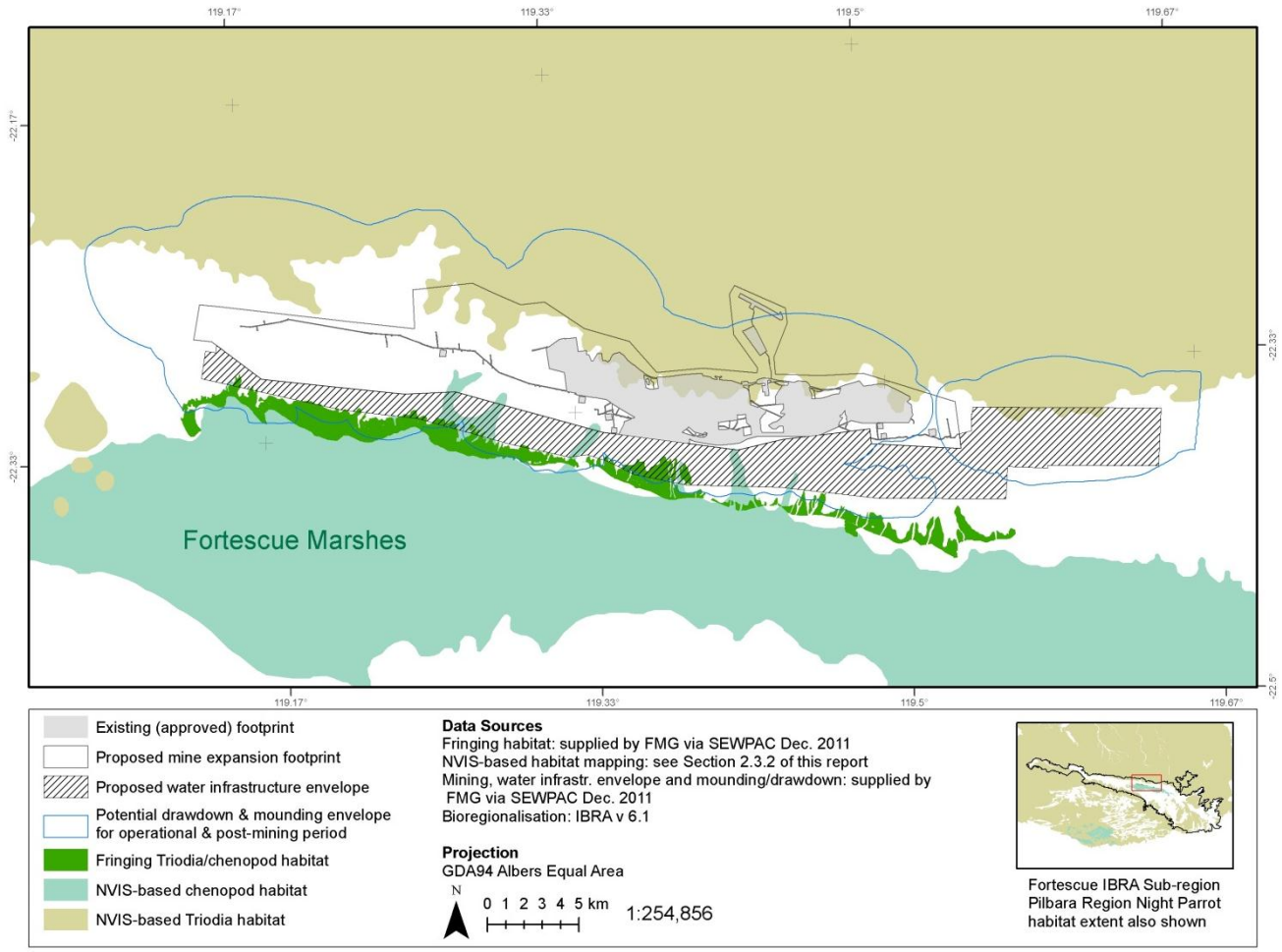

Figure 5. Data elements used to assess potential impacts of the proposed expansion on Night Parrot habitat

2.5.2 Direct and indirect impacts on combined definition of Night Parrot habitat

The direct impacts of the proposed mine will affect 2,909 ha of all Night Parrot habitat, as defined by NVIS (coarse resolution) and FMG (high resolution) combined. The indirect impacts (that is, the combined area of the water infrastructure and the mounding & drawdown envelopes) will affect 18,668 ha. The total area is 21,577 ha and is shown in Fig. 6.

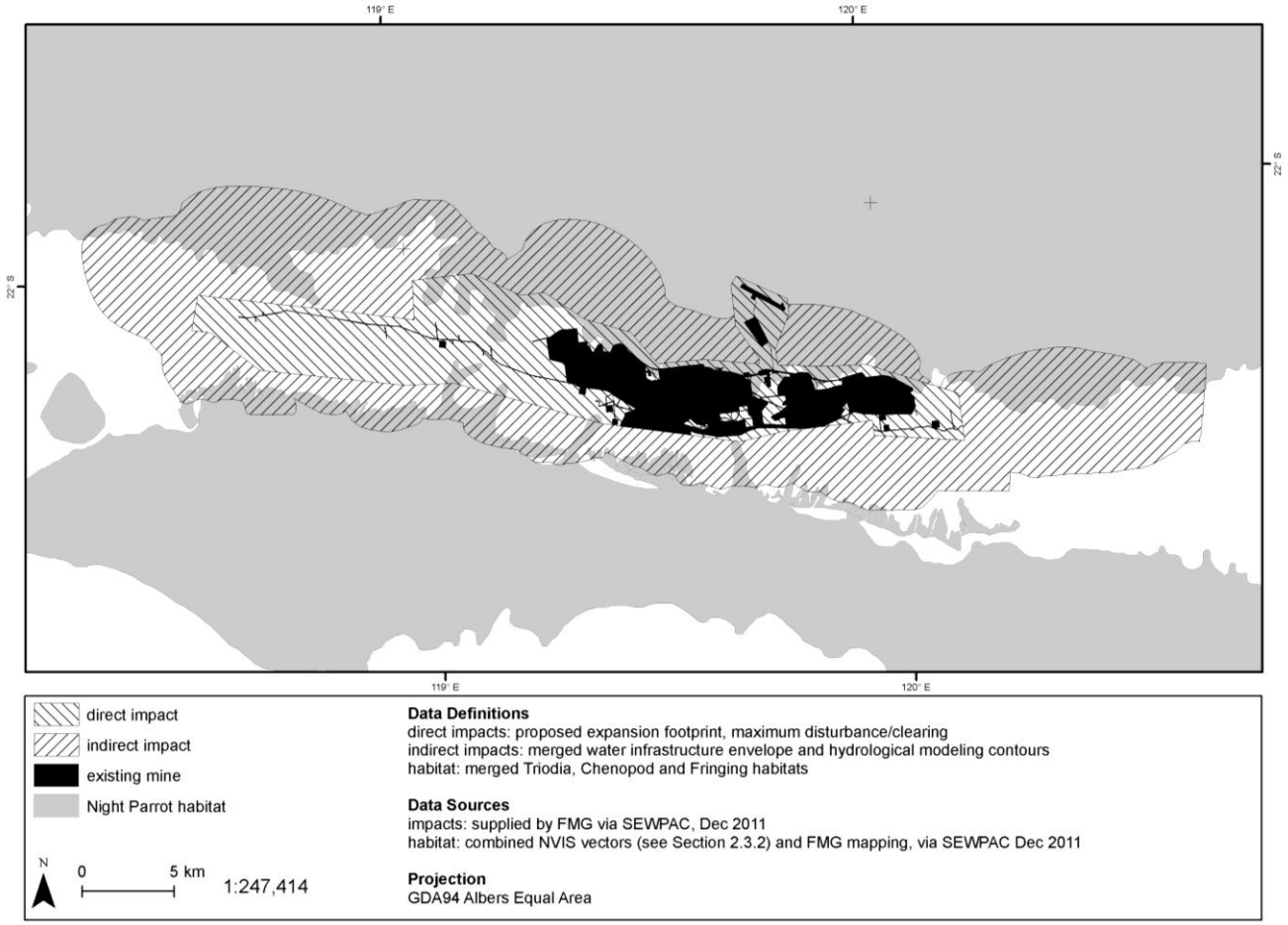

Figure 6. Direct and indirect impacts on combined NVIS and FMG-defined Night Parrot habitat

2.5.3 Direct and indirect impacts on marsh-fringing Night Parrot habitat

As discussed above (Section 2.2.3), Night Parrot habitat fringing the edges of the Fortescue Marshes (as mapped by FMG) is likely to be disproportionately important and thus warrants a specific spatial analysis. Its spatial extent, and the individual impact envelopes are shown in Fig. 5.

The impact summary is shown in Table 6. Specifically, there will be no direct impacts upon this habitat type, but the water infrastructure envelope will affect 398 ha. The predicted groundwater change envelope (blue polygon in Fig 5) will possibly impact upon 1,807 ha. When the water infrastructure and modelled drawdown/mounding envelopes are considered together their combined impact area on fringing habitat is 1,833 ha.

The true proportion of fringing habitat that could be affected cannot be calculated because this habitat type has not been mapped comprehensively in the sub-region. It is recommended that further mapping at this scale be conducted around the entire Fortescue Marshes.

It is important to note that it is unclear how changes to groundwater levels will actually affect Night Parrot habitats. For Chenopod/Triodia habitat adjacent to the Marshes, monitoring these potential impacts should be undertaken using pre- and post-impact baseline data, in addition to data collected at control sites away from the disturbance area.

Table 6. Direct and indirect impacts of Cloudbreak mine expansion on marsh-fringing Night Parrot habitat

Areas in hectares

Direct Impact	**Water infrastructure envelope**	**Drawdown/ mounding**	**Combined impact area**
0	398	1,807	1,833

2.5.4 Habitat fragmentation and landscape functionality

Key point:

1. Fragmentation and the disruption of landscape functionality are likely only to be a problem for Night Parrot habitat fringing the Marshes, if groundwater changes and water injection infrastructure affect that area.

The actual disturbance footprint of the proposal is unlikely to fragment Night Parrot habitats, as defined by either NVIS or FMG (see Figure 5). Similarly, it is unlikely that the disturbance footprint will lead to significant changes to landscape functionality.

Of more concern is the potential fragmentation of the marsh-fringing habitat due to groundwater disturbance (Figures 6 and 7) and water injection activities. As discussed in Section 2.2.3, this habitat could be disproportionately important to Night Parrots but has not been comprehensively mapped in the region. The modelled groundwater disturbance during and post- mining operations shows significant impacts in the area that has been mapped, and this could lead to significant fragmentation of this habitat type. More extensive mapping of this habitat is required to place the potential impacts in a regional context. In addition, monitoring the impacts of groundwater disturbance on this habitat association should be undertaken, with appropriate peer review of the methodology and results.

2.5.5 Overall impacts of the proposed mining on Night Parrots

Summary and salient points:

- A history of Night Parrot sightings and the existence of suitable habitat suggest that the Fortescue IBRA sub-region, and the Fortescue Marshes and immediate surrounds in particular, support Night Parrots at least sporadically and possibly in relation to landscape-scale movement patterns.
- Spatial analyses of the disturbance footprint (excluding the water infrastructure envelope) suggests limited direct impacts on Night Parrot habitats in the area, as defined by NVIS and higher resolution marsh-fringing habitat mapping commissioned by FMG.
- The water infrastructure envelope could disturb Night Parrot habitats fringing the Marshes (as mapped by FMG; Fig 5). Precise details about the activities and locations to be conducted within this envelope need to be clarified.

- Spatial analyses suggest that the predicted groundwater impacts could disturb Night Parrot habitats fringing the Marshes (as mapped by FMG; Figs 6 and 7). There are two issues relating to these potential impacts:
    - First, the likelihood and magnitude of any potential disturbance is difficult to assess because it is not entirely clear how changes to groundwater will affect *Triodia* and chenopods growing in this area. A monitoring programme should be initiated that is designed to detect changes in vegetation structure and seed production caused by altered groundwater. It will be important to pay particular attention to the design of such a monitoring programme so that any detected vegetation changes can be interpreted correctly (for example, a Before-After Control-Impact design, where pre- and post-disturbance data is combined with data collected at a control site away from the disturbance area would work well).
    - Second, it is not possible to assess the regional significance of any disturbance to Night Parrot habitat fringing the marsh (either through groundwater changes or impacts directly associated with injection infrastructure) because this habitat has not been mapped away from the disturbance area. It seems likely that this habitat occurs as a ring right around the marsh, although this needs to be confirmed by further high resolution habitat mapping.

2.5.6 Assumptions and uncertainties about predicted impacts

The main assumptions underlying the analyses in this report are:

- Night Parrots do use habitats in and around Fortescue Marshes, at least sporadically. There is a reasonably high degree of uncertainty about this assumption in both directions. That is, it is possible that there is a sedentary population in the area that has remained undetected despite systematic surveys. This is plausible given that Night Parrots are notoriously difficult to detect even when they are known to be in an area (see Section 2.1.2). Conversely, it is possible that Night Parrots only use habitats in the Fortescue Marshes area rarely or only during specific times. The spatio-temporal movements of Night Parrots are unknown so it is not possible to evaluate the likelihood of this scenario.
- Areas of *Triodia* and chenopod away from the Marshes are all equally likely to support Night Parrots. Implicit in calculating whether the impacts pose acceptable risks to Night Parrots is the assumption that any habitat that is impacted is represented elsewhere in the bioregion. In other words, is there any reason to suspect that Night Parrot habitat in the vicinity of the proposal area is more likely to support Night Parrots than elsewhere? In relation to *Triodia*

habitat away from the Marshes, it is likely that large areas of similar habitat exist elsewhere that are equally likely to support Night Parrots. Similarly, there is no reason to suspect that the chenopod systems that will be impacted are any different to those in the broader Marshes area, or indeed those that occur south in the Hamersley IBRA subregion.

- Areas of Triodia adjacent to the Marshes are disproportionately important to Night Parrots. While it is a reasonable assumption that habitats along the fringes of the Marshes do behave phenologically different to distant areas of *Triodia*, it is uncertain if this difference is important to Night Parrots. Having said this, given that *Triodia* hummocks in these areas are likely to be larger and set seed earlier, more often or more prolifically (due to longer fire-free intervals and the presence of reliable groundwater), if Night Parrots are in the area it seems reasonable that such areas are important to them. As noted above, the regional extent of this habitat should be assessed by further high resolution mapping.
- The extent of groundwater disturbance predicted by modelling is accurate. This is an important consideration given the potential impacts on Night Parrot habitat immediately adjacent to the Marshes. On-going monitoring of such disturbance should be given a high priority which will allow management intervention and model refinement should predictions depart from reality.

2.6 Public submissions and FMG responses

Seven issues were raised during the public consultation processes, and these were subsequently addressed by FMG in "Cloudbreak Life of Mine Response to Public Submissions EPA Assessment No. 1848 – September 2011" and follow-up attachments provided by FMG to SEWPAC. Each of these issues and FMG's response is discussed below:

2.6.1 Issue 3: In the absence of knowledge the precautionary principle should apply.

The critical aspects to consider for this assessment process are: (1) what Night Parrot habitat is known to be in the Cloudbreak area, and (2) what are the likely impacts on that habitat should the proposal be approved. Although there are large gaps in our understanding of Night Parrot ecology, a series of high veracity records (including specimens) and statements by authoritative collectors and Aboriginal informants extending back to the 1800s are consistent with the idea that *Triodia* and chenopod systems are the main habitats used by Night Parrots. As such, Night Parrot habitat can be mapped with a reasonably high degree of confidence in the Cloudbreak area. There is a similarly high degree of confidence in the likely impacts on mapped Night Parrot habitats because (a) the disturbance footprint has been identified (and presumably will be binding) and (b) impacts on groundwater levels have been modelled (and presumably will be monitored). Considering both of these aspects, it is reasonable to have a relatively high degree of confidence in predicting the impacts of the proposal on the extent of Night Parrot habitat.

Far less certain is how Night Parrots use *Triodia*/Chenopod habitats in a spatio-temporal sense. Either there is a sedentary population that has remained undetected since 2005 (which is entirely plausible given how difficult Night Parrots are to detect) or the area supports Night Parrots more rarely under certain environmental conditions. Either way, it is appropriate to apply the precautionary principle in assumptions about how Night Parrots use the Fortescue Marshes area and assume for the purposes of assessing the potential impacts of the mine that all habitat types are used at least sporadically. It then becomes a process of deciding whether or not those impacts are acceptable, given the regional extent of similar habitats (which must also be assumed to be occupied or usable by Night Parrots).

2.6.2 Issue 4: The development would have unacceptable impacts on Night Parrots

There are several key points to consider when assessing this issue and FMG's response. First, given that potential Night Parrot habitat can be mapped with a reasonable degree of confidence and that the disturbance footprint and potential groundwater impacts have been modelled, it is possible to assess the impact of the proposal if one makes the assumption that the various habitat types are equally likely to support Night Parrots throughout the bioregion. Given this assumption, the low percentages quoted by FMG to describe how much Night Parrot habitat is likely to be affected are justified (although they are lower than those calculated in this report). However, careful consideration must be given to the habitats fringing the Marshes area, which (as discussed

elsewhere in this report) may be disproportionately important to Night Parrots. Based on the impact footprint provided by FMG, it appears that none of this habitat will be directly affected. In contrast, the analyses presented in Section 2.5.2 of this report show that the disturbance to groundwater could affect significant areas of this habitat by way of altering its phenology and therefore its importance to Night Parrots. It is not possible to place the anticipated area of impact of this habitat type in a regional context because the high resolution mapping that defines this habitat type has not been conducted widely throughout the region.

2.6.3 Issue 5: The definition of "preferred" Night Parrot habitat is unsubstantiated

FMG's definition of preferred Night Parrot habitat refers to *Triodia*/chenopods surrounding the Marshes. As discussed in Section 2.2.3 of this report, there are legitimate reasons for accepting this definition as preferred habitat, although it cannot be ruled out that Night Parrots may also use long-unburnt *Triodia* away from the Marshes.

Statements made by FMG in response to this issue that "*There are reasonable grounds for believing that the Fortescue Marsh does not constitute a unique habitat for the species*" is arguable. Certainly at the subregional level the habitat is unique. A systematic and quantitative analysis that aims to assess the occurrence of habitats similar to those found around Fortescue Marshes is needed before such claims can be substantiated.

One public submission (#6) argued that the definition of preferred Night Parrot habitat should be expanded to include habitats such as mulga woodlands. It is possible that Night Parrots do move through such habitats. However, as outlined in Sections 1 and 2, all reliable evidence points to *Triodia* and/or chenopod dominated systems being the most important habitat for Night Parrots. Indeed it could be argued that Night Parrots are likely to be more easily detected in relatively more open habitats (such as mulga woodlands). As such, the lack of sightings from such areas may provide genuine evidence that they do not use these habitats regularly.

2.6.4 Issue 6: The report dismisses unconfirmed Night Parrot observations during surveys as lack of evidence

As discussed in Section 2.1.2, Night Parrots have a very low probability of detection even when they are known to be in an area. As such, the precautionary principle should apply, with the assumption that there is either a sedentary or itinerant Night Parrot population reliant on habitats in and around the Fortescue Marshes. This is acknowledged by FMG in the PER: "*the species is considered likely to occur."* (page 132).

2.6.5 Issue 7: The survey effort to date has not been adequate

As discussed in 2.1.3, while the survey techniques used to date have used an impressive suite of standard and novel techniques, given the low probability of detecting Night Parrots the total survey effort has not been adequate and therefore the issue raised here is justified. However, whether additional survey effort is required before accurate assessment of potential impacts is warrant is debatable. Night Parrots do have an extremely low probability of detection and yet they are known to inhabit the Cloudbreak area. In this case (and as already discussed), the precautionary principle should be applied in assuming that Night Parrots do occur in suitable habitats in the region, at least sporadically.

In their response to Public Submission Issue 3, FMG list the survey effort to date, which superficially sounds extensive (eg 500 person hours), but given multiple people have been involved in field trips over multiple years, the search effort is actually not all that extensive (for example, consider that 500 person hours can be reached by 5 people working 10 hour days for 10 days). Similarly, quoting 813 camera-trap nights is not evidence of an extensive survey, considering that that total could be reached by setting 10 cameras for 10 days to record 8 hours per night. Given the low probability of detecting Night Parrots, it is not surprising that Night Parrots have not been detected with this *relatively* low level of survey effort. Permanent monitoring protocols need to be used to increase the probability of detection, however, as discussed above, whether or not this is warranted for the purposes of assessing potential impacts is debatable.

2.6.6 Issue 8: Estimation of the impacts of the development in the wider area (i.e. light, noise, hydrology) are inadequate

There is some basis for this concern, although without more detailed knowledge of Night Parrot ecology, the impacts referred to (i.e. light and noise) are difficult to assess. The exception to this is the impacts of changed hydrology on Night Parrot habitat, which is considered using predictive modelling both in the PER (e.g. Section 9.5.2 of PER) and in this report (Section 2.5.2). The latter, in particular, highlights the potential for groundwater disturbance to impact on Night Parrot habitat that fringes the edges of the Marshes.

2.6.7 Issue 9: Night Parrot habitat fragmentation is not addressed

In their response to this Issue, FMG state that "*the level of habitat clearance… is not expected to cause fragmentation or significant edge effects*". For widespread *Triodia* habitat and chenopod

habitat in the main part of the Marshes, FMG's statement appears to be justified. In contrast, FMG have not addressed clearly the potential for altered hydrology to fragment the narrow ring of *Triodia*/Chenopod habitat fringing the Marshes, although they do state that "*Changes to groundwater levels as a result of dewatering are also unlikely to affect a significant area of this potential habitat*" (p. 145). The analysis presented in Section 2.5.2 of this report shows that altered hydrology could affect this habitat if the hydrological models are accurate, although the overall proportion affected cannot be calculated because of limited high resolution vegetation mapping elsewhere in the subregion. Nevertheless, monitoring is required to assess the potential effects of altered hydrology on this habitat, which could trigger appropriate management responses and model refinement.

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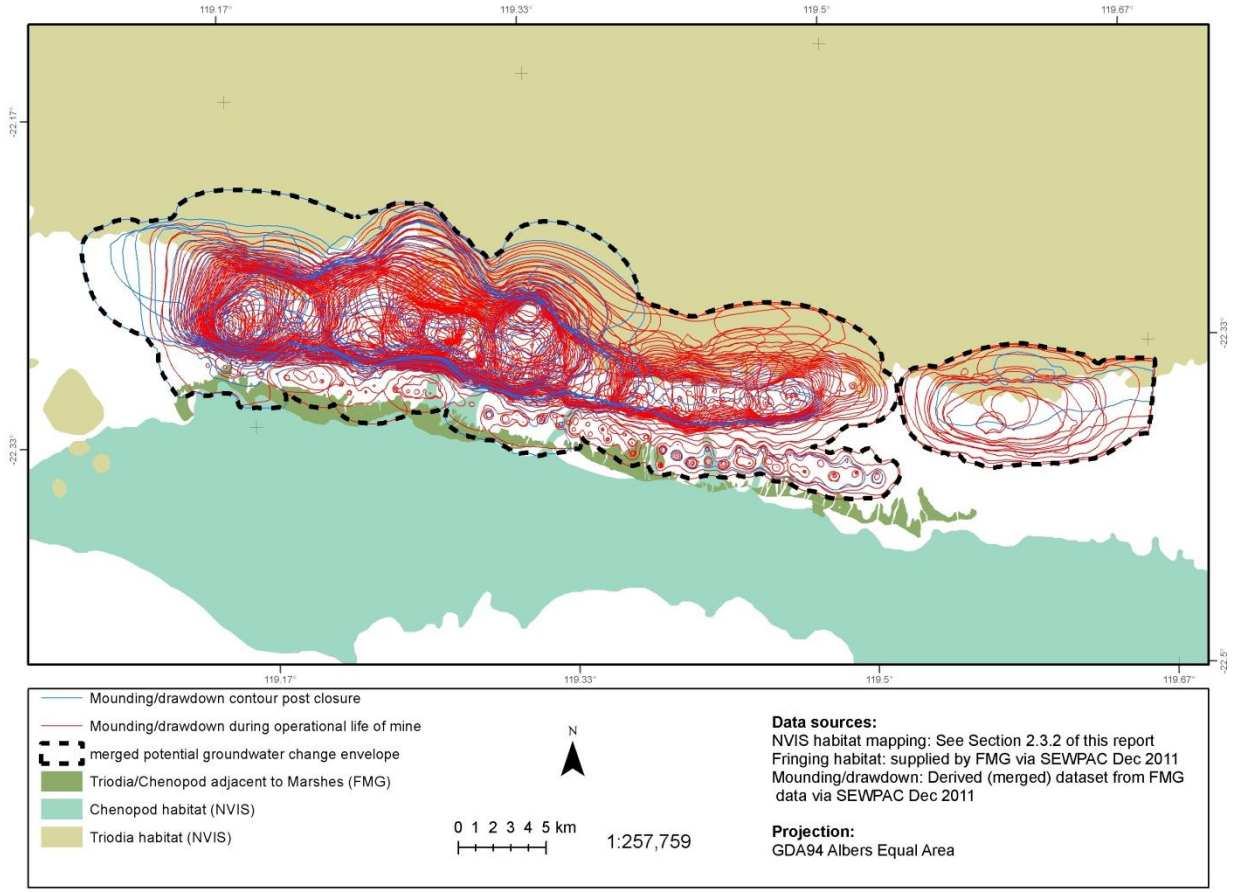
Appendix



Individual mounding and drawdown contours for operational and post-mining periods used to define overall mounding and drawdown impact envelope.