Warrawoona Gold Project:

Conservation Significant Vertebrate Fauna Impact Assessment

Biologic Environmental Survey

Report to Calidus Resources Ltd

October 2019

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EXECUTIVE SUMMARY

The Warrawoona Gold Project (Warrawoona) is located approximately 20 km south of Marble Bar in the Pilbara Region of Western Australia. Calidus Resources Limited (Calidus) is the proponent and is seeking to further develop the Warrawoona Gold Project. This Impact Assessment provides a detailed summary of the recent survey work completed within the Warrawoona Gold Project area to date and assesses the potential impacts from implementation of the proposed development to species listed under the under the *Biodiversity Conservation Act 2016* (BC Act) and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The systematic framework within which this Environmental Impact Assessment (EIA) was completed comprised:

- Identification of potential key receptor species and habitats relevant to the assessment;
- Identification of input sources (both direct and indirect) to define potential impacts for the consolidated vertebrate fauna list;
- Assess the significance of these potential impacts on the key receptors; and
- Identify areas of potential management to mitigate the impacts of these sources on the key receptors.

Twenty-nine species of conservation significance have been confirmed or have the potential to occur within the Study Area, based on the results of the desktop assessment and field surveys, comprising nine mammals, 18 birds and two reptiles. Six of these species have been recorded within the Study Area to date; Ghost Bat *Macroderma gigas*, Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*, Northern Quoll *Dasyurus hallucatus*, Pilbara Olive Python *Liasis olivaceus barroni*, Brush-tailed Mulgara *Dasycercus blythi.* The Ghost Bat, Pilbara Leaf-nosed Bat, Northern Quoll and Pilbara Olive Python are considered Matters of National Environmental Significance (MNES). Impacts to Ghost Bat and Pilbara Leaf-nosed Bat are discussed in a separate Environmental Impact Assessment.

Habitat mapping across the Study Area includes a total of eight broad fauna habitat types (excluding disturbed areas). This comprises, in increasing order of extent, Claypan, Medium Drainage Line, Rocky Breakaway, Minor Drainage Line, Sandplain, Rounded Hills, Stony Plain, and Hillcrest/ Hillslope. The Rocky Breakaway is deemed to be of high significance as it provides high density denning and foraging habitat for the Northern Quoll, and foraging habitat for the Pilbara Olive Python, Ghost Bat, and Pilbara Leaf-nosed Bat. The Sandplain habitat type in the southern portion of the Study Area is also considered of high significance as it supports Brush-tailed Mulgara, and potentially Greater Bilby. The Night Parrot is considered to have the potential to occur but is unlikely.

Impact Assessment

Land clearance is listed as a Key Threatening Process under the EPBC Act, and fauna habitat loss as a direct result of land clearing and excavation is considered the primary impact of the Project on terrestrial vertebrate fauna. Habitat loss and degradation is expected to occur throughout most of the habitats present, including those considered of high significance. The scale of impact is expected to range from moderate (within areas of land clearing for the proposed Klondyke pit, TSF, and WRD), through to minimal (within Sandplain habitat for a proposed access track). Although direct impacts from habitat loss due to land clearing can be estimated, indirect impacts to regional and local populations (i.e. loss or displacement of individuals) is difficult to quantify.

Northern Quoll

Northern Quoll are listed as Endangered under the EPBC Act and BC Act. The species has been recorded within the Study Area in high densities over three consecutive years. Within the Study Area, high quality denning and foraging habitat for the species is found within the Rocky Breakaway habitat, and further foraging and dispersal habitat is potentially found in the Rounded Hills, Hillcrest/Hillslope and Medium and Minor Drainage Lines. At a local scale the species is likely to experience a Low to Moderate level of impact, primarily from removal, fragmentation and modification of habitat, but also potentially vehicle strike and the increased threat of introduced species. Low level impacts may also be experienced by increased light and noise and changed fire regimes. As the population occurring within the Study Area meets the definition of a ‘high-density population’ and thus a population ‘important for the long-term survival of the species’, the impacts to the species are likely to be significant as defined by DoEE.

Pilbara Olive Python

The Pilbara Olive Python is classified as Vulnerable under the EPBC and BC Act, and has been confirmed in the Study Area. Habitat loss is likely to be the most significant potential impact to the species resulting from the proposed development activities. Critical foraging and dispersal habitats are present in the Medium and Minor Drainage Lines and Rocky Breakaway, which is to be impacted during development. Other potential impacts to the species are increased rates of vehicle strike, potential increases to introduced predators, and changes to water quality or quantity. The Pilbara Olive Python is likely to experience a Moderate level of impact by implementation of the proposed development, from numerous impact sources. However, this impact is unlikely to extend beyond the Study Area to the regional level. The Project is not likely to have a significant impact on the species, as defined by DoEE.

Greater Bilby

The Greater Bilby is classified as Vulnerable under the EPBC and BC Act, and is considered Likely to occur based on the availability of suitable Sandplain habitat, the distribution of the species, and the proximity of previous records. Greater Bilbies are recorded as having low site fidelity and high mobility, and as such may be transitionally present without being recorded during field surveys. The expected impacts to core habitat (Sandplain) is expected to be Low, however the species may also be impacted by increases to predation and vehicle strikes to a Moderate level. Overall, the Project is not likely to have a significant impact on the species on a local or regional scale as defined by DoEE.

Brush-tailed Mulgara

The Brush-tailed Mulgara is classified as Priority 4 by the DBCA and has been confirmed in the Study Area. There is only one habitat type considered highly suitable to support the species within the Study Area (Sandplain). The impacts considered to be of most significance for the species are habitat loss and degradation, predation from introduced species, and changed fire regimes potentially decreasing spinifex cover. However, overall the Project is not likely to have a significant impact on the species on a local or regional scale.

Western Pebble-mound Mouse

The Western Pebble-mound Mouse is classified as Priority 4 by the DBCA and has been confirmed in the Study Area. The habitat type most suitable to support the species is the Stony Plain. The impacts considered to be of most significance for the species are habitat loss and degradation, and predation from introduced species. However, overall the Project is not likely to have a significant impact on the species on a local or regional scale.

Management

It is recommended that all aspects of the Project be designed with mitigation to impacts on native fauna considered. It is understood that Calidus will implement a range of adaptive management strategies for Project design and operation, including a significant species management plan, blast management plan, TSF and cyanide management procedures, surface water procedure, and groundwater management procedure. The significant impacts to fauna and fauna habitats highlighted in this report should be considered and mitigation measures to reduce the impact be incorporated into relevant management plans and procedures and used to address any knowledge gaps discussed.

1. INTRODUCTION

1.1 Project Description and Location

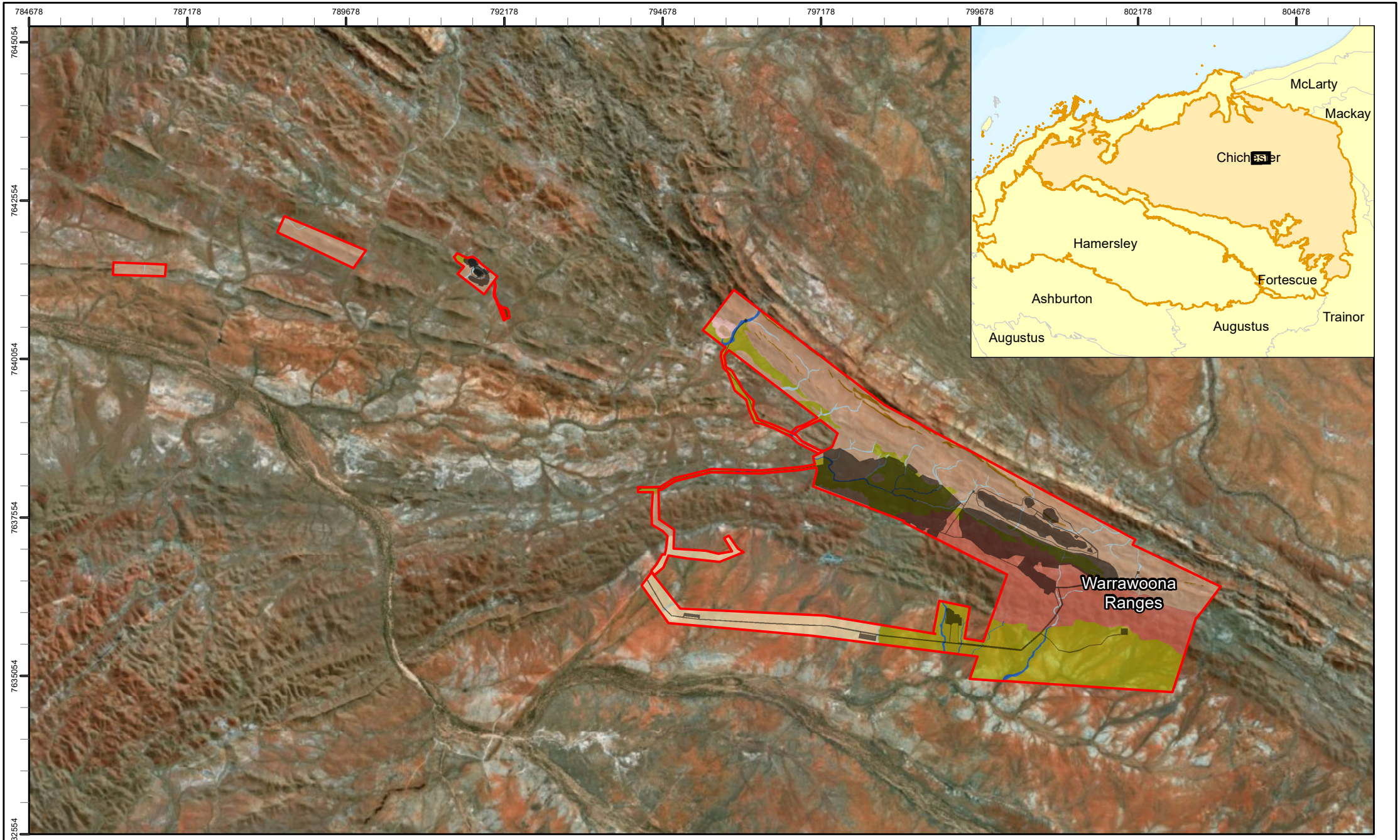
Warrawoona Gold Project (hereafter referred to as the Study Area). The Study Area for the project covers approximately 1,822 ha and is located approximately 20 km south of Marble Bar within the Pilbara region of Western Australia (Figure 1.1).

Calidus Resources Limited (Calidus) is the proponent of this project. The Warrawoona Gold Project is upon the Warrawoona Ranges greenstone belt which has been worked since the late 1800s and has over 200 historic workings (mostly small shafts, stopes, and diggings). Calidus is seeking to further develop the Warrawoona Project as follows:

- Develop an open pit and cutback an existing satellite open pit
- Develop an underground mine below the main Klondyke Open Pit
- Construct a conventional Carbon in Leach (CIL) processing plant
- Store tailings in a 'valley fill' Tailings Storage Facility (TSF)
- Construct waste rock dumps (WRD) and additional elements such as internal roads and material stockpiles.
- Construct support infrastructure including an accommodation village, wastewater treatment plants, mine water treatment plant, surface water management structures and power station.

The disturbance footprint of these activities is shown on Figure 1.1.

The total indicative disturbance footprint for the proposed development within the Study Area is estimated to be 378.6 ha. The main areas of land disturbance are associated with the construction of a Tailings Storage Facility (TSF) (142.5 ha), Waste Rock Disposal (WRD) (95.1 ha), and Mining Pits (37.1 ha).



Legend

- Study Area
- Disturbance footprint

Habitat

- Claypan
- Disturbed
- Hillcrest/Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Rocky Breakaway
- Rounded Hills
- Sandplain
- Stony Plain

biologic Environmental Survey

N

1:75,000

0 0.75 1.5 3 km

Calidus Resources - Warrawoona Gold Project
2019 Significant Species Survey
Warrawoon Impact Assessment
Figure 1.1: Study Area and Regional Location

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 24/09/2019

1.2 Scope and Objectives

Within Western Australia, native fauna are protected under the *Biodiversity Conservation Act 2016* (BC Act) and at a national level under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). A number of species regarded as being of conservation significance, including some considered Matters of National Environmental Significance (MNES) (DoE, 2013a), are known, or have the potential, to occur within the Study Area. These include;

- Northern Quoll (*Dasyurus hallucatus*) – classified as Endangered under the EPBC Act and BC Act – Confirmed in the Study Area
- Ghost Bat (*Macroderma gigas*) - Vulnerable under the EPBC Act and the BC Act – Confirmed in the Study Area
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*) - Vulnerable under the EPBC Act and the BC Act – Confirmed in the Study Area
- Pilbara Olive Python (*Liasis olivaceus barroni*) - Vulnerable under the EPBC Act and the BC Act – Confirmed in the Study Area
- Greater Bilby (Macrotis lagotis) - Vulnerable under the EPBC Act and BC Act – Likely to occur in the Study Area.
- Night Parrot *Pezoporus occidentalis* - Endangered under the EPBC Act and Critically Endangered under the BC Act – Has the potential but is unlikely to occur.

This report aims to provide a detailed summary of the recent survey work completed within the Warrawoona Gold Project to date, and to use this data along with available published literature to assess the potential impacts from implementation of the proposed development.

This will be achieved by

- Identification of potential key receptor species and habitats relevant to the assessment. This assessment will be specific to the species of conservation significance identified as potentially occurring within the Study Area and/ or have previously been recorded within the Study Area;
- Identification of input sources (both direct and indirect) to define potential impacts for the consolidated vertebrate fauna list. The impacts are based on areas considered likely to be impacted prior to and following modification of the Study Area;
- Assessment of the significance of these potential impacts on the key receptors, in relation to extent, duration, magnitude (local and regional) and certainty; and
- Identification areas of potential management to mitigate the impacts of these sources on the key receptors.

This report is intended to support environmental approvals sought by Calidus. The impact assessment relevant to the bat species of conservation significance present within the Study Area (the Ghost Bat and Pilbara Leaf-Nosed Bat) is detailed in Biologic (2019b). These species will not be discussed further in this document.

1.3 Assessment of Significance

This impact assessment was carried out in a manner consistent with the following documents developed by the Western Australian Environmental Protection Authority (EPA), the State Department of Biodiversity, Conservation and Attractions (DBCA - formally Department of Parks and Wildlife [DPaW]) and the Commonwealth Department of Environment and Energy (DoEE - formally the Department of Environment [DoE], Department of Sustainability, Water, Population, and Communities [DSEWPaC] and Department of Environment, Water, Heritage and Arts [DEWHA]):

- EPA (2016a) Environmental Factor Guideline: Terrestrial Fauna
- EPA (2016b) Technical Guidance: Survey Methods for Terrestrial Vertebrate Fauna (developed in collaboration with DBCA);
- EPA (2016c) Technical Guidance: Terrestrial Fauna Surveys;
- EPA (2018c) Statement of Environmental Principles, Factors and Objectives
- DoE (2016) EPBC Act referral guideline for the endangered Northern Quoll (*Dasyurus hallucatus);*
- DBCA (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia
- DPaW (2017) Interim guideline for the preliminary surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia;
- DEWHA (2010a) Survey Guidelines for Australia's Threatened Bats;
- DEWHA (2010b) Survey Guidelines for Australia's Threatened Birds;
- DSEWPaC (2011b) Survey Guidelines for Australia's Threatened Reptiles; and
- DSEWPaC (2011a) Survey Guidelines for Australia's Threatened Mammals.

1.3.1 Terrestrial fauna significance

Terrestrial fauna may be significant for a range of reasons, including (EPA, 2016a):

- being identified as a threatened or priority species;
- species with restricted distribution;
- degree of historical impact from threatening processes; or
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

For the purposes of this report, a key receptor vertebrate fauna species is one of elevated conservation significance which may be impacted by the proposed development, and forms

part of the focus of this EIA. Species are deemed to be of conservation significance if they are afforded protection under the EPBC Act and/or BC Act. A summary of applicable legislation and status codes is provided in Table 1.1. For some species, there is insufficient information to determine their status. These species are also considered by the EPA and DBCA as being of conservation significance for all development related approvals and are listed on a 'Priority List' that is regularly reviewed and maintained by the DBCA (Table 1.1).

Table 1.1: Definitions and terms for fauna of conservation significance

Agreement, Act or List	Status Codes
Federal	
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)** The Department of the Environment and Energy (DoEE) lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) per criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Migratory (MG) • Marine (MA)
State	
***Biodiversity Conservation Act 2016* (BC Act)** At a state level, native fauna are protected under the *Biodiversity Conservation Act 2016*. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Migratory (MI) • Conservation Dependent (CD) • Other Specially Protected (OS)
DBCA Priority List DBCA produces a list of Priority species that have not been assigned statutory protection under the *Biodiversity Conservation Act 2016*. This system gives a ranking from Priority 1 to Priority 4.	• Priority 1 (Poorly known species) (P1) • Priority 2 (Poorly known species) (P2) • Priority 3 (Poorly known species) (P3) • Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4)

1.3.2 Fauna habitats

Fauna habitats may be significant if they provide habitat important to the life history of a significant species, i.e. breeding, feeding and roosting or aggregation areas, or where they are unique or isolated habitats, for example wetlands, in the landscape or region (EPA, 2016a). These significant fauna habitats are also considered a key receptor and are another focus of this EIA.

1.3.3 Impacts

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the

intensity, duration, magnitude and geographic extent of the impacts (DoE, 2013a). To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (DoE, 2013a).

2. PREVIOUS STUDIES

Numerous surveys have been undertaken in the Study Area since 2017, including three which were focussed on assessing the likelihood of occurrence for species of conservation significance: A Level 1 and two targeted fauna surveys. These surveys have been summarised below in Table 2.1 and Sections 2.1 - 2.2.

Table 2.1: Summary of survey effort for terrestrial fauna surveys conducted within the Study Area

Survey Title	Year of survey	Survey Type	Survey effort	Conservation Significant Species recorded
Warrawoona Level 1 Vertebrate Fauna, and Desktop SRE and Subterranean Assessment (Biologic, 2017a)	Sept 2017	Level 1 survey	• 34 motion camera nights (3 sites) • 12 habitat assessments	• Northern Quoll (2 individuals) • Western Pebble Mound Mouse
Warrawoona Gold Project: Habitat Assessment and Targeted Vertebrate Fauna Survey (Biologic, 2019c).	July 2018	Targeted survey	• 40 acoustic recording nights (10 sites) • 156 motion camera nights (4 sites) • 12 habitat assessments	• Northern Quoll (6 individuals)
Warrawoona Gold Project: 2019 Significant Species Monitoring (Biologic, 2019a)	April 2019	Targeted survey	• 33 acoustic recording nights (3 sites) • 346 motion camera nights (5 sites) • 40 habitat assessments	• Northern Quoll (3-4 individuals) • Pilbara Olive Python • Brush-tailed Mulgara

2.1 Baseline Surveys

One Level 1 fauna survey has been conducted within the Study Area to date (Biologic, 2017a). This was the first survey to confirm the presence of Northern Quoll in the Study Area. Two unique individuals were recorded via motion camera on five separate occasions. Vertebrate fauna of the Study Area were sampled via motion cameras, targeted transects and habitat assessments; the survey was conducted concurrently with a targeted bat assessment (Biologic, 2017b). Five Western Pebble Mound mice mounds were opportunistically recorded during the survey, including two recently active mounds (Biologic, 2017a).

2.2 Targeted Surveys

The first monitoring surveys undertaken by Calidus within the Warrawoona Study Area began in September 2018, and two targeted fauna surveys have now been conducted within the Study Area to date (Biologic, 2019a, 2019c). Both surveys were conducted concurrently with targeted bat surveys (Biologic, 2018, 2019d). These surveys focussed on species considered to be MNES, in particular the Northern Quoll, Night Parrot, and Greater Bilby. The primary survey methods were motion cameras and acoustic recorders. Six Northern Quoll individuals were recorded from three motion cameras transects (each comprising ten cameras in place for 10 nights) during 2018 (Biologic, 2019c). A minimum of three individuals, and potentially (but

unlikely) a fourth were recorded from two sites during the targeted survey in 2019 (Biologic, 2019a).

The targeted survey conducted in April 2019 also opportunistically recorded two other species of conservation significance; a Pilbara Olive Python within the Klondyke Queen mine workings, and Brush-tailed Mulgara in Sandplain habitat via motion camera (Biologic, 2019a). No evidence of the Night Parrot or Greater Bilby were recorded during the surveys.

3. KEY RECEPTORS

3.1 Fauna Habitats

Habitat mapping across the Study Area includes a total of eight broad fauna habitat types (excluding disturbed areas). This comprises, in increasing order of extent (Figure 3.1, Table 3.1):

- Claypan,
- Medium Drainage Line,
- Rocky Breakaway,
- Minor Drainage Line,
- Sandplain,
- Rounded Hills,
- Stony Plain, and
- Hillcrest/ Hillslope.

The Rocky Breakaway was deemed to be of high significance as it provides high density denning and foraging habitat for the Northern Quoll, and foraging habitat for the Pilbara Olive Python, Ghost Bat, and Pilbara Leaf-nosed Bat.

The Sandplain habitat type in the southern portion of the Study Area is also considered of high significance as it supports Brush-tailed Mulgara, and potentially Night Parrot and Greater Bilby.

Five of the habitats recorded are considered to be of moderate significance:

- Medium and Minor Drainage Lines provide dispersal and foraging habitat for the Northern Quoll, Pilbara Olive Python, Ghost Bat, and Pilbara Leaf-nosed Bat.
- Stony Plain habitat provides potential habitat for the Spectacled Hare-Wallaby and Western Pebble-mound Mouse and contains some suitable areas of potential habitat for the Night Parrot.
- Hillcrest/ Hillslope and Rounded Hills habitat contains small rocky breakaways that provide additional denning habitat of the Northern Quoll, although such features are small in extent and sparsely distributed.

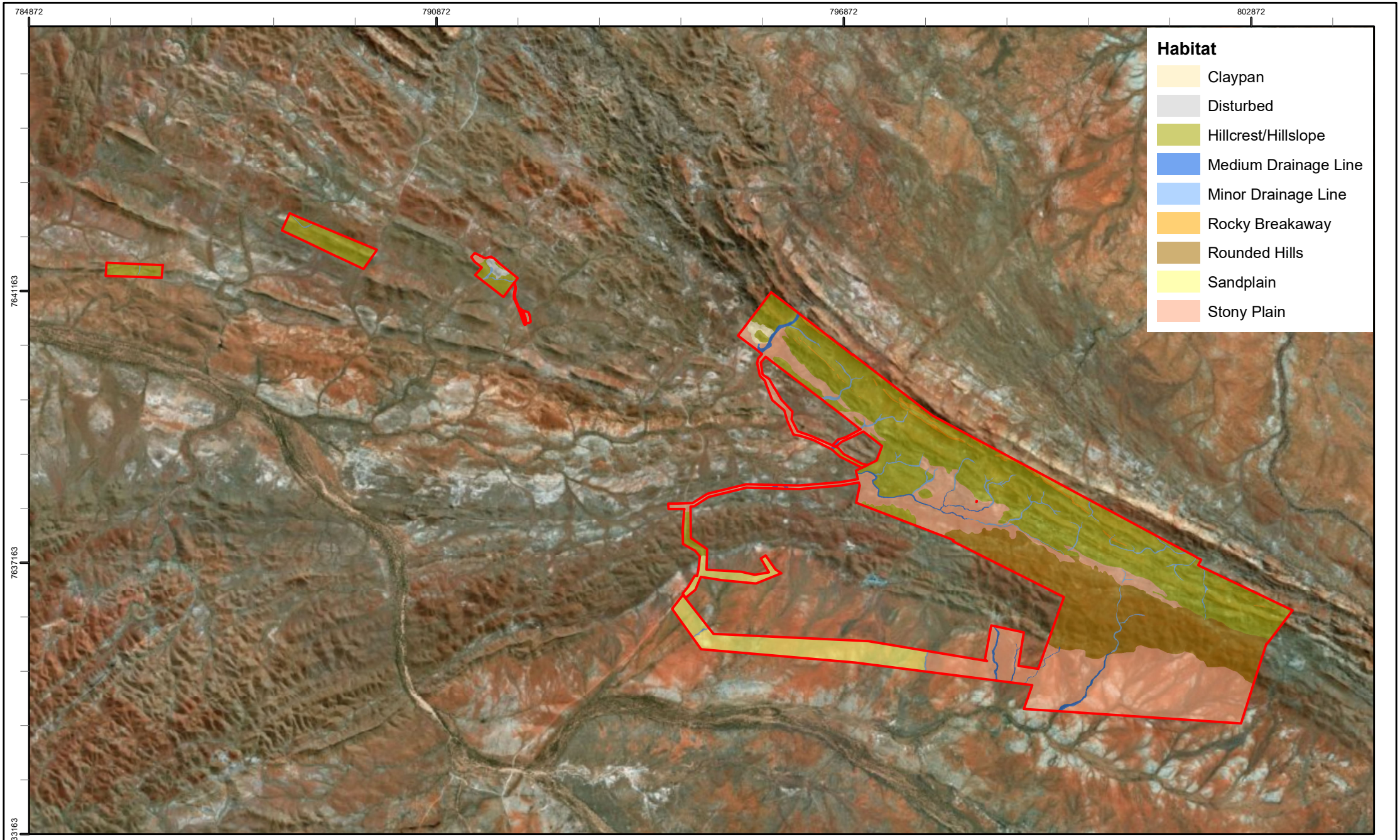
The remaining habitat (Claypan) was deemed to have a low significance as it either does not support species of high conservation value and/ or such species are not dependent on the habitats at the broad scale.

The values and reasons for significance for each of these habitats are summarized in Table 3.1 below, and presented in Figure 3.1.

Table 3.1: The extent of fauna habitats within the Study Area, and their justification for significance

Habitat	Habitat Value Score	Reason for significance	Area within Study Area		Area of habitat type in Develop-ment Footprint (ha)	% of total habitat type occurring in the Develop-ment Footprint
			ha	%		
Rocky Break-away	High	• Northern Quoll - Provides core denning and foraging habitat • Pilbara Olive Python – provides core foraging habitat	19	1.03	0.71	3.82
Sand-plain	High	• Greater Bilby and Brush-tailed Mulgara – provides core burrowing and foraging habitat • Spectacled Hare-Wallaby – core foraging habitat and shelter • Night Parrot – potential foraging and nesting habitat	137	7.51	10.15	7.41
Medium Drainage Line	Moderate	• Northern Quoll and Pilbara Olive Python - Provides dispersal and foraging habitat	19	1.02	5.80	31.35
Rounded Hills	Moderate	• Northern Quoll - Provides dispersal and foraging habitat	339	18.61	88.23	26.03
Hillcrest/ Hillslope	Moderate	• Northern Quoll - Provides dispersal and foraging habitat • Western Pebble-Mound Mouse – provides core habitat	718	39.42	120.02	16.72
Minor Drainage Line	Moderate	• Northern Quoll and Pilbara Olive Python - Provides dispersal and foraging habitat	31	1.69	7.14	23.03
Stony Plain	Moderate	• Western Pebble-Mound Mouse – provides core habitat • Spectacled Hare-Wallaby – core foraging habitat and shelter • Night Parrot – potential habitat	548	30.07	142.77	26.05
Claypan	Low	• No conservation significant species occurring or likely to occur are solely dependent on this habitat type within the Study Area or vicinity. It may be used by migratory birds when inundated.	6	0.33	0	0
Disturbed	Low	• No conservation significant species are dependent on this habitat type	5.9	0.32	3.40	57.63
		Total	**1,822**	**100**	**378.23**	**-**

Note: Area values are taken from habitat mapping completed in Biologic (2017a) across the Study Area



Legend

Study Area

biologic Environmental Survey

N

1:70,000

0 0.75 1.5 km

Calidus Resources - Warrawoona Gold Project

Figure 3.1: Warrawoona Gold Project: Vertebrate Fauna Habitat Types

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 28/05/2019

3.2 Fauna of Conservation Significance

As discussed in Section 1.3.1, for the purposes of this report a key receptor vertebrate fauna species is one of elevated conservation significance which may be impacted by the proposed development. Of the 319 species of vertebrate fauna identified as being previously recorded and/ or having the potential to occur, 29 species are of conservation significance, comprising nine mammals, 18 birds and two reptiles. Four of these species have been recorded within the Study Area:

- Northern Quoll (Biologic, 2017a, 2019a, 2019c), listed as Endangered under the EPBC Act and BC Act;
- Pilbara Olive Python (Biologic, 2019a), listed as Vulnerable under the EPBC Act and BC Act;
- Brush-tailed Mulgara (*Dasycercus blythi*) (Biologic, 2019a), listed as a Priority 4 by DBCA; and
- Western Pebble-Mound Mouse (*Pseudomys chapmani*) (Biologic, 2019c) listed as a Priority 4 by DBCA;

Significant roost sites of Ghost Bat and Pilbara Leaf-nosed Bat are also present in the Study Area, and are discussed separately in Biologic (2019b).

A further three species of conservation significance are considered "likely" to occur in the Study Area, the:

- Greater Bilby, listed as Vulnerable under the EPBC Act and BC Act;
- Peregrine Falcon (*Falco peregrinus*), listed as Specially Protected under the BC Act;
- Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardti*), listed a Priority 3 species by DBCA;

Four species are "possible" to occur, the:

- Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*), listed as Vulnerable under the BC Act;
- Grey Falcon (*Falco hypoleucos*), listed as Vulnerable under the BC Act;
- Long-tailed Dunnart (*Sminthopsis longicaudata*), listed as a Priority 4 by DBCA; and
- Black-lined Ctenotus (*Ctenotus nigrilineatus*), listed as a Priority 4 by DBCA.

The remaining sixteen species are considered "rarely", "unlikely" or "high unlikely" to use the Study Area, including the Night Parrot *Pezoporus occidentalis*. Note that there are 'no unique fauna assemblages', no species with restricted ranges, or species required for ecological integrity recorded in the Study Area. Fourteen migratory bird species are recorded as potentially using the artificial water sources present in the Study Area (Biologic, 2017a). These are deemed as "Unlikely" or "Rarely" to occur based on the distance to previous records and a lack of habitat features (*e.g.* tidal mudflats, samphire, mangroves) associated with these water

sources that are considered part of the species preferred habitat types. However, these migratory species are included within this Impact Assessment due to the TSF which has the potential to attract individuals passing through the area.

4. POTENTIAL IMPACT SOURCES

Broad threatening processes for fauna of the Pilbara include such events as over-grazing, frequent wildfires, exotic species promoting predation and competition, changed hydrological regimes, and the expansion of mining, agriculture, and tourism (Carwardine *et al.*, 2014). Of these threats, impact sources inherent to the proposed development of the Study Area were identified. The mechanisms by which the impact sources can arise can be generally categorised as either direct, indirect, or both (EPA, 2016a). These impact sources can be permanent or temporary, and result in changes to fauna or fauna habitat beyond the immediate development (EPA, 2016a)

4.1 Direct

Direct impacts reduce the diversity and abundance of species in an area through mortality or displacement of individuals or populations (EPA, 2016a). The impact source most commonly causing direct impacts to fauna is the removal, fragmentation or modification of habitat (EPA, 2016a).

Removal, fragmentation or modification of habitat

Habitat loss is the single most important factor in the continuing decline of nearly all species of conservation significance (Cogger *et al.*, 1993; Garnett *et al.*, 2011; Woinarski *et al.*, 2014), including the clearing of land and vegetation for mining (including waste rock and water storage) and infrastructure (e.g. roads and pipelines) (EPA, 2016a). Associated with this loss is habitat fragmentation, that can cause division and isolation of local populations of animals through disruption of movement patterns (Debinski & Holt, 2000). Species most likely to experience such isolation would be those inhabiting continuous stretches of habitat (e.g. gorges or rocky breakaways) and those with less mobility, such as sub-fossorial herpetofauna and small terrestrial mammals (e.g. Western Pebble-Mound Mouse). A reduction in population size and reduced gene flow between separated local groups of these animals could result in founder effects, genetic drift and increased inbreeding and exacerbate local extinctions (Furlan *et al.*, 2012; Lande, 1999). Clearing for infrastructure, such as roads and pipelines, could also increase edge effects on the adjacent vegetation, causing altered levels of predation, restricting or increasing fauna movements, and altering assemblage structure (Goosem, 2001), resulting in an impact area larger than the actual cleared footprint.

The removal, fragmentation, or modification of fauna habitat will occur through activities such as clearing of vegetation, and the removal of topsoil and landforms. The total indicative disturbance footprint for the proposed development within the Study Area is estimated to be approximately 378.6 hectares (ha). The main areas of land disturbance are associated with the construction of a Tailings Storage Facility (TSF) (142.5 ha), Waste Rock Disposal (WRD) (95.1 ha), and Mining Pits (37.1 ha). Construction of roads, designed 16 metres (m) wide

designed to accommodate heavy vehicles, also potentially provides a potential source of habitat fragmentation within the Study Area within habitat types such as Sandplain, although this will not occur within highly significant habitat for Northern Quoll and Pilbara Olive Python such as Rocky Breakaway. Note that the disturbance footprint areas reported in this document are approximate and subject to minor change.

Vehicle Strike

Vehicle strike is a known threat to conservation significant fauna of the Pilbara, particularly for nocturnal species foraging or travelling near roads at night and species that tend to be active on roads (e.g. basking, foraging) during daytime. For example, Northern Quolls are known to cross roads, (Dunlop *et al.*, 2014) and are opportunistic foragers known to scavenge roadkill (Radford, 2012), which can lead to vehicle strike and mortality. Pilbara Olive Pythons are slow-moving, and many have died on roads due to a natural instinct to remain still in response to the vibrations of an approaching vehicle (Pearson, 2003). Deliberate road deaths are a recognised threat, particular when they are often mistakenly identified as a poisonous brown snake (TSSC, 2008b). Road and rail traffic is known to cause mortality of Greater Bilbies (Bradley, 2015), and there is a record of a Greater Bilby vehicle strike at McPhee Creek in 2012, 32 km south east of the Study Area (Outback Ecology, 2012).

The proposal will expand the road network and increase traffic volumes in the Study Area, with an indicative total land disturbance of roads and pipeline/ powerline corridors of approximately 40 ha. In addition, major roads shall be up to 16 m wide for two-way traverse and designed to accommodate heavy vehicles, presenting a higher risk of collision with vertebrate fauna. However, these major roads will not be constructed in habitat types of high significance for Northern Quoll and Pilbara Olive Python (*i.e.* Rocky Breakaway), although they may traverse roads and infrastructure in other habitats during foraging, and proposed road construction in significant Sandplain habitat is only expected to consist of an access track.

4.2 Indirect

The impact sources most commonly causing indirect impacts to fauna are discussed below in relation to development proposed within the Study Area and are summarized in Table 4.1.

Introduced Species

Introduced species pose a range of potential impact sources to Pilbara fauna species. These include over-grazing and land degradation from introduced herbivores (e.g. camels *Camelus dromedarius*, goats *Capra aegagrus*), competition (e.g. rabbits, cats), habitat degradation from weeds (e.g. Buffel Grass *Cenchrus ciliaris*), poisoning from cane toads (Prugh *et al.*, 2009), disease (e.g. toxoplasmosis (Dickman, 1996), and most critically, the introduction of feral predators such as Cats (*Felis catus*) and Red foxes (*Vulpes vulpes*) (Carwardine *et al.*, 2014). Poisoning from invasive species management (e.g. 1080 poison) is identified as a threat factor

for some mammal species (Woinarski *et al.*, 2014), and Northern Quolls are identified as possibly being more susceptible to the toxin than other dasyurids (Calver *et al.*, 1989).

Although weeds and feral animals are not a mining specific impact, there is the potential for a range of invasive species to be introduced or attracted to the area as a result of operational activities such as the expanded traffic network and increased traffic movements, waste and water management, and human habitation. Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). Once established, the presence of these species is considered a permanent impact, as modification to the habitat within the Study Area *i.e.* clearing of large areas, opens up landscape for these species increasing their ability to hunt, transit and therefore reside in the area. In addition, after mine closure the conclusion of pest management procedures will allow these species to permanently establish in the Study Area.

Feral cats have been recorded within the Study Area via motion camera by Biologic (2019a) (Figure 4.1). Buffel grass is listed as high ecological impact and rapid invasiveness (DBCA, 2019b), and has been previously recorded in the Study Area, as has European cattle *Bos taurus* (Biologic, 2017a). Pastoral leases in the immediate vicinity include Eginbah and Corunna Downs. Other invasive predators (Red Foxes) and grazers (Camels) have been recorded multiple times in the vicinity of the Study Area (Bamford Consulting, 2009; ecologia Environment, 2012; How *et al.*, 1991) and by their nature, are likely to become present.

Figure 4.1: Feral cat recorded on motion camera in the Study Area (Biologic, 2019a)

Increased Light and Noise

Altered light environments may affect foraging, reproduction, migration, and communication (Longcore & Rich, 2004). The most likely disturbance responses on native fauna from increases in light spill are the avoidance of illuminated areas previously used for foraging by light-sensitive species, or changes to prey item aggregation for insectivorous species resulting in changes to foraging behaviour. Similarly, species using audible cues for breeding activity, especially birds and amphibians, may also experience disruption to breeding cycles or reduced breeding success. For example, traffic noise is thought to negatively impact on bird and amphibian

communities by masking territorial or mate attracting calls (Parris & Schneider, 2009; Shannon *et al.*, 2014). Other behavioural responses to increased noise levels are reduced foraging time, through minimisation to exposure and by increased vigilance behaviour (Shannon *et al.*, 2014). However, there is a lack of research into the impact of these factors on native fauna in the Pilbara.

Increased noise and vibration will be associated with all elements of the proposed development within the Study Area, most likely around the pit area and roads. Temporary mobile lighting will be installed in active mine pits and active operational areas.

Dust

Dust can indirectly affect fauna by altering the structure and composition of native vegetation (Farmer, 1993). Dust interferes with photosynthesis, respiration and transpiration and allows penetration of gaseous pollutants (Farmer, 1993). Most plant communities can be adversely affected by dust deposition, resulting in alteration of plant community structure (Prajapati, 2012) although no prior studies have been able to detect a significant adverse impact of airborne dust on plant function in the Pilbara (Grierson, 2015). A decline in vegetation quality impacts faunal assemblages by reducing both food and habitat resources.

Within the Study Area, increased dust emissions may result from the pit mining, dumping of waste rock material and from vehicle movements on haul roads. Dust deposition near significant fauna habitat is expected to be minimised through controls established in the Blast Management Plan and dust management procedures.

Altered Fire Regimes

Fire is a natural process in the Pilbara that commonly arises through lightning strike. However, changes to fire regimes, in particular when fires are too frequent or intense, can have negative ecological impacts, such as the loss of the understory growth that provides many reptiles and mammals with protection from predators and the loss of food resources, such as seeding grass for graminivorous birds (Carwardine *et al.*, 2014). The impacts of altered fire regime can vary between fauna species, and low frequency fires may also have an impact; for example, inhibiting movement through retention of high vegetation cover for Greater Bilbies (Bradley, 2015). Altered fire regimes have been identified as one of causes of decline or extinction of medium-sized mammals in arid Australia (Burbidge & McKenzie, 1989; Burrows *et al.*, 2006). The proposal may increase the frequency of fires (e.g. expanded traffic network and increased traffic movements, or an increase in grassy fuel load (Carwardine *et al.*, 2014)) or reduce the scale/extent of natural wildfires, as a result of infrastructure acting as firebreaks and on-site management (i.e. fire suppression). Calidus will implement fire management procedures to address this impact source.

Modification of Water Regimes

Within the Pilbara, the growth of the mining industry presents new challenges for water management, from mine de-watering causing groundwater drawdown, to alteration of flow regimes and creation of new water sources on the surface (Carwardine *et al.*, 2014). Development activities have the potential to impact water sources through changes to water quality (e.g. temperature, heavy metals, carbonates) from dewatering discharges, and direct discharge of waste to surface water systems can occur (Bunn & Arthington, 2002; EPA, 2018a). Groundwater that discharges into existing bodies may also promote invasive species (Fensham & Fairfax, 2008).

The Study Area is located centrally within the Coongan River catchment situated along the Warrawoona Ridge (GRM, 2019a). All the watercourses and drainages in the vicinity are ephemeral, with flows occurring periodically during the summer, with no semi-permanent or permanent pools recorded (Biologic, 2017a). There are several minor ephemeral watercourses and drainage lines that cross the Study Area on the south side of the Warrawoona Ridge in a roughly northeast to southwest direction, the most significant of which are Brockman Hay Cutting Creek and Sandy Creek with catchment areas of some 46.5 and 199.2 km^2 respectively. These catchments are predicted to have reduced run-off volume post-mining, with Brockman Hay Cutting most greatly affected (97.7% of pre-mining runoff) (GRM, 2019b). Some activities will actively seek to re-use surface runoff from catchments during operations, such as recycling surface water through the plant. Advanced dewatering of the proposed Klondyke pit will also be undertaken, to minimise groundwater inflows during active mining. It is understood that these activities will be monitored and follow developed groundwater and surface water procedures.

Alteration to Water Quality

Waste structures, including tailings storage facilities and waste rock dumps can cause impacts to water quality during operations and/or after operations cease (EPA, 2018a), both structures of which will be constructed during mining in the Study Area. In the gold industry, cyanide is the most significant contaminant influencing wildlife, and is known to cause significant mortality events when present above a critical toxicity threshold (Griffiths *et al.*, 2014), particularly for migratory birds and bats (Eisler & Wiemeyer, 2004). To minimise potential wildlife toxicity, the Warrawoona Project will employ a cyanide reduction/destruction process and implement cyanide management procedures to maintain a concentration <30 mg/L and less than the 50 mg/L industry standard.

Table 4.1: Summary of the relationship between impact sources and outcomes on fauna that may arise from development within the Study Area

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Removal, fragmentation or modification of habitat (including reduced or prevention of access to feeding or roosting habitats)	• Total land disturbance of approximately 378.6 ha ha* (including roads, mining pits, Tailings Storage Facility, processing plant, camp etc). • Total disposal of no more than 22 million loose cubic metres (LCM) adjacent surface • Disposal of up to 2 million tonnes per annum of process tailings at Klondyke	Direct	• Habitat loss or reduction in condition	• Mortality or displacement of individuals • Population fragmentation • Decline in population size • Local extinction • Reduction in the carrying capacity of the environment, or a reduction in the species or individuals that the environment can support *i.e.* where population size levels off through time • Reduced in reproductive success • Reduction in diversity
		Indirect	• Habitat fragmentation and/or reduction in habitat quality of adjacent areas. • Habitat modification or loss due to structural changes (*i.e.* shafts and adits). • Disturbance responses or other behavioural changes in individual animals • Erosion and altered drainage patterns.	
Vehicle Strike	• Indicative total length of roads and pipeline/ powerline corridors of 7.6 km length (approximately 40 ha disturbance* • Records of conservation significant fauna vehicle strike in the region *e.g.* Greater Bilby (Outback Ecology, 2012)	Direct	• Collision with animals.	• Mortality or injury of individuals • Decline in population size
Introduced Species	• Feral cats (Biologic, 2019a) and Buffel grass (Biologic, 2017a) have been recorded within the Study Area • Other invasive species such as red foxes, cattle, donkey have been recorded in the vicinity	Indirect	• Habitat degradation and loss (from grazers and weeds) • Competition for resources. • Predation • Increased mortality from toxic introduced species or management (e.g. poisoning) • Introduction/spread of disease. • Increased fuel loads from grassy weeds	• Mortality of individuals. • Decline in population size. • Local extinction.

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Increased light	• Unquantified. Temporary mobile lighting will be installed in active mine pits and active operational areas.	Direct	• Disturbance responses or other behavioural changes in individual animals, especially for light sensitive species.	• Displacement of individuals • Reduction in reproductive success • Decline in population size • Reduction in diversity • Reduction in carrying capacity • Local extinction
		Indirect	• Changes in prey item aggregation for insectivorous species, resulting in changes to foraging behaviour	
Vibration and noise	• Vibration from the operation of heavy machinery and site works, including blasting.	Indirect	• Disturbance responses or other behavioural changes in individual animals • Species using audible cues for breeding activity may also experience disruption to breeding cycles or reduced breeding success. • Habitat modification or loss due to structural changes from vibration (i.e. shafts, adits) - the Pilbara Olive Python was recorded from a shaft.	• Displacement of individuals • Reduction in carrying capacity • Reduction in faunal diversity.
Dust	• Unspecified but increases certain to occur, particularly after blasting	Indirect	• Habitat modification due to degradation of vegetation or topsoil modification	• Displacement of individuals • Reduction in carrying capacity • Reduction in faunal diversity.
Changed Fire Regimes	• Unspecified.	Indirect	• Habitat modification; high frequency or intensity can reduce understorey habitat cover and reduce food sources such as seeding grass for graminivorous birds. High frequency fires may impact fire sensitive species (*e.g.* Mulga) or increase dominance of early stage Triodia communities. • Low frequency fires can result in dominance of senescent vegetation and high fuel loads	• Reduction in carrying capacity. • Reduction in faunal diversity.

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Altered water quality	• Known production of cyanide waste to occur in TSF. Cyanide level is expected to be contained to < 30mg/L	Direct	• Mortality or illness due to decreased water quality, in particular in relation to cyanide levels in water sources.	• Mortality/ displacement of individuals • Temporal changes in carrying capacity • Temporal changes in population size • Temporal changes in diversity
Modification to water regimes	• Minor reduction to pre-mining runoff for surface catchments present • Advanced dewatering will occur in the Klondyke pit	Direct	• Disturbance response from water-dependent species (e.g. migratory avian species, bat species)	• Mortality/ displacement of individuals • Temporal changes in carrying capacity • Temporal changes in population size • Temporal changes in diversity
		Indirect	• Habitat modification arising from local hydrogeological changes, including change in distribution and abundance of vegetation	

** Note – disturbance footprint areas reported in this document are approximate and subject to minor change.*

4.3 Criteria for assessing significance

The terms “significant impact” and “significant effect” are not defined in the EP Act 1986. Therefore, the prediction of significance for each potential impact identified in the Study Area is assessed using criteria considered by the EPA in their referral process (EPA, 2018b). These criteria were considered and defined by Biologic in Table 4.2 below, and are considered in detail for each conservation significant species in Table 5.1.

Table 4.2: Impact criteria used for each impact source assessed in the Study Area

Criteria	Assessment value	Definition
Duration	Short-term	>1 year
	Long-term	Years – decades
	Permanent	Indefinitely
Magnitude	Negligible	Displacement or loss of condition in individual animals
	Low	Loss of individuals but no measurable change in population size
	Moderate	Demonstrable change in population
	High	Population persistence threatened
Certainty	Data deficient	Insufficient data exist to quantify the impact pathway or the species’ ecological response
	Low	The impact has not been documented during similar mining developments, but anecdotal accounts, literature reviews of other data suggest it could arise
	Moderate	A reasonable body of data exist to support the assessment, or the impact has occurred during similar mining developments and would reasonably be expected to arise from the current proposal
	High	The impact is quantifiable and can be predicted with confidence from a reasoned evidence base

5. IMPACT ASSESSMENT OF KEY RECEPTORS

5.1 Impacts to Fauna Habitats

Land clearance is listed as a Key Threatening Process under the EPBC Act, and fauna habitat loss, as a direct result of land clearing and excavation, is considered the primary impact of the Project on terrestrial vertebrate fauna. Some habitat loss and degradation is expected to occur throughout most of the habitats present, including those considered of high significance. The scale of impact is expected to range from moderate (for land clearing at the proposed Klondyke mine pit, TSF, and WRD), through to minimal (for a proposed access track within Sandplain habitat). Habitat loss or degradation is going to occur on the greatest scale in the Hillcrest/ Hillslope and Stony Plain habitats from these development activities and construction. However, there is habitat connectivity outside of the Study Area boundary and none of the habitat types are restricted to the Study Area.

Potential indirect impacts to fauna habitat may include changes to fire regimes, reduction in habitat quality from dust deposition, decline in water quality and increases in the abundance of introduced species (Section 4.2).

5.2 Impacts to Vertebrate Fauna of Conservation Significance

The direct and indirect impact sources that may affect key receptor species can be difficult to quantify and predict in advance of developments occurring. Habitat loss is considered to be the primary impact to conservation significant fauna within the Study Area, and although land clearing or degradation may be estimated, the final impact to the species regional and local population (i.e. loss or displacement of individuals), is difficult to quantify and not well demonstrated. The extent and magnitude of other impact sources, such as noise, light, or changed fire regimes, have not been well researched for Pilbara fauna species, and the final impact is limited in its accuracy.

Apart from habitat loss, degradation, or fragmentation, potential increases to introduced species numbers is the impact source most likely to impact conservation significant fauna, as it has the potential to affect species through multiple avenues; predation (i.e. cats, foxes, dogs), competition (i.e. food resources), disease, and further habitat degradation (i.e. introduced grazers). Of particular concern is predation, particularly by feral cats, and there is ample evidence that predation by such introduced species is a primary factor in the decline of numerous taxa (Burbidge & McKenzie, 1989). Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015), and so mining activities and development are expected to facilitate increased predation, for example through linear road clearings facilitating cat movement, and free water availability enabling cat persistence (Bradley, 2015).

For all vertebrate species present in the Study Area, extreme fire events could lead to a severe reduction or loss in localized populations; however the indirect impacts are varied and depend upon the ecology of the species, in particular core habitat requirements, and also the season, frequency, extent and severity of fires. For Northern Quoll, the most detrimental local impact of fire is likely to be through consequential changes in habitat structure and floristics (Hill & Ward, 2010), although the topographic complexity of their core habitat (Rocky Breakaway) may ameliorate the effect. Fire is likely to have a significant effect on Brush-tailed Mulgara populations through loss of individuals and prey items (Masters *et al.*, 2003), and increased predation risk after removal of mature spinifex cover following fire (Koertner *et al.*, 2007). However, Western Pebble-Mound Mice persist in their core spinifex habitats and mounds are still actively tended after fires have removed surrounding vegetation, with populations retaining density well in the initial post-fire period (Start *et al.*, 2000). In addition, it is known that smaller and more frequent fire can increase habitat and resource diversity for Greater Bilbies (Bradley, 2015), and recently burnt habitat (within the last 1-3 years) is included as a suitable habitat type, due to promotion of a key food source (Bradley, 2015; DBCA, 2017). However, there is a lack of knowledge concerning both increases in efficiency of predation on Greater Bilbies following fire (from decreased vegetation cover) and high vegetation cover becoming impenetrable to the species from a lack of fire (Bradley, 2015).

Vehicle strike is a well-recognised threat to most fauna species, and there are published reports of mortality associated with vehicular collision for most of the significant fauna present in the Study Area. Northern Quolls are known to cross roads, (Dunlop *et al.*, 2014) and are opportunistic foragers known to scavenge roadkill (Radford, 2012). Pilbara Olive Pythons are slow-moving, and many have died on roads due to a natural instinct to remain still in response to the vibrations of an approaching vehicle (Pearson, 2003). There is a record of a Greater Bilby vehicle strike in 2012 at McPhee Creek, 32 km south east of the Study Area (Outback Ecology, 2012). However, the level of certainty associated with this impact source is generally low, as many mortality events go unrecorded. However, there is unlikely to be a significant increase to vehicular strike of conservation significant fauna in the region, and any impacts are expected to be localized to individual deaths. Species such as the Western Pebble-Mound Mouse, as a rodent, have high fecundity and a “boom-bust” life-mode to recover from individual deaths (Start *et al.*, 2000).

Table 5.1 below summarises the potential impacts to fauna of conservation significance confirmed or likely to occur in the Study Area as a result of the proposed development. Other vertebrate fauna within the assessment area, including common and widespread species, would also be subject to a similar range of impacts.

Table 5.1: Potential impacts to vertebrate species of conservation significance potentially occurring in the Study Area

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species recorded within the Study Area								
<u>Northern Quoll</u> *Dasyurus hallucatus* **EPBC Act** Endangered **BC Act** Endangered	Confirmed (Biologic, 2017a, 2019a, 2019c)	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (Rocky Breakaway), but also in foraging/dispersal habitat in Hillcrest/ Hillslope, Rounded Hills and Medium/Minor Drainage Line Extent of barrier to movement or habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** The population within the Study Area is most likely permanent and considered a high-density population important for the long-term survival of the species. Although their semelparous nature (Oakwood, 2000) may make them susceptible to local extinction, the species does have good dispersal ability (Spencer, 2013; Woolley, 2015). The Warrawoona Ranges represent rocky habitat connecting north and south populations of Northern Quoll, and removal may cause some fragmentation. However, as a large portion of the rocky ridge is remaining, and full localised extinction is not expected, this is unlikely to be the case. Nineteen hectares of Rocky Breakaway habitat (core denning habitat) is present in the Study Area, and although only 0.71 ha intersects with the Disturbance Footprint, the proposal is also likely to impact on key foraging and dispersal habitat (Hillcrest/hillslope, Rounded Hills, and Medium/Minor Drainage Line).	**Low –** The preferred habitat for this species extends well outside the Study Area and the species is widespread in a regional context. In the Pilbara, the distribution of Northern Quolls is already fragmented (Hill & Ward, 2010) and there is good dispersal habitat present (drainage lines and the Warrawoona Ranges). Minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ denning habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**High** – habitat fragmentation and loss by mining and infrastructure development are well recorded as potential impacts for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014)
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Moderate –** Northern Quolls are known to cross roads (Dunlop *et al.*, 2014), and are opportunistic foragers known to scavenge roadkill (Radford, 2012). The species is regularly recorded from both vehicle strike and from being crushed in machinery (Cramer *et al.*, 2016). The widening of a single access track was found to significantly increase mortalities and led to the extirpation of a population of eastern quolls in Tasmania (Jones, 2000). Although no records of vehicle strike of Northern Quoll exist within the Study Area road infrastructure may increase within denning and foraging habitat. The threat of vehicle strike is likely to subside substantially post life of mine.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Loss of individuals • Temporary reduction in population size	**Moderate** –there may be unrecorded deaths from vehicular collisions within the Study Area.
		Increased light and noise Increased noise	Extent of ground disturbance in foraging/ denning areas	Long-term (life of mine)	**Low –** Northern Quoll are known to occur around mine sites and human dwellings, and shelter amongst mine infrastructure such as vehicles, machinery and laydown areas (Oakwood, 2008) where there are enhanced levels of light and noise. There may be a higher concentrations of prey items e.g. insects around lights (Oakwood, 2008).	**Negligible –** Increased light and noise will not affect individuals outside of the Study Area.	• Possible dispersal from greatly enhanced levels of light and noise disturbance, especially in denning areas • Changes to prey distribution	**Low** - The extent to which the species may be affected by noise or light is not well understood
		Introduced Species	Extent of distribution of introduced predators and invasive weeds.	Permanent	**Moderate –** Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). The threat posed by cats to the Northern Quoll is thought to be severe, although the impacts of cats may be reduced in rugged refuge areas (Woinarski *et al.*, 2014). Northern Quoll are susceptible to cane toad toxins (Hill & Ward, 2010), and if cane toads expand south through the Pilbara, any temporary creation of artificial water sources from discharge may attract these introduced species. Invasive weed species may disadvantage Northern Quolls through inhibiting movement or fostering inappropriate fire regimes (Hill & Ward, 2010).	**Low –** The presence of introduced predators and invasive weeds may be exacerbated by the proposed development however, it is not likely to have a significant impact on top of background levels already present.	• Loss of individuals from predation • Reduction in population size • Loss of prey items from competition • Alteration/degradation of habitat	**Low** – there are no records of Cane toads expanding into the Pilbara although they are predicted to invade the region (Cramer *et al.*, 2016). However, detailed modelling of Northern Quoll and Cane Toads does not indicate the two species distributions converging (Molloy, 2015)

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long-term (life of mine)	**Low –** Northern quolls cope with fire in rocky habitats (Cook, 2010). The most detrimental local impact of fire on Northern Quolls is likely to be through consequential changes in habitat structure and floristics (Hill & Ward, 2010); however certain habitats such as deeply incised Valleys, Gorge/ Gully habitats and Rock Outcrops provide refuge from fire. Fire may also affect reproductive characteristics of Northern Quolls, or cause increased predation after removal of cover (Hill & Ward, 2010).	**Low –** The season, frequency, extent and severity of fires are all likely to be key factors influencing regional Northern Quoll populations (Hill & Ward, 2010). Fires ignited in the Study Area are likely to burn outside of the boundary and therefore impact on populations in the surrounding region; however, these are not expected to be at a significantly higher than existing levels.	• Possible loss of prey items, although Northern Quolls are less vulnerable to starvation due to an opportunistic diet • Loss of foraging/ dispersal/ denning habitat • Potential change in breeding cycles • Loss of individuals from increased predation	**Moderate** – altered fire regimes (causing habitat change and loss) is well recorded as a potential impact for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014).
Pilbara Olive Python *Liasis olivaceus barroni* **EPBC Act** Vulnerable **BC Act** Vulnerable	Confirmed (Biologic, 2019a)	Removal, fragmentation or modification of habitat	Extent of clearing or barrier to movement in core habitat (Medium Drainage Line, Rocky Breakaway)	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** This species is confirmed from the Study Area, and core foraging and dispersal habitat is likely to partially removed. Destruction of habitat is an identified threat to the species (TSSC, 2008b). They may disperse across roads but drains and pits will represent barriers to movement.	**Low –** The species is known to be widespread in the surrounding region, and the preferred habitat for this species extends well outside the Study Area. Although males occupy a distinct home range, travelling up to 4 km during breeding season to locate females (Pearson, 2003), minor impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ denning habitat • Reduction in population size • Increase in population isolation • Increase in population isolation • Loss of genetic diversity	**Moderate** – Some level of habitat disturbance appears to be tolerated by the Pilbara Olive Python. Numerous nearby records exist, and Pilbara Olive Pythons are a larger species with higher dispersal capabilities and home ranges (Pearson, 2003; Tutt, 2004).
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** there is a confirmed record of the species within the Study Area. Deliberate road kills, associated with increased road traffic from tourism and industry, are a listed threat for the species (TSSC, 2008b). The species is slow-moving, and many have died on roads due to a natural instinct to remain still in response to the vibrations of an approaching vehicle (Pearson, 2003). Road mortality is more likely to occur during breeding season when males are in search of females (Eco Logical Australia, 2015). However, most of the proposed road network is to be constructed in low quality habitat for the species.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Loss of individuals • Reduction in population size	**Moderate** – Vehicle strike is a well recorded threat for the species, and there may be unrecorded deaths from vehicular collisions within the Study Area.
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long-term (life of mine)	**Low –** The most detrimental local impact of fire on the species is likely to be through consequential changes in habitat structure and floristics, and loss of prey items. Individuals are mobile, and dispersal habitat will not be removed, allowing individuals movement across the Study Area.	**Low –** season, frequency and extent of fires across the Pilbara may play a key role in influencing Pilbara Olive Python habitat suitability in the Pilbara bioregion	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of foraging/ dispersal/ denning habitat • Possible loss of prey items	**Low** - the response of species to changes in regime is largely unknown and difficult to predict due to lack of data for season, frequency and extent of fires across the Pilbara, all of which may play a key role in influencing Pilbara Olive Python habitat suitability in the Pilbara bioregion (DoE, 2019).

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced species	Extent of distribution of introduced predators and invasive weeds.	Permanent	**Moderate –** Predation by introduced species (cats, foxes, dogs), particularly on juveniles, is identified as a major threat (TSSC, 2008b), as well as predation from these species on the Pilbara Olive Python's food sources (Ellis, 2013). Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). There is likely to be a degree of overlap of preferred habitat with the Cane Toad, and the potential for opportunistic feeding of juvenile Pilbara Olive Pythons on toads at these riparian habitats (Eco Logical Australia, 2015)	**Low –** The presence of introduced predators and invasive weeds may be exacerbated by the proposed development however, the threat of such species is not expected to escalate at a regional level due to the proposed development.	• Direct loss of individuals • Reduction in population size • Loss of prey items • Alteration/degradation of habitat	**Moderate** – predation by introduced species is well recorded for the species.
		Alteration of water quality	Extent of existing and future water sources	Long term	**Moderate –** Waterholes and sources are an important feature of Pilbara Olive Python core habitat in the Pilbara (Pearson, 2003). They have been observed to use artificial water sources, such as sewage treatment ponds and recreational lakes, along with overburden heaps and railway embankment (Pearson, 2003). Changes in groundwater and surface hydrology from the proposed development activities, including in the vicinity e.g. Copenhagen, may affect the local population. The presence of TSF may attract individuals and cause direct impacts.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality or regimes from the proposed development is unlikely to have an impact on regional populations.	• Loss of foraging/ dispersal/ denning habitat • Loss of individuals from reduction in water quality leading to mortality/displacement • Loss of prey items utilizing water sources	**Moderate** - Habitat quality is strongly influenced by the presence of water sources (Pearson, 2003), and so alteration of existing water sources in the vicinity, or creation of new sources, is likely to influence the species.
		Modification of water regimes						
<u>Brush-tailed Mulgara</u> (*Dasycercus blythi*) **DBCA Priority** Priority 4	Confirmed (Biologic, 2019a)	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (primarily Sandplain) and barrier to movement	Long-term (life of mine)	**Low –** there is only one habitat type considered highly suitable to support the species within the Study Area (Sandplain). Although disturbance or fragmentation (i.e. the proposed access track) within this habitat type may have a local impact, studies have suggested that the species can tolerate a moderate local reduction in cover (to 15 %) of its preferred habitat (Masters *et al.*, 2003).	**Low –** Mulgara have a low propensity for dispersal once a home range has been established, with high site fidelity recorded (Masters, 2003; Thompson & Thompson, 2007), and there are no other contemporary records in the vicinity. However, the preferred habitat for this species extends well outside the Study Area, and the species is widespread in a regional context. Hence low impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ burrowing habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – It is known that Mulgara do not disperse readily and there is a confirmed record of the species within the Study Area. The preferred habitat type is likely to be impacted through planned disturbance (construction of an access track); however the species can tolerate a **Moderate** local reduction in cover of its preferred habitat (Masters *et al.*, 2003).
		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Low –** at the local scale there are confirmed records within the Study Area (eight records over multiple nights in 2019 (Biologic, 2019b)), and planned disturbance (a proposed access track) within the Sandplain habitat in which it was recorded. Therefore, there is the possibility of vehicle strike to Mulgara within the Study Area, although the probability is likely low and the ability for the population to recover is likely high.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Direct loss of individuals • Reduction in population size	**Low** – there may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced Species	Extent of distribution range of introduced predators and grazers.	Permanent	**Moderate –** The species is preyed upon by feral predators (e.g. cats, foxes, dogs *etc*) (Woinarski *et al.*, 2014, 2015). These species are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). Introduced grazers such as cattle have been found to favour dune swales as "alleyways", and mammal diversity in habitat types suitable to support Mulgara is lower in areas grazed by cattle (Frank *et al.*, 2008). The combination of threat from both grazers and introduced predators poses a Moderate risk to the species.	**Low –** although predation by introduced species is recorded as one of most significant threats to Brush-tailed Mulgara, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Direct loss of individuals • Reduction in population size • Degradation of foraging/ burrowing habitat by introduced grazers	**Moderate** – predation by introduced species is well recorded for the species

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ burrowing areas	Long term	**Moderate –** Fire will have a significant effect on Mulgara populations by loss of individuals and prey items (Masters *et al.*, 2003), and extreme fire events could lead to a severe reduction or loss in localized populations in the Study Area. Mulgara are vulnerable to changes in vegetation cover through removal or fire, preferring a habitat mosaic that includes patchiness in cover and mature Spinifex hummocks, although they will continue to use burnt areas (Körtner *et al.*, 2007). Mulgaras are also subjected to increased predation risk after removal of mature spinifex cover fol**low**ing fire (Koertner *et al.*, 2007).	**Low –** The impact of fire on regional Brush-tailed Mulgara populations is likely to be influenced by the season, frequency, extent and severity of fires.	• Direct mortality from fire events • Loss of prey items (invertebrates and rodents) • Loss of foraging/ burrowing habitat • Loss of individuals from increased post-fire predation	**Moderate** – although the impacts of fire on a local scale, such as habitat removal and loss of prey items, have been studied (Körtner *et al.*, 2007; Masters *et al.*, 2003), there is a need for more certainty on the impact of fire on Mulgara on a regional level.
Western Pebble-mound Mouse *Pseudomys chapmani* **DBCA Priority** Priority 4	Confirmed (Biologic, 2019c)	Removal, fragmentation or modification of habitat	Extent of clearing/ habitat modification, or barrier to movement, on core habitat (Hillcrest/ hillslope and Stony Plain)	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** core habitat types of Hillcrest/ hillslope (718 ha, 39.42 %) and Stony Plain (548 ha, 30.07 %) are the greatest in extent within the Study Area and are likely to experience loss to some extent. Given the species is a habitat specialist to these areas, the individuals within the Study Area are likely to be negatively impacted by any ground disturbances on a local level. Individuals within mounds are known to have small "core" home ranges (0.29-0.93 ha), and do not use secondary mounds, indicating that they are utilising a patchy food resource (Anstee *et al.*, 1997). Therefore, although the species occupy habitat types of greatest extent in the Study Area, they may not utilise the whole of these habitat types, occupying resource rich niches, and local disturbance may be significant. However, clearing for roads is unlikely to cause a barrier to movement between local populations, as small rodents are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000).	**Low –** The distribution of the species is strikingly fragmented by unsuitable plains and it is unlikely that the species can disperse across substantial barriers within the region (Ford & Johnson, 2007). However, the species and its core habitat are widespread in the local region and throughout the Pilbara, and despite the smaller body size (which limits long-distance dispersal) (Whitmee & Orme, 2013), only minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – there are multiple records within the Study Area, and the core habitat types are greatest in extent and likely to be impacted. Therefore, there is a high degree of certainty that habitat loss/modification will occur for this species.
		Vehicle strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** at the local scale, the species has multiple records within the Study Area, and as a rodent has a high fecundity and "boom-bust" life-mode to recover from individual deaths (Start *et al.*, 2000).	**Negligible –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Study Area.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** Western Pebble-Mound Mice persist in their core spinifex habitats, and mounds are still actively tended, after fires have removed surrounding vegetation (Start *et al.*, 2000). Populations can retain density well in the initial post-fire period (Start *et al.*, 2000).	**Low –** The species have persisted in more fire-prone habitats, and it is noted as unlikely that fire has been a significant, causative factor in their decline (Start *et al.*, 2000). The season, frequency and extent of fires across the Pilbara may play a role in influencing Western Pebble-Mound Mice habitat suitability in the region, but the overall regional impact is considered low.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Moderate** – The species is known to persist or recover well post-fire
		Introduced Species	Extent of distribution range of introduced predators and competitors	Long term (life of mine)	**Low –** Feral predators (e.g. cats, foxes, dogs *etc*) are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). Predation by these species is likely to be a contributing factor to the species decline; however this threat is not well researched for the species and this threat will be actively managed for the life of the development.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat	**Low** – the threats to the species have not been rigorously studied
		Increased light Increased noise	Extent of local behavioural disturbances	Long-term (life of mine)	**Low –** The species is quite adaptable and may acclimatise to certain disturbances such as noise and light as evident from active mounds been observed adjacent to exploration camps (e.g. M. O'Connell, *pers. obs.*).	**Negligible –** Increased light and noise will not affect individuals outside of the Study Area.	• Possible dispersal from greatly enhanced levels of light and noise disturbance • Changes to prey distribution	**Moderate** – species is known to tolerate a small amount of disturbance.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species identified as likely or possibly occurring in the Study Area								
<u>Greater Bilby</u> (*Macrotis lagotis*) **EPBC Act** Vulnerable **BC Act** Vulnerable	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat (primarily Sandplain)	Long term (life of mine)	**Low –** the species is a habitat specialist in Sandplain (and potentially Stony Plain). Greater Bilbies are semi-fossorial and nocturnal, remaining in their burrows during the day and intermittently during the night for rest and refuge. They occur naturally as scattered solitary individuals or small groups (Smythe & Philpott, 1968; Southgate, 1990), and the loss or modification of core habitat may have a potential impact on the ability of the Study Area to support a population. The effects of linear land clearing for tracks, road and rail on bilby numbers is uncertain (Bradley, 2015).	**Low –** Greater Bilbies are recorded as having low site fidelity and high mobility (Southgate *et al.*, 2007); males regularly move three to five kilometres between burrows on consecutive days; and have been recorded moving up to 15 km in a few weeks (Southgate & Possingham, 1995). This high mobility, together with low population density, ensures that the area of occupancy is often far less than the extent of occurrence, and the distribution is highly fragmented within the Pilbara bio-region (Friend *et al.*, 2012). However, it is not a commonly recorded species during surveys and on a regional scale, the loss of individuals and core Sandplain habitat may have some impact.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ burrowing habitat • Reduction in population size	**Moderate** – there are local records of the species, and as a habitat specialist, the removal of core habitat would impact any individuals present in the Study Area. However, the species is known to have **Low** site fidelity and high mobility.
		Vehicle strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Moderate –** Road and rail traffic is known to cause mortality of bilbies (Bradley, 2015). There is planned disturbance (a proposed access track) within the Sandplain habitat which may support the species. Therefore, there is the probability of vehicle strike to Greater Bilby within the Study Area; however, the local impact is considered moderate due to the low population that may potential occur in the Study Area, thus a small number of vehicle strikes may have a significant impact to the species at the local scale. .	**Low –** There is a record of a Greater Bilby vehicle strike in 2012 at McPhee Creek, 32 km south east of the Study Area (Outback Ecology, 2012). Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced Species	Extent of distribution range of introduced species.	Long-term (life of mine)	**Moderate –** cat predation is assumed to be a major driving factor in the decline of bilbies, and mining activities and development are expected to facilitate increased predation e.g. linear road clearings facilitating cat movement, and free water availability enabling cat persistence (Bradley, 2015). Foxes are also considered a significant threat (Bradley, 2015). However, there is a need to improve the understanding of the threat posed by introduced predators and herbivores (Dziminski & Carpenter, 2017).	**Low –** Although cats are a significant threat to the species, they do co-occur with the bilby across its extant range. Bilby distribution is associated with an absence or scarcity of grazers and rabbits, which often target areas of prime Greater Bilby habitat in the Pilbara (Bradley, 2015). Such threats are already present in the region and unlikely to be significantly exacerbated by the proposed development.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat	**Moderate** - It is hoped that numbers of feral predators such as feral cats and foxes and introduced grazers will not significantly increase with suitable monitoring and management. However, there is a need to improve the understanding of the threat posed by introduced predators and herbivores (Dziminski & Carpenter, 2017)
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** It is known that smaller and more frequent fire increase habitat and resource diversity for bilbies (Bradley, 2015). Recently burnt habitat (within the last 1-3 years) is included as a suitable habitat type for Greater Bilby (DBCA, 2017), due to promotion of a key food source (Bradley, 2015). However, there is a lack of knowledge concerning both increases in efficiency of predation on bilbies following fire (from decreased vegetation cover) and high vegetation cover becoming impenetrable to bilbies from a lack of fire (Bradley, 2015).	**Low –** the scale and frequency of fires in the region are not expected to increase. Greater Bilbies are recorded as responding well to recent fires, as well as persisting in areas of low fire frequency (e.g. Gibson Desert) (Bradley, 2015) and so the impact of changed fire regimes is not expected to be significant.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Change in food items (in the absence of plant food availability, bilbies are more reliant on invertebrate food sources).	**Moderate** - There is a need to improve the understanding of how fire regimes affect Greater Bilbies (Dziminski & Carpenter, 2017)
<u>Spectacled Hare-wallaby</u> (*Lagorchestes conspicillatus leichardti*)	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat (primarily Sandplain and Stony Plain)	Long term (life of mine)	**Low –** there are no records within the Study Area, and the species is highly unlikely to experience significant loss of core habitat. There is connectivity to similar habitat outside the boundary. It is larger species with higher dispersal capabilities, thus would be able to move away from disturbances.	**Low –** Little is known of the regional distribution of this species; however, it is unlikely that any local impacts would manifest at a regional scale.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat (Sandplain, Stony Plain)	**Moderate** – although no records within the Study Areas, the nearest record is adjacent to the boundary (1 km away). The species is highly unlikely to experience significant loss of core habitat, and as a medium sized mammal the species may be more likely to be able to overcome local barriers to movement

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
DBCA Priority Priority 3		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Moderate –** There is planned disturbance, including areas of vehicular use, within habitats likely to support the species. The species is more active at night, when it forages on shrubs, grasses, and herbs (Burbidge, 1983), which reduces the likelihood of vehicle strike. While there is the probability of vehicle strike to Hare-wallaby within the Study Area. Due to the likelihood of a low-density population, if present, the impact is considered to be moderate at the local scale as a small number of vehicle strikes is likely to impact the local population.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – there may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced species (predation and competition)	Extent of distribution range of introduced predators.	Long-term (life of mine)	**Low –** Significant threats to the species include potential predators and impacts to core habitat from grazing (Broome Bird Observatory, 2017). However, potential predators (cats, foxes etc) are unlikely to significantly increase with suitable monitoring and management.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat from grazers	**Low** – Although predation is listed as a significant threat to the species, little ecological data on the species regarding this impact is available from the region.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Moderate –** All sites occupied by the species have potentially suitable shelters (shrubs, grass tussocks or spinifex hummocks) within 50 m of the feeding areas (Ingleby & Westoby, 1992). Although it may feed in areas regenerating after fire (Maxwell *et al.*, 1996), frequent or recent fires in the Study Area are considered to have a moderate local impact and decrease the suitability of the core habitats to provide shelter for the species.	**Low –** the scale and frequency of fires in the region are not expected to significantly increase.	• Loss of individuals from direct mortality, • Increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Change in food availability	**Moderate** – the species is known to require shelter in close proximity to feeding sites, and any increases in fire frequency or severity is likely to decrease the habitat suitability within the Study Area
<u>Northern Brushtail Possum</u> *Trichosurus vulpecula arnhemensis* **BC Act** Vulnerable	Possible	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (Medium/ Minor Drainage Line, and potentially rocky habitats such as Rocky Breakaway) and the extent of barrier to movement or habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits other infrastructure will be rehabilitated	**Low –** Within Western Australia, the former range of the Brushtail Possum has been considerably reduced by habitat clearing and fox predation, including in large areas of arid country (DEC, 2012). Although there will be clearing and disturbance to habitat suitable to support the species, there are no records of the species occurring within the Study Area and the suitable habitat (Medium/Minor Drainage Lines) makes up a small proportion of the Study Area. However, home ranges of the species are relatively small (males 1.12 ha and 165 m; females 0.89 ha and 155 m) (Kerle, 1998), and although they overlap both inter- and intra-sexually, fragmentation may have an impact. Additionally, the habitat is only marginally suitable.	**Low –** Little ecological information is known about the Pilbara population, although it is most often recorded from gorges and major drainage lines that contain large hollow-bearing Eucalypts (DBCA, 2019a). The preferred habitat for this species therefore extends well outside the Study Area. Although the species is widespread in a regional context, it is infrequently recorded in the Pilbara region, with less than 20 records existing on NatureMap (DBCA, 2019a). The nearest record is 26 km SW of the Study Area from 2014 (DBCA, 2019a). Based on the flexibility of their habitat preferences (Kerle *et al.*, 1992), and lack of records, minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ hollow habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**Low** – Little ecological information is known about the Pilbara population of the Northern Brushtail Possum and is infrequently recorded in the Pilbara region.
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** Brushtail Possums are known to cross roads (Giffney *et al.*, 2009), and this can lead to vehicle strike and mortality. However, no records of the species exist within the Study Area, although road infrastructure is going to increase within suitable habitat. With a potential reproductive rate of nearly two per year (Kerle, 1998), it is probable that populations of the Northern Brushtail Possum can readily recover from individual deaths.	**Low –** there is unlikely to be a significant increase to vehicular strike of Northern Brushtail Possums in the region.	• Loss of individuals • Reduction in population size	**Moderate** –there may be unrecorded deaths from vehicular collisions within the Study Area.
		Increased light Increased noise	Extent of ground disturbance in foraging/ denning areas	Long-term (life of mine)	**Low –** Brushtail Possums are known to occur around human habitation and activities (Roetman & Daniels, 2009) where there are enhanced levels of light and noise, although there are no specific studies on the impact of light and noise on the northern subspecies. There may be a higher concentrations of prey items e.g. insects around lights (Oakwood, 2008). There is unlikely to be a significant impact from increased light or noise to any potentially occurring local individuals.	**Low –** there is unlikely to be a significant impact from increased light or noise to Northern Brushtail Possum in the region.	• Possible dispersal from greatly enhanced levels of light and noise disturbance, especially in denning areas	**Moderate** – Although Brushtail Possums are known to co-inhabit with humans, the extent to which the northern subspecies of Brushtail Possum is affected by noise or light is not researched.

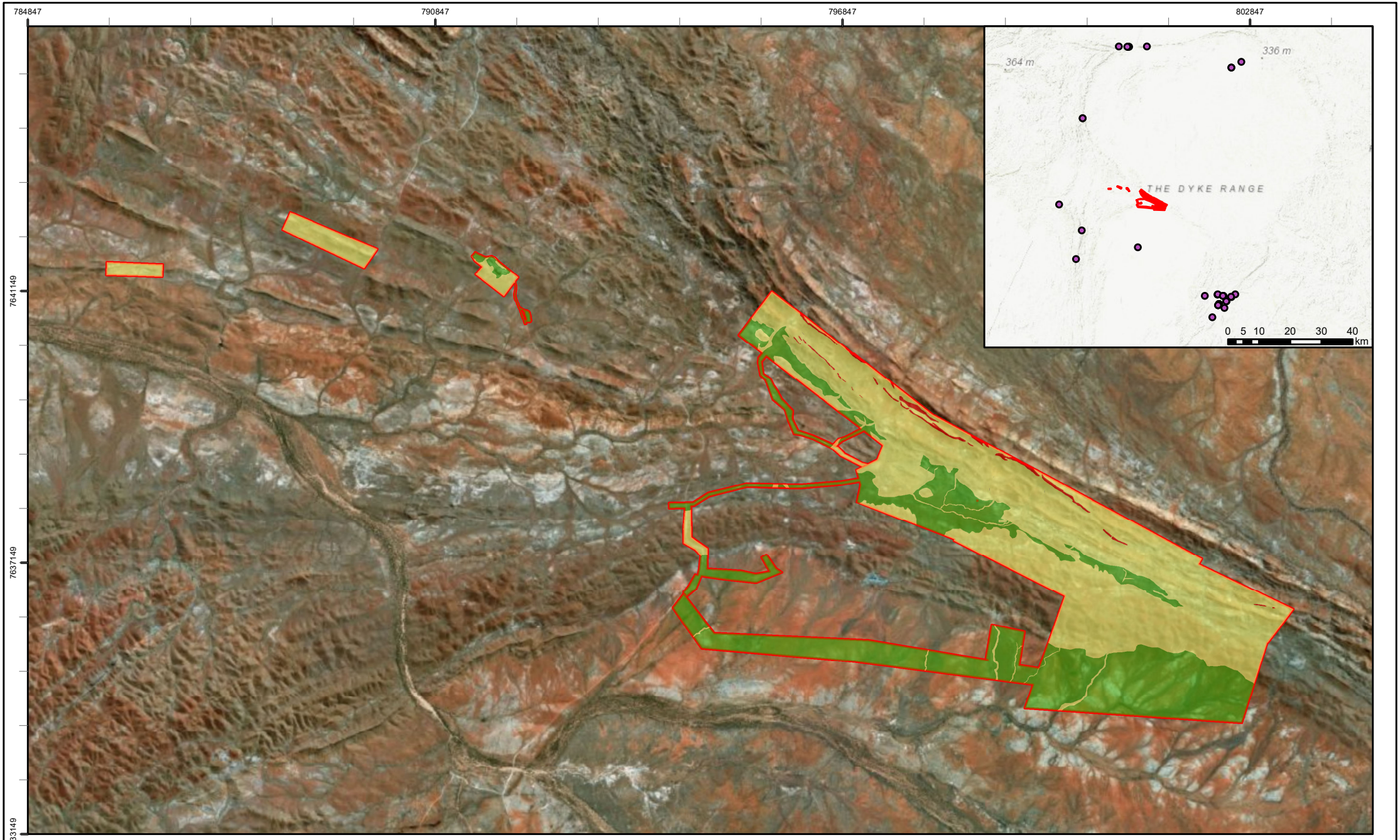
Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species	Extent of distribution of introduced predators and invasive weeds.	Long-term (life of mine)	**Low –** The Northern Brushtail Possum is regarded as a 'critical weight range' mammal, and thus more susceptible to pressure from introduced predators (Burbidge & McKenzie, 1989). Predation of the species by dingoes was observed by Kerle (1998). Although predation by foxes, cats, dingos, large pythons and large monitors is particularly significant in areas where population numbers are low (DEC, 2012), there are no records of the species within the Study Area. Invasive weed species may disadvantage Northern Brushtail Possum through inhibiting movement or fostering inappropriate fire regimes.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Loss of prey items from competition • Alteration/degradation of habitat	**Moderate** – Predators such as feral cats and foxes are unlikely to significantly increase with suitable monitoring and management.
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long term (life of mine)	**Low –** On a local level, inappropriate fire regimes are likely to impact any individuals present through consequential changes in habitat structure and floristics. In particular, the availability of the tree hollows and ground refuges (hollow logs, rockpiles and the burrows of other animals) utilized by the species (Kerle *et al.*, 1992) will be detrimentally impacted by frequent fire. Fire may also affect cause increased predation after removal of cover (Carwardine *et al.*, 2014). However, the high fecundity of the species means that they can readily recover from short periods of unfavourable conditions within their preferred habitat (Kerle, 1998).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be a factor influencing Northern Brushtail Possum populations, the proposed development is unlikely to have an impact on a regional scale.	• Loss of foraging/ dispersal/ denning habitat, in particular refuges • Possible loss of prey items, although species is omnivorous (Cruz *et al.*, 2012) • Loss of individuals from increased predation	**Moderate** – altered fire regimes (causing habitat change and loss) is well recorded as a potential impact for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014).
		Altered water quality Modification to water regimes	Extent of existing and future water sources	Long term (life of mine)	**Low –** Within the Pilbara the species is most often recorded from gorges and major drainage lines that contain large hollow-bearing Eucalypts (DBCA, 2019a); therefore, modification to existing water regimes and water quality from mining activities may impact suitable habitat within the Study Area. Morton (1990) emphasized the importance of drought refuges, and Kerle *et al.* (1992) believe that for Brushtail Possum, these refuges may need sufficient ground water supplies for the survival of palatable trees and shrubs. The management plan for the groundwater drawdown at Klondyke Pit and changes to surface water catchments is not expected to have a significant impact on any Northern Brushtail Possum present.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality or regimes from the proposed development is unlikely to have an impact on regional populations.	• Changes to foraging/ dispersal/ habitat within Medium/Minor Drainage Lines • Displacement of individuals	**Low** – Little ecological information is known about the Pilbara population, and although the species may require drought refuges with sufficient groundwater, this requires further study.
Long-tailed Dunnart *Sminthopsis longicaudata* **DBCA Priority** Priority 4	Possible	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (Rocky Breakaway, and potentially Hillcrest/ hillslope and Rounded Hills) and extent of barrier to movement on habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits and other infrastructure will be rehabilitated	**Low –** The species is a habitat specialist to rocky scree and plateau areas and thus clearing of such habitat may directly impact the species (Burbidge *et al.*, 2008). Clearing for roads is unlikely to cause a barrier to movement between local populations, as small rodents are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000).	**Low –** In consideration of the species smaller body size (which limits long-distance dispersal), the highly patchy nature of records and the distance between populations, the dispersal ability of this species is potentially very poor (WAM, 2019). However, the core habitat extends beyond the Study Area boundary and is considered widespread in the region and throughout the Pilbara. Hence only minor impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**Moderate** – no records exist within the Study Area; however, it is likely that habitat suitable for the species will be impacted by the proposed development. Habitat fragmentation is unlikely, as small mammals are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000)
		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Low –** no records of the species exist within the Study Area, and Long-tailed Dunnarts have a relatively high fecundity to recover from individual deaths (McKenzie *et al.*, 2008).	**Negligible –** there is unlikely to be a significant increase to vehicular strike of Long-tailed Dunnarts in the region.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Assessment Areas. Management of vehicles within core habitat for conservation significant fauna needs to be implemented.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species (predation)	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** Although predation by introduced species is listed as a threat, these species (cats, foxes etc) are unlikely to significantly increase with suitable monitoring and management. Buffel grass is noted as threat through alteration of habitat structure and increasing fire hazard (Crowley, 2008), and the weed has been recorded within the Study Area previously and unlikely to significantly impact habitats of the species.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Low** – the cause of the species decline is not well defined, and assumed to be from a range of impact sources, including predation (Crowley, 2008).
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** the impact of changed fire regimes on this species is thought to be a contributing factor to its decline but is not well researched. Studies on other Sminthopsis species recorded that post-fire abundance was greatest at 4-9 years (mid succession habitat preference) (Wilson & Aberton, 2006).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing Long-tailed Dunnart populations, the proposed development is unlikely to have an impact on a regional scale.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Low** – The species response to fire and changes to fire regimes is not well documented.
		Increased light Increased noise	Extent of local behavioural disturbances	Long-term (life of mine)	**Low –** The effects of light and noise to the species are not at all studied. However, such factor do not seem to have a major impact of other species with a similar life history and which occupy similar niches thus it is assumed the species may acclimatise to such factors.	**Negligible –** there is unlikely to be a significant impact from increased light or noise to the species in the region.	• Possible dispersal from greatly enhanced levels of light and noise disturbance • Changes to prey distribution	**Low** – The species response to fire and changes to light and noise is not well documented.
Peregrine Falcon *Falco peregrinus* **BC Act** Specially Protected	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat. Potential nesting habitat may be present within Rocky Breakaway habitat, and the Medium Drainage Line provides suitable foraging habitat	Permanent	**Low –** This species is a habitat generalist. It is highly mobile and can easily move away from disturbances, making it less susceptible for any impact from the proposal. Although there are no records within the Study Area, the Peregrine Falcon was recorded in 2001 approximately 10 km west of the Study Area (DBCA, 2019a).	**Negligible –** Suitable habitat for the Peregrine Falcon is widespread and common regionally outside the Study Area. The proposed development is unlikely to have an impact on this species at a regional scale due to its general habitat preference, high mobility and large distribution.	• Loss/displacement of individuals during vegetation clearing and mining developments	High – the species is highly mobile and a habitat generalist, and no breeding records or evidence of resident individuals exist.
Grey Falcon *Falco hypoleucos* **BC Act** Vulnerable	Possible	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat. Potential nesting habitat may be present within Rocky Breakaway habitat, and the Medium Drainage Line provides suitable foraging habitat	Permanent / long term (life of mine) • some core habitat loss from open pits and other infrastructure will be rehabilitated	**Negligible –** No evidence of breeding or resident individuals within the Study Area. The species is most likely to be represented by foraging individuals within the Study Area only. This species is also highly mobile and can easily move away from disturbances, making it less susceptible for any impact from the proposal. The nearest record for this species is approximately 41 km south-east of the Study Area from 1994 (DBCA, 2019a).	**Negligible –** The proposed development is unlikely to have an impact on this species at a regional scale due to its general habitat preference, high mobility and large distribution.	• Loss/displacement of individuals during vegetation clearing and mining developments	High – the species is highly mobile and a habitat generalist, and no breeding records or evidence of resident individuals exist.
		Introduced Species	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** Introduced predators are identified as a possible major threat to the species within roosting habitat, as individuals frequently roost of the ground exposing them to predation (cats, foxes etc). Additionally, such species may indirectly reduce the availability of prey items for the species. However, species likely to impact upon the species are already present in the Study Area.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Moderate** – the impact of introduced predators on the species is not well documented although the threat is nonetheless regarded as a major threat likely to impact the species.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** the impact of changed fire regimes on this species is thought to be a contributing factor to its decline but is not well researched. Frequent fire may impact the quality of nesting, roosting and foraging habitat available to the species.	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing the species, the proposed development is unlikely to have an impact on a regional scale.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Low** – The species response to fire and changes to fire regimes is not well documented.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Black-lined Ctenotus *Ctenotus nigrilineatus* **DBCA Priority** Priority 1	Possible	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (Rounded Hills, Hillcrest/ Hillslope, Stony Plain)	Permanent (some core habitat loss)	**Low –** Despite extensive surveys it has very rarely been recorded (Craig, 2017). The closest record of *Ctenotus nigrilineatus* is located ~57 km east of the Study Area from 2000 (DBCA, 2019a). Any diggings (trenches etc.) are likely to provide barriers for movement for this small species.	**Low –** Little ecological information is known about the distribution of the species. Based on the flexibility of their habitat preferences and lack of records, minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments	**Low** – Little ecological information is known about the species and there are very few records of the species.
		Introduced Species (weeds, predation)	Extent of distribution range of introduced weeds and predators.	Long term (life of mine)	**Low –** Buffel grass is noted as threat for other threatened Ctenotus species through alteration of habitat structure and increasing fire hazard (TSSC, 2008a), and the weed has been recorded within the Study Area previously. Individuals of the species are likely to be predated opportunistically by introduced predators such as Cats and Red Foxes.	**Low –** Although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Low** – the cause of the species decline is not well defined, and assumed to be from a range of impact sources, including predation (Crowley, 2008).
Other significant fauna								
Night Parrot *Pezoporus occidentalis* **EPBC Act** Endangered **BC Act** Critically Endangered	Unlikely	Removal, fragmentation or modification of habitat	Extent of clearing and barrier to movement on core habitat (Stony Plain, Sand Plain)	Long term (life of mine)	**Low –** the species is a habitat specialist in old age spinifex on Sand and Stony plain with Acacia (DPaW, 2017). The Study Area contains Sandplain habitat considered highly suitable to support the species, however despite targeted surveys the species has not been recorded. Night Parrots are known to fly up to 100 km per night (Burbidge, 2016), and would be able to avoid habitat fragmentation at the scale imposed by the Proposal.	**Low –** The proposed development is unlikely to have a significant impact on the species at a regional level due to the low likelihood of occurrence.	• Loss/displacement of individuals during vegetation clearing and mining developments	**Moderate** – the age of the spinifex present in the Assessment Area (based on fire records and level of disturbance) and number of habitat assessments conducted suggests that the Study Area is unlikely to support Night Parrot.
		Vehicle Strike	Extent of expansion of existing road network	Long term (life of mine)	**Low –** Published accounts of Night Parrot behaviour suggest that the Night Parrot may be prone to vehicle strikes, if it is breeding or foraging near roads or tracks in or near the Study Area. Hamilton (2017) observed a bird crouching on a road, 1-1.5m from the road edge. The bird did not fly when approached but ran under a slow-moving vehicle. A second observation recorded a bird emerging from the base of a group of Eremophila shrubs, and the bird ran across the road (Hamilton, 2017). However, the species is rare and has not been previously recorded in the Study Area.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant due to the unlikely occurrence of the species within the local vicinity and region,	• Direct loss of individuals • Reduction in population size	**High** – it is unlikely that there are unrecorded deaths from vehicular collisions within the Study Area.
		Changed fire regimes	Extent of disturbance from fire in core habitat areas	Long term (life of mine)	**Low –** The Study Area occurs within the species former distribution, thus further degradation to habitat within this area will have an ongoing effect on the species. The core habitat of the species is old age spinifex (>50 years) (DPaW, 2017) and so changes to regimes that may increase fires will detrimentally affect core habitat and likelihood of species (TSSC, 2008c).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing the species, the proposed development is unlikely to have an impact on a regional scale due to the unlikely occurrence of the species.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of food items	**High** – core foraging and roosting habitat is known to require spinifex of a certain age. Therefore, fire is a known impact to core habitat requirements of the species.
		Introduced Species	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** TSSC (2008c) lists numerous threats arising from introduced species including; predation by feral cats and foxes, competition for food and degradation of habitat by livestock and feral herbivores, reduced availability of water due to consumption by camels and livestock and habitat degradation by rabbits and goats. However, the species has not been recorded in the Study Area despite targeted surveys.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area due to the unlikely occurrence of the species.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Moderate** – the impact of introduced predators on the species is not well documented although the threat is nonetheless regarded as a major threat likely to impact the species.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Migratory Birds • Barn Swallow (MI) • Fork-tailed Swift (MI) • Sharp-tailed Sandpiper (MI) • Common Greenshank (MI) • Wood Sandpiper (MI) • Curlew Sandpiper (CR/MI) • Common Sandpiper (MI) • Grey Wagtail (MI) • Oriental Pranticole (MI) • Oriental Plover (MI) • Pectoral Sandpiper (MI) • Yellow Wagtail (MI) • Osprey (MI) • Glossy Ibis (MI)	Unlikely/ Rare	Altered water quality	Extent of existing and future water sources	Long term (life of mine)	**Low –** Cyanide will be produced in the leaching of gold from ore, which will be added to the ore slurry. Cyanide is known to cause significant mortality events when present above a critical toxicity threshold (Griffiths *et al.*, 2014), particularly for migratory birds and bats (Eisler & Wiemeyer, 2004). to significantly impact upon the local population. Moderately high levels of Nickel arsenic may be present in the Klondyke pit lake post closure and may directly impact upon the health of individuals. However, over time this will become increasing saline and thus become too saline for wildlife to drink (B. Bullen *pers. comms.*). Open waterbodies (e.g. the TSF) are an attractant to these species; however, their occurrence is deemed Unlikely or Rare based on a lack of previous records and other habitat requirements.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality from the proposed development is unlikely to have an impact on regional populations due to their unlikely or rare occurrence.	• Loss of individuals from reduction in water quality (e.g. cyanide) leading to mortality/ displacement • Loss of foraging habitat during mining • Loss of prey items utilizing water sources	**Moderate -** cyanide is known known to cause significant mortality events to avian species when present above a critical toxicity threshold (Griffiths *et al.*, 2014).

Note: coloured cells indicate a scale of magnitude significance, where yellow = Low, Orange = Moderate, and red = High.



Legend

- Study Area
- Regional Northern Quoll records

Northern Quoll habitat

- High Quality
- Medium/Moderate Quality
- Low Quality

biologic Environmental Survey

N

1:70,000

0 0.75 1.5

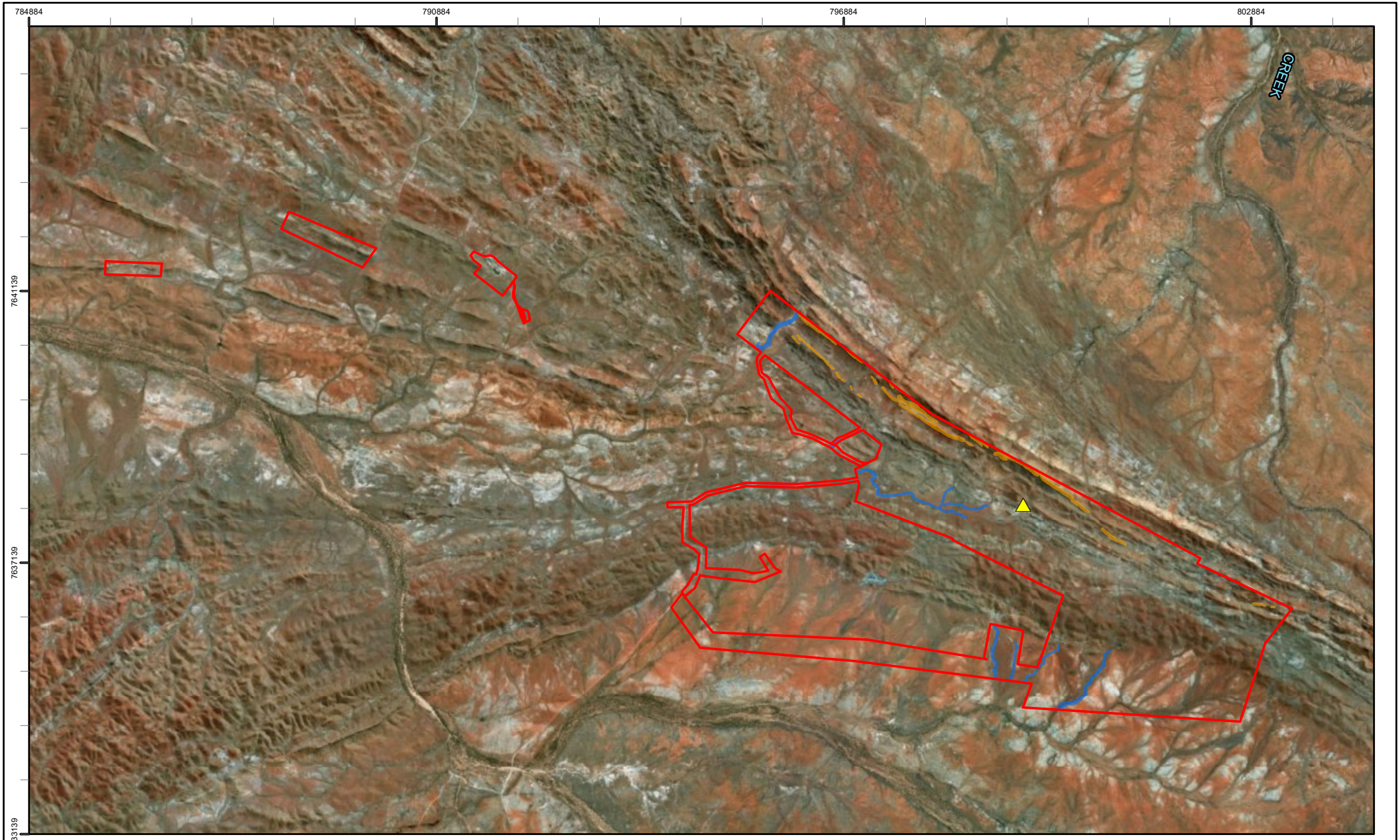
km

Calidus Resources - Warrawoona Gold Project

Figure 5.1: Potential Northern Quoll Habitat within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 10/06/2019



Legend

- Study Area
- Pilbara Olive Python

biologic Environmental Survey

N

1:70,000

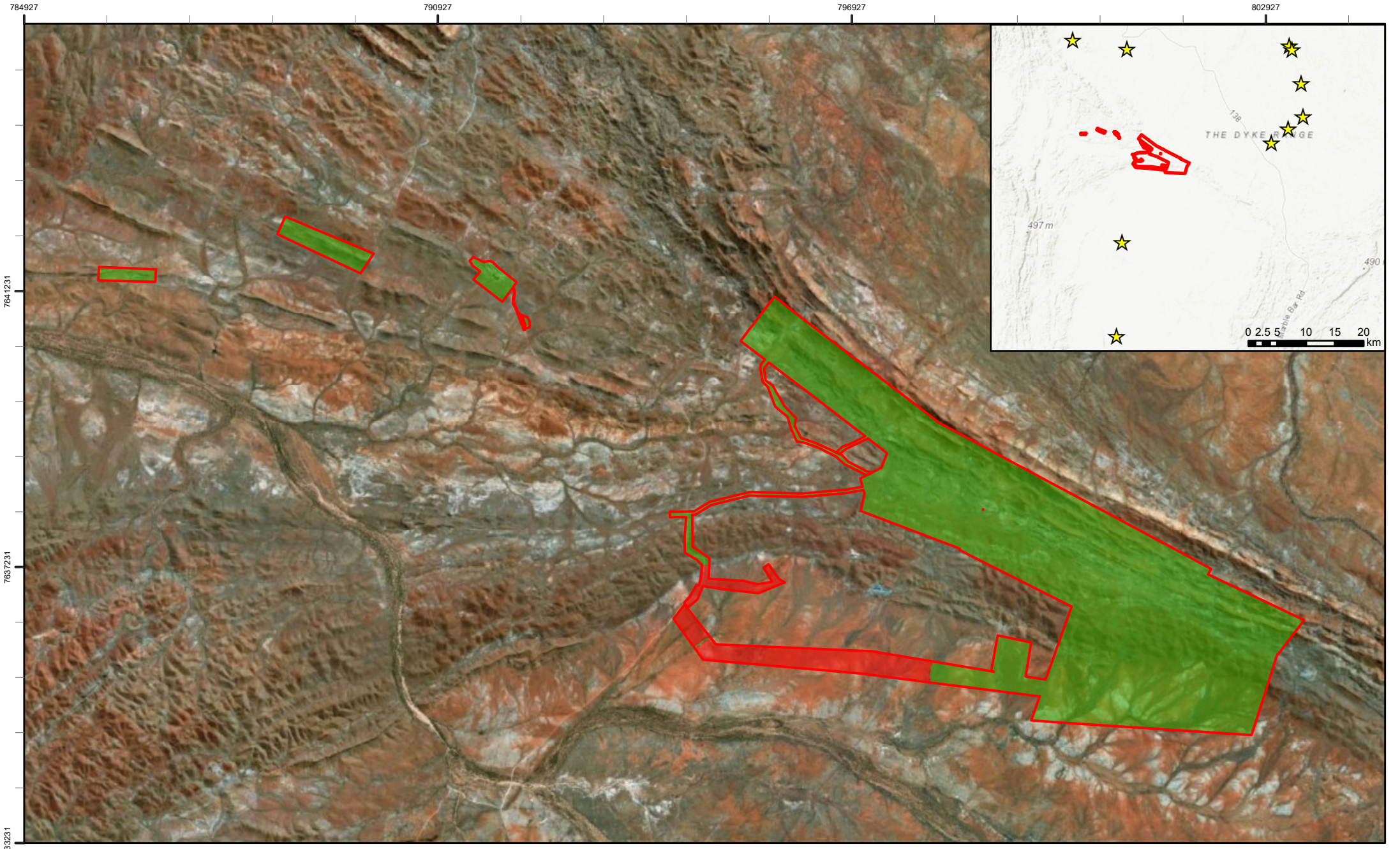
0 0.75 1.5 km

Calidus Resources - Warrawoona Gold Project

Figure 5.2: Habitat with the potential to support Pilbara Olive Python within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 28/05/2019



Legend

- Study Area
- Regional Greater Bilby records

Greater Bilby habitat

- High Quality
- Low Quality

biologic Environmental Survey

N

1:70,000

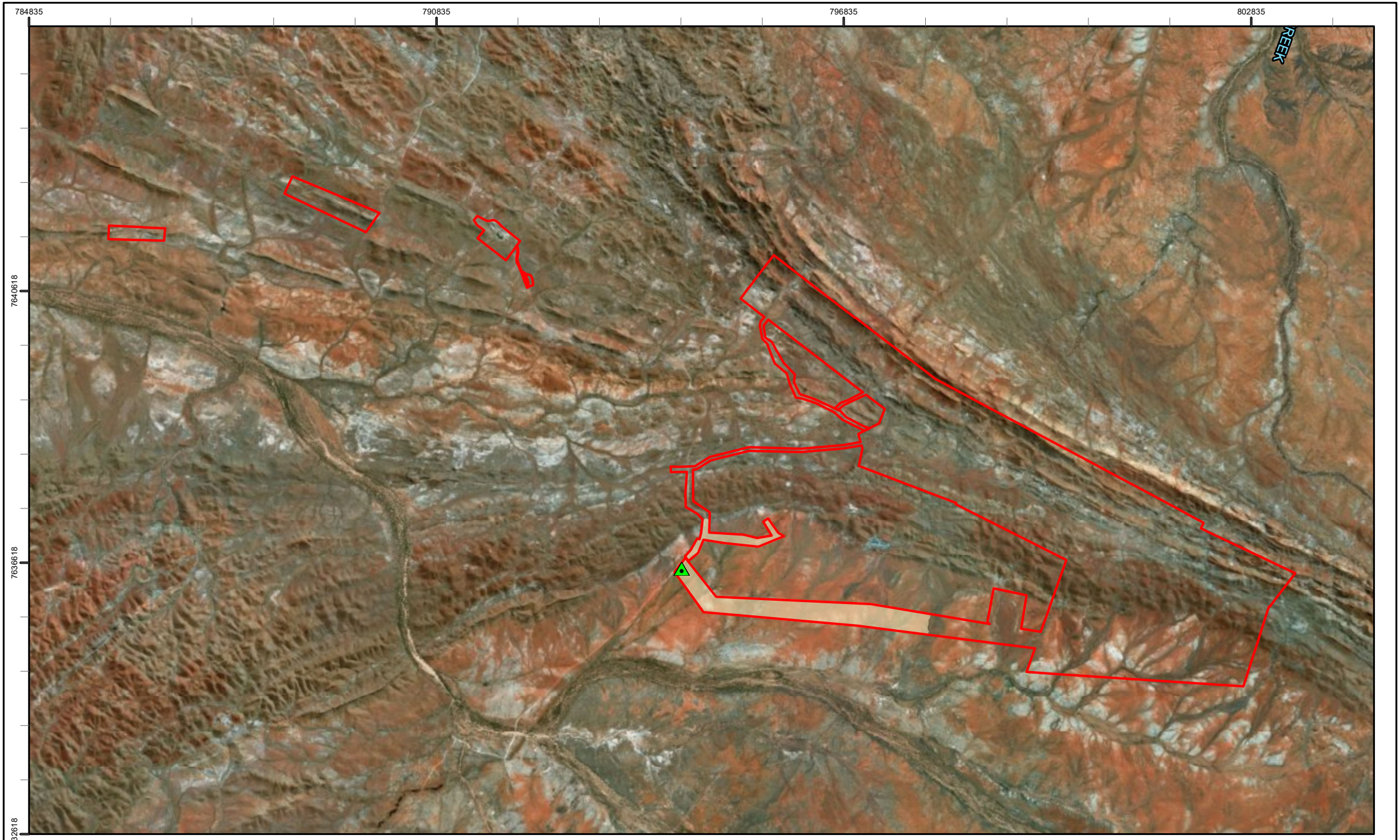
0 0.75 1.5 km

Calidus Resources - Warrawoona Gold Project

Figure 5.3: Potential Greater Bilby habitat within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4, Created 6/12/2018



Legend

- Study Area
- Brush-tailed Mulgara

Habitat

- Sandplain

biologic Environmental Survey

N

1:70,000

0 0.75 1.5 km

Calidus Resources - Warrawoona Gold Project

Figure 5.4: Habitat with the potential to support Brush-tailed Mulgara within the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 28/05/2019

5.3 Impacts to Matters of National Environmental Significance

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance. In addition to assessing a species risk under specific risks to the Study Area (Section 5.2), species listed as a "Matter of National Importance" (DoE, 2013b) that have been recorded or are "Likely to Occur" within the Study Area have been assessed in accordance to DoEE guidelines as to whether the proposal will have a significant impact on their survival. The likelihood of a significant impact (likely or unlikely), followed that of DoE (2013b), whereby 'likely' is defined as "it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility" DoE (2013a). The criteria assessed for each species also followed significant impact criteria for Endangered and Vulnerable species by DoE (2013a) as well as the conservation listing advice for each species (DBCA, 2017; DEWHA, 2008; TSSC, 2005). The definitions of important populations for each MNES species has been described below, and the results of this assessment have been summarized in Table 5.2.

5.3.1 Endangered species

The Northern Quoll is classified as Endangered under the EPBC Act and BC Act. The Northern Quoll referral guidelines (DoE, 2016) define populations important for the long-term survival of the species are defined as;

- high density quoll populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present
- occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e. granite habitats in WA, populations surrounded by desert and without permanent water; or
- subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocation.

A high density population may be characterised by numerous camera triggers of multiple individuals across multiple cameras and or traps on the site (DoE, 2016). The continued annual presence of a similar number of animals in high densities as defined above (DoE, 2016) defines the likely resident population within the Study Area as important for the long-term survival of the Northern Quoll. The estimated population size in the Study Area is comparable to that of Indee Station (annual population sizes between 3 -12 females and 0 – 3 males), considered to offer the area of highest suitability for northern quolls in the Pilbara (Hernandez-Santin *et al.*, 2019).

For the Northern Quoll, habitat critical to the survival of the species is defined DoE (2016) as: Habitat within the modelled distribution of the Northern Quoll, which provides shelter for breeding, refuge from fire or predation and potential poisoning from Cane Toads. Dispersal and

foraging habitat associated with or connecting populations important for the long-term survival of the Northern Quoll are also considered habitat critical to the survival of the Northern Quoll (DoE, 2016). Habitat for the Northern Quoll present within the Study Area is discussed in Section 5.1.

5.3.2 Vulnerable species

Both the Pilbara Olive Python and Greater Bilby are classified as Vulnerable under the EPBC Act and BC Act. An 'important population' of a Vulnerable species is defined by (DoE, 2013b) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

For the Pilbara Olive Python and Greater Bilby, 'habitat critical to the survival of a species or ecological community' is defined by (DoE, 2013b) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; and/or
- for the reintroduction of populations or recovery of the species or ecological community.

Habitat for the Pilbara Olive Python and Greater Bilby present within the Study Area is discussed in Section 5.1.

Table 5.2: Significance of the Project to fauna considered Matters of National Environmental Significance (confirmed or likely to occur)

Species	National Listing	Likelihood of occurrence	MNES Significant Impact Criteria	Likelihood of Impact	Justification
Northern Quoll *Dasyurus hallucatus* **EPBC Act** Endangered	Endangered	Confirmed	1. Result in the loss of habitat critical to the survival of the northern quoll	**Likely**	Critical denning habitat for the Northern Quoll comprises rugged, rocky areas, often in close association with permanent water (Molloy, 2015; Oakwood, 2000), consistent with Rocky Breakaway habitat within the Study Area. Approximately 19 ha (1 % of the Study Area) of the Rocky Breakaway habitat is present in the Study Area (Biologic, 2017a), although this denning habitat and foraging habitat continues outside the Study Area. The Medium/Minor Drainage Lines, Rounded Hills, and Hillcrest/Hillslope habitats are also considered important habitat due to the ability to provide foraging and dispersal habitat for the species. Approximately 1,107 ha (61 % of the Study Area) of such habitats are in the Study Area, and 221 ha of this total intersects the Development Envelope. As the proposed development is likely to disturb an amount of critical denning habitat and also important foraging and dispersal habitat, it is possible that the Project may have a significant impact on the species based on this criterion.
			2. Decrease the size of a population important for the long-term survival of the northern quoll and therefore interfere with the recovery of the species	**Likely**	As defined by DoE (2016), the population existing within the Study Area is considered to be a high density population, as numerous camera triggers of multiple individuals across multiple cameras and or traps has occurred over three consecutive years. The continued annual presence of a similar number of animals in high densities as defined above (DoE, 2016) defines the likely resident population as important for the long-term survival of the Northern Quoll. The proposed development will reduce the amount and quality of foraging and dispersal habitat, and potentially exacerbate threatening processes such as introduced species, habitat loss, altered fire regimes, vehicle collision, altered hydrology, and therefore likely impact the population through a loss of individuals. The Project is likely to have a significant impact on the species based on this criterion.
			3. Introduce inappropriate fire regimes or grazing activities (i.e. Increasing the risk of late dry season high intensity fires to the area) that substantially degrade habitat critical to the survival of the northern quoll or decrease the size of a population important for the long-term survival of the species	**Unlikely**	The proposed project is unlikely to significantly increase the impact caused by grazing in the area or changed fire regimes. The Project is unlikely to cause significant impact to the species based on this criterion.

Species	National Listing	Likelihood of occurrence	MNES Significant Impact Criteria	Likelihood of Impact	Justification
			4. Fragment a population important for the long-term survival into two or more populations	**Unlikely**	Infrastructure of the proposed Project is unlikely to restrict interaction between individuals. The species is regarded as having good dispersal capabilities (Spencer, 2013; Woolley, 2015) and the Study Area is surrounded by suitable dispersal habitat (drainage lines and the Warrawoona Ranges). The Project is unlikely to cause significant impact to the species based on this criterion.
			5. Result in invasive species or increases of them that are harmful to the northern quoll becoming established in its habitat, namely cane toads, feral cats, red foxes or exotic grasses which increase fire risk.	**Unlikely**	Feral cats have been recorded in the Study Area (Biologic, 2019a) and are likely to reside in habitat critical to the Northern Quoll. The proposed Project, without effective management, may result in higher feral cat numbers. However, as this population is already established, the Project is unlikely to have a significant impact on the species based on this criterion.
Pilbara Olive Python *Liasis olivaceus barroni* **EPBCA Act** Vulnerable	Vulnerable	Confirmed	1. Lead to a long-term decrease in the size of an important population of a species	**Unlikely**	Critical foraging and dispersal habitats are present in the Medium/Minor Drainage Lines and Rocky Breakaway (68 ha or 37 % total in the Study Area) (Biologic, 2017a), which is likely to be impacted during development, although some level of habitat disturbance appears to be tolerated. There is also a lack of permanent water features recorded. Based on the lack of regular records and the quality and quantity of core habitat (relative to the surrounding region) the population of Pilbara Olive Pythons inhabiting the Study Area is unlikely to represent a source population (therefore not an 'important population'). For this reason, it is unlikely that the proposed development will have a significant impact on the species based on this criterion.
			2. Reduce the area of occupancy of an important population	**Unlikely**	The proposed Project is likely to disturb or remove of up to 68 ha (37 % of the Study Area) of the Medium/Minor Drainage Lines and Rocky Breakaway habitats considered critical for the species (Biologic, 2017a). However, the population occurring within the Study Area is unlikely to represent an important population and thus the proposed development is not likely to have a significant impact on the species based on this criterion.
			3. Fragment an existing important population into two or more populations	**Unlikely**	The species is highly mobile and able to travel extensive distances (Pearson, 2003; Tutt, 2004). Drainage Line and Rocky Breakaway habitat, used as dispersal habitat, is well represented outside the Study Area through the Warrawoona Ranges, and will provide thoroughfare for the species to disperse through the region. The Project is unlikely to have a significant impact on the species based on this criterion.

Species	National Listing	Likelihood of occurrence	MNES Significant Impact Criteria	Likelihood of Impact	Justification
			4. Adversely affect habitat critical to the survival of a species	**Unlikely**	The proposed Project will involve the removal of up to 68 ha (37 % of the Study Area) of the Medium/Minor Drainage Lines and Rocky Breakaway habitats critical for the species (Biologic, 2017a); however, some level of habitat disturbance appears to be tolerated by the Pilbara Olive Python and the remaining habitat is unlikely to be adversely affected by the proposed development. Thus, the Project is not likely to have a significant impact on the species based on this criterion.
			5. Disrupt the breeding cycle of an important population	**Unlikely**	Although habitat critical to the species will potentially be lost, after clearing has occurred there are few threatening processes that will have an ongoing adverse impact on the breeding cycle of the population. Furthermore, the population does not meet the criteria of an important population and the Project is unlikely to cause significant impact to the species based on this criterion.
			6. Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely**	The species is highly mobile and able to travel extensive distances (Pearson, 2003; Tutt, 2004). Drainage Line and Rocky Breakaway habitat, used as dispersal habitat, is well represented outside the Study Area through the Warrawoona Ranges, and will provide thoroughfare for the species to disperse through the region. The Project is unlikely to have a significant impact on the species based on this criterion.
			7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely**	Feral cats have been recorded in the Study Area (Biologic, 2019a) and are likely to reside in habitat critical to the Pilbara Olive Python. Predation by introduced species (cats, foxes, dogs) is identified as a major threat, as well as predation from these species on the Pilbara Olive Python's food sources (Ellis, 2013). The proposed Project, without effective management, may result in higher feral cat numbers. However, as this population is already established, the Project is unlikely to have a significant impact on the species based on this criterion.
			8. Introduce disease that may cause the species to decline	**Unlikely**	The Project is not likely to introduce or increase transmission of any diseases relevant to this species. The Project is likely to have a significant impact on the species based on this criterion.
			9. Interfere substantially with the recovery of the species.	**Unlikely**	Development of the proposed Project is unlikely to interfere substantially with any conservation recovery initiative for the species. The Project is unlikely to significant impact the species based on this criterion.
Greater Bilby *Macrotis lagotis*	Vulnerable	Likely	1. Lead to a long-term decrease in the size of an important population of a species	**Unlikely**	Greater Bilbies are often sparsely distributed across large areas and populations can move across the landscape, and it is probable that a single survey may not detect bilby presence (DBCA, 2017). However, Greater Bilby have not been recorded within the Study Area boundary, and although contemporary records in the vicinity exist the Project is not likely to directly impact upon an important population. The Project is unlikely to significant impact the species based on this criterion.

Species	National Listing	Likelihood of occurrence	MNES Significant Impact Criteria	Likelihood of Impact	Justification
EPBC Act Vulnerable			2. Reduce the area of occupancy of an important population	**Unlikely**	Greater Bilbies have high mobility, and together with low population density, ensures that the area of occupancy is often far less than the extent of occurrence. As Greater Bilbies are solitary in nature, lack territoriality and have large home ranges, it is likely that males adopt a roving strategy to find receptive females (Miller *et al.*, 2010). Furthermore, Greater Bilby have not been recorded within the Study Area boundary, and although contemporary records in the vicinity exist the Project is not likely to directly impact upon an important population. The Project is unlikely to have a significant impact on the species based on this criterion.
			3. Fragment an existing important population into two or more populations	**Unlikely**	Greater Bilby distribution is highly fragmented within the Pilbara bio-region (Friend *et al.*, 2012). The species is recorded as having low site fidelity and high mobility (Southgate *et al.*, 2007); males regularly move three to five kilometres between burrows on consecutive days; and have been recorded moving up to 15 km in a few weeks (Southgate & Possingham, 1995). Critical habitat extends outside of the Study Area. The Project is unlikely to impact upon an important population and thus unlikely to have a significant impact on the species based on this criterion.
			4. Adversely affect habitat critical to the survival of a species	**Unlikely**	Although there are no records of Greater Bilby within the Study Area, the Sandplain habitat type in the southern portion of the area (136.92 ha, 7.51 %) displays characteristics considered critical to the survival of the species (Biologic, 2017a). However, development within this area is likely to be minimal (i.e. an access track) and it is continuous with similar habitat outside of the Study Area. The Project is unlikely to impact upon an important population and thus unlikely to have a significant impact on the species based on this criterion.
			5. Disrupt the breeding cycle of an important population	**Unlikely**	Greater Bilby have not been recorded within the Study Area boundary, and although contemporary records in the vicinity exist the Project is not likely to directly impact upon the breeding cycle of an important population, with males adopting a roving strategy to find receptive females (Miller *et al.*, 2010). The Project is unlikely to impact upon an important population and thus unlikely to have a significant impact on the species based on this criterion.
			6. Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely**	The Sandplain within the Study Area is for the most part relatively continuous with that in the general vicinity, extending both north and south of the Warrawoona Ranges. The Project is unlikely to significant impact the species based on this criterion.

Species	National Listing	Likelihood of occurrence	MNES Significant Impact Criteria	Likelihood of Impact	Justification
			7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely**	Feral cats have been recorded in the Study Area (Biologic, 2019a), and pose a threat to any individuals within the vicinity. Cat predation is assumed to be a major driving factor in the decline of bilbies, and mining activities and development are expected to facilitate increased predation (Bradley, 2015). Without effective management, the Project may result in higher feral cat numbers. However because cats are known to reside in the Study Area already, it is unlikely to significant impact the species based on this criterion.
			8. Introduce disease that may cause the species to decline	**Unlikely**	It is unknown whether diseases such as toxoplasmosis, carried by cats, affects Greater Bilbies (Bradley, 2015). The Project is unlikely to significant impact the species based on this criterion.
			9. Interfere substantially with the recovery of the species.	**Unlikely**	The presence of Greater Bilby habitat within conservation areas in the Pilbara bioregion is minimal and restricted to small areas within the Millstream Chichester National Park and the Meentheena Conservation Reserve (50 km to the east of the Study Area). Development of the proposed Project is unlikely to interfere substantially with any conservation recovery initiative for the species. The Project is unlikely to significant impact the species based on this criterion.

6. GENERAL MANAGEMENT RECOMMENDATIONS

The following broad management recommendations have been developed as a guide for mitigating the potential impacts to fauna of conservation importance, their respective habitat, and native fauna assemblages in general.

Mitigation has the principal aim of avoiding significant impacts and should be applied in a hierarchical order. The EPA (2014) mitigation hierarchy is: Avoid, Minimise, Rehabilitate, Offset. Similarly, the DoE (2016) mitigation hierarchy is:

1. Avoid impacts – preserve populations and habitat to avoid further loss.
2. Mitigate impacts – prevent habitat degradation and retain habitat function.
3. Monitor effectiveness of mitigation – ensure mitigation is effective and feeds back into an adaptive management plan

Avoid

The two habitats considered of High significance in the Study Area are the Rocky Breakaway and Sandplain habitats. To minimise impacts to the Northern Quoll and Pilbara Olive Python, both of which have been recorded in Rocky Breakaway habitat, the Project has been designed to avoid most of this habitat type. The single record of Pilbara Olive Python within the Study Area also falls within the 32-hectare mining exclusion zone proposed by Calidus to preserve significant bat roosting habitat at the Klondyke Queen roost. The Sandplain habitat in the southern portion of the Study Area is expected to only contain road infrastructure, and thus reduce the potential to impact species that specialise in this habitat type such as Greater Bilby and Brush-tailed Mulgara. Brush-tailed Mulgara have been previously recorded in the Study Area in this habitat type (Biologic, 2019a).

Minimise

An SSMP incorporating adaptive management is expected to assist in mitigating and minimizing potential impacts to conservation significant fauna species. Other management procedures developed to minimise potential impacts include Ground Disturbance Procedures, to control and minimise clearing for the Project, and Cyanide Monitoring Procedures to reduce the level of cyanide present in water sources using a cyanide reduction / destruct circuit.

Rehabilitate

The Site Closure Plan is expected to outline where progressive rehabilitation will be employed and be used to manage for Closure.

Offset

Unlike mitigation actions which occur on-site and reduce the direct impact of that project, offsets are undertaken outside of project areas to counterbalance significant residual impacts (EPA,

2014). Under this definition, the proposed 32-hectare Mining Exclusion Zone to minimise impacts to significant bat habitat is not considered an offset for the Project due to its location within the Study Area boundary.

Management recommendations should reduce impacts to individuals of fauna of conservation significance; however, it is unlikely that all impacts will be avoided. This is because habitat loss/ degradation is the primary threat posed to each of these species and is an integral part of mining activities. Several annual monitoring programs are already implemented for conservation significant species occurring within the Study Area (e.g. Northern Quoll, Ghost Bat, Pilbara Leaf-nosed Bat), which will assist in identifying if population declines occur beyond what is expected and inform strategic adaptive management strategies during or subsequent to development.

Table 6.1 details potential mitigation and management strategies for each impact source identified in the Study Area.

Table 6.1: Potential mitigation and management strategies for each impact source identified in the Study Area (adapted from DoE, 2016)

Impact source	Potential mitigation
Removal, fragmentation or modification of habitat	• Where practicable, minimise land disturbance and clearing activities in habitat known to or likely to support species of conservation significance, such as Rocky Breakaway, Medium/Minor Drainage Lines, and Sandplain habitats • Stockpile cleared vegetation, topsoil and oversize waste overburden separately to ensure maximum reuse of these resources in subsequent rehabilitation. • Consider timing of clearing activities to reduce the impact on nesting birds and weaning season of the Northern Quoll (July - September; Hernandez-Santin *et al.*, 2019) • Retain or construct corridors or linkages, for example culverts or underpasses underneath roads in key habitat areas, so that individuals can move between among fragmented fauna habitats. Rumble strips on roads has also led to decreased rates of road-kill of nocturnal animals in some areas. • Investigate strategies to reduce impacts of high frequency traffic on fauna and barriers to fauna dispersal created by the haul road corridors. • Implement a progressive rehabilitation and closure plan to ensure disturbed areas are rehabilitated as soon as practicable. • Ensure no entry into conservation significant areas of the Study Area with signage (except for necessary environmental management and monitoring).
Introduced Species	• Conduct monitoring and control of feral animals and implement management measures to prevent the increase of feral species numbers and control the attraction of any new feral species • Employ housekeeping measures such as covering up landfill and bin management. • Modify existing habitat to make it less suitable for feral cats e.g. reduce fragmentation by rehabilitating tracks and clearings and making it more structurally complex with shelter and escape sites • Prepare and implement a weed management procedure to prevent the spread of existing weed species and the establishment of new weeds, with priority on habitat-modifying weeds. • Implement quarantine and hygiene controls to prevent the inadvertent introduction of Cane Toads.
Increased light, noise	• Design artificial lighting to illuminate designated operations areas and limit illumination of the surrounding landscape, such as water sources and substantial rocky outcrops. Lights will be directed lights inwards towards mine activities to minimise lighting effects on fauna in adjacent areas. • Avoid blasting at night to minimise noise disruption to nocturnal species • Implement the Blasting Management Plan, and use adaptive management to mitigate unforeseen impacts
Vibration	• Avoid blasting at night to minimise noise disruption to nocturnal species • Implement the Blasting Management Plan, and use adaptive management to mitigate unforeseen impacts
Dust	• Implement dust suppression measures to reduce the effects of dust on vegetation and natural water bodies, and hence on fauna habitats and assemblages, including; management of vehicle speed on unsealed roads, and proximity of habitats to blasting and excavation
Changed Fire Regimes	• Manage fuel loads of weeds (known to alter fire patterns) to reduce risk of high fire intensity. • Prepare and implement a strategy to manage unplanned fires • Educate and train staff about equipment and procedures to act on unexpected fire events.

Impact source	Potential mitigation
Vehicle Strike	• Implement measures to minimise roadkill, especially for nocturnal species or those prone to vehicle collisions – such measures could include speed limits, signage, erecting fences or barriers, and providing alternative routes for fauna such as underpasses. • Report and record road kills. • Prevent unauthorised off-track driving
Pollution or modification of water quality and water regimes	• Minimise and manage impacts to natural surface hydrology to ensure the Drainage Line habitats are maintained. • Ensure any water bodies created during mining activity are of as high-water quality as can be attained. • Minimise the potential for waterbirds to be attracted to artificial water sources, particularly where cyanide may be present via cyanide destruct, minimising areas of tailings supernatant ponding (beach management), minimising the decant pond, and covering tanks. • Implement Surface Water and Groundwater Management Procedures
Other Project Designs	• Implement a Significant Species Management Plan (SSMP) that contains specific management and monitoring targets for fauna of conservation significance recorded within the Study Area, to be reviewed on a regular basis • Implement the Blast Management Plan • Implement the Cyanide Management Procedures • Educate mine site personnel and contractors with respect to fauna of conservation significance. • Any incident that results in the injury or death of a fauna species of conservation significance should be reported to DBCA and specimens should be retained (i.e. stored in a freezer) for further examination

7. CONCLUSION

This Impact Assessment provides a summary of the recent survey work completed within the Warrawoona Gold Project area to date and assesses the potential impacts of the proposed development on terrestrial fauna of conservation significance within the Study Area. The main threat to fauna in the Study Area is habitat loss as a result of direct clearing for the mine and mine infrastructure.

The largest impacts are likely to occur to species of elevated conservation significance, in particular the Northern Quoll. At a local scale the Northern Quoll is likely to experience a Moderate level of impact from removal, fragmentation and modification of habitat, vehicle strike and an increase in introduced species. Furthermore, because the population occurring within the Study Area meets the definition of a 'high-density population', the impacts to the species are perceived to potentially have a significant impact, as defined by DoE (2016).

For the Pilbara Olive Python, confirmed within the Study Area, habitat loss is likely to be the most significant potential impact to the species resulting from the proposed development activities. Other potential impacts to the species are increased rates of vehicle strike, potential increases to introduced predators, and changes to water quality or quantity. The Pilbara Olive Python is likely to experience a Moderate level of impact by implementation of the proposed development, from numerous impact sources. However, this impact is unlikely to extend beyond the Study Area to the regional level and the Project is not likely to have a significant impact on the species, as defined by DoEE.

The Brush-tailed Mulgara is classified as Priority 4 by the DBCA and has been confirmed in the Study Area. There is only one habitat type considered highly suitable to support the species within the Study Area (Sandplain). The impacts considered to be of most significance for the species are habitat loss and degradation, predation from introduced species, and changed fire regimes potentially decreasing spinifex cover. However, overall the Project is not likely to have a significant impact on the species on a local or regional scale.

The Western Pebble-mound Mouse is classified as Priority 4 by the DBCA and has been confirmed in the Study Area. The habitat type most suitable to support the species is the Stony Plain. Similar to the Brush-tailed Mulgara, impacts considered to be of most significance for the species are habitat loss and degradation, and predation from introduced species. However, overall the Project is not likely to have a significant impact on the species on a local or regional scale.

A further three species are likely to experience some level of impact by the proposed development; however, their presence has not been confirmed within the Study Area, including Greater Bilby, Spectacled Hare-wallaby, and Northern Brushtail Possum. The Greater Bilby is considered a Matter of National Environmental Significance, and although the expected impacts to core habitat (Sandplain) are expected to be Low, the species may also be impacted by

increases to predation and vehicle strikes to a Moderate level. Overall, the Project is not likely to have a significant impact on the species on a local or regional scale as defined by DoEE.

A further nineteen species, including fourteen migratory avian species, may experience a Low level of disturbance although their presence in the Study Area is also not confirmed despite multiple surveys conducted.

It is anticipated that that this EIA, by adopting a systematic approach and considering a set of defined criteria supported by published research, identifies the potential impact sources most likely to be enhanced by the proposed development in relation to conservation significant species present or likely to be present. It is understood that Calidus will implement a range of adaptive management plans and procedures for Project operation. The significant impacts to fauna and fauna habitats highlighted in this report should be considered and mitigation strategies that reduce potential impacts will be incorporated into relevant management plans / procedures.

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