Lake Disappointment Potash Project:

Potential Impacts on Fauna

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Front Cover: *Ardeotis australis* (Australian Bustard)

EXECUTIVE SUMMARY

Reward Minerals Ltd is proposing to abstract potassium-rich brines from sediments associated with Lake Disappointment to produce sulphate of potash and truck the potash to the coast. The Lake Disappointment potash project is in the Little Sandy Desert, Western Australia, approximately 320km east of Newman and approximately 40km south of the Karlamilyi (Rudall River) National Park. Access to the project area is via the Talawana and Willjabu Tracks.

The proposed disturbance footprint is 7,774ha of which 401ha is vegetated fauna habitat, and the remaining area is part of the playa surface of Lake Disappointment. The project will include the widening and straightening of small sections of the Talawana and Willjabu Tracks, bore fields, and the construction of infrastructure adjacent to the northern end of Lake Disappointment, as well as infrastructure on the playa surface.

This assessment addresses the potential impacts of the proposed Reward Minerals project on terrestrial vertebrates, waterbirds and aquatic invertebrates. Impacts on terrestrial short-range endemic invertebrates are not considered.

The development envelope (40,100ha) includes the area of proposed disturbance and surrounding land, supports or is likely to support four terrestrial species listed under the *Wildlife Conservatio*n and *Environment Protection and Biodiversity Conservation* Acts, as well as six species on the Department of Biodiversity, Conservation and Attractions' Priority Species list. These species are:

- Night Parrot (*Pezoporus occidentalis*)- Critically Endangered;
- Bilby (*Macrotis lagotis*) - Vulnerable;
- Lake Disappointment Dragon (*Ctenophorus nguyana*) - P1;
- Lake Disappointment Gecko (*Diplodactylus fulleri*) - P1;
- Unpatterned Robust Lerista (*Lerista macropisthopus remota*) - P2;
- Northern Marsupial Mole (*Notoryctes caurinus*) - P4; and
- Princess Parrot (*Polytelis alexandrae*) - P4;

The species that were not recorded in the development envelope, but which probably occur are:

- Great Desert Skink (*Liopholis kintorei*) - Vulnerable;
- Peregrine Falcon (*Falco peregrinus*) - Other Specially Protected; and
- Brush-tailed Mulgara (*Dasycercus blythi* / *cristicauda*) - P4.

The project area supports seven listed, as well as one 'otherwise significant' waterbird species. An additional four listed waterbird species may occasionally occur in the project area, but any occurrences are of no conservation significance. The recorded species are:

- Banded Stilt (*Cladorhynchus leucocephalus*) - Otherwise significant
- Marsh Sandpiper (*Tringa stagnatilis*) - Migratory (Schedule 5);
- Common Greenshank (*Tringa nebularia*) - Migratory (Schedule 5);
- Pectoral Sandpiper (*Calidris melanotos*) - Migratory (Schedule 5);
- Sharp-tailed Sandpiper (*Calidris acuminata*) - Migratory (Schedule 5);
- Red-necked Stint (*Calidris ruficollis*) - Migratory (Schedule 5);
- Gull-billed Tern (*Gelochelidon nilotica*) - Migratory (Schedule 5); and
- Eastern Great Egret (*Ardea modesta*) - Migratory (Schedule 5).

This impact assessment describes the potential threats to the various conservation significant species, provides strategies for minimisation and mitigation of these threats, and then evaluates the residual impacts for each species.

Seven species (all terrestrial vertebrates) are considered likely to benefit from project development, while two waterbird species may experience negative impacts.

The Night Parrot is Critically Endangered under the *Wildlife Conservation Act* and had a range across most of inland Australia. This species was recorded in the Lake Disappointment potash project development envelope, although the number of birds present in this area (and elsewhere in Australia) is unknown. It is considered likely

the management and mitigation measures proposed by the proponent for terrestrial vertebrate wildlife during the project operations will have a positive benefit on the Night Parrot.

The Bilby, which is listed Vulnerable, has also been recorded in the development envelope, but it has a wide distribution in relation to the size of the project area. The impact of project on this species is likely to be positive, with the effect of possible road kills associated with project traffic on the access road to Lake Disappointment counteracted by the benefits of predator control.

The Great Desert Skink has not been recorded in the Lake Disappointment potash project development envelope, although it may occur there. If it is present, then it may benefit from the management and mitigation for wildlife undertaken as part of project operations.

The Lake Disappointment Gecko and Lake Disappointment Dragon are both P1 species known only from the immediate vicinity of Lake Disappointment. While a small amount of these species' habitat will be lost during vegetation clearing for the project, a reduction in predation pressure will have a significant positive benefit on populations of both species.

The Unpatterned Robust Lerista, a Priority 2 species, very probably has a wider geographic range than currently documented in the western desert. The potential impacts on this species are like those on the preceding two species, but a predator reduction program is likely to benefit the species.

The Northern Marsupial Mole is present in the development envelope. The overall impacts on this species are likely to be positive with the implementation of sustained a feral and pest animal reduction program.

It is possible that the Mulgara is present in the development envelope, however, impacts on this species are likely to be positive with the implementation of a sustained feral and pest animal reduction program.

The Banded Stilt is not a conservation significant species. It occurs across Australia but known breeding sites are restricted to a small number of arid or semi-arid, saline playa wetlands in Western Australia and South Australia. The species appears to rely, at least to a large extent, on occasional mass recruitment events to maintain its population. Nine of the 10 islands supporting Banded Stilt breeding populations at Lake Disappointment in 2017 lie within the planned envelope in which the drainage channels will be dug, and the extent of future lake flooding episodes (and suitability of the islands for breeding) may be affected. Even with management and mitigation measures in place, the impact of the proposed development on this species may be moderate although the actual extent of impact on the population will be determined by finer details of hydrological management at Lake Disappointment and the extent of breeding success at other locations.

The Australian subspecies of Gull-billed Tern is resident (although it is listed as migratory under the EPBC Act) and occurs across Australia. Breeding is poorly documented and mostly occurs on inland playa lakes. Seven of the 10 islands on which the species nested at Lake Disappointment were in the main saline playa, but all were outside the envelope in which the drainage channels will occur (although the waterbody is contiguous, and some feeding will occur inside the development envelope). The impact of development on this species will be low.

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1 INTRODUCTION

1.1 Background

Lake Disappointment lies in the Little Sandy Desert of Western Australia, approximately 320km east of Newman, in the north-west of Western Australia. Reward Minerals Ltd (i.e. Reward) proposes to harvest potassium, in the form of sulphate of potash (i.e. K_2SO_4), from groundwater brine associated with Lake Disappointment. The sulphate of potash will be harvested in a process involving differential crystalisation of various salts in solar evaporation ponds and the harvested potash will be trucked to a coastal port in the Pilbara. The abstraction and processing of potassium-rich brine and transport of the potash is referred to as the potash project.

The potash project is situated within the Native Title claim area held by the Martu People on vacant crown land. The project area is approximately 40km south of the Karlamilyi (Rudall River) National Park which is managed by the Department of Biodiversity, Conservation and Attractions (DBCA). The southern section of the project area abuts the north-eastern section of a nature reserve proposed by the Reserves Committee, but it has never been gazetted. Access to the project area is via the Talawana and the Willjabu Tracks.

The proposed development envelope is 40,100ha and the proposed disturbance area is 7,774ha, of which 401ha is vegetated fauna habitat (Figures 1 and 2). The proposed development envelope has three components. The lake development envelope circumscribes a network of the brine trenches, evaporation ponds and stockpiles of precipitated salt (sodium chloride) within the main saline playa at Lake Disappointment, as well as an area of shore and hinterland on the northern side of the playa. The terrestrial development envelope includes a processing plant, bore fields, an accommodation village, an airstrip, a landfill, septic waste treatment facilities, fuel storage facility, a wash down facility and an administration area. The transport development envelope contains the Talawana and Willjabu Tracks, small sections of which will be realigned.

The network of trenches in the main saline playa at Lake Disappointment will be approximately 130km long and will supply brine to a shallow solar pond system of around 4,500ha in extent. The water will be evaporated to concentrate the salts and form crystal beds on the pond floors. Halite salt (sodium chloride) will be harvested from the ponds and stockpiled on the lake. Crude potash salt will then be precipitated out, harvested and purified through a processing plant by a process of dissolution (washing contaminants, especially magnesium sulphate) from the crude potash salt. It is proposed that approximately 63 million m^3 of brine will be abstracted annually from groundwater in the floor of the playa to produce approximately 400,000 tonnes of sulphate of potash. No toxic by-products (waste) will be generated.

It is planned to transport the potash via trucks to Newman and then to shipping facilities at either Port Hedland or Geraldton. It is envisaged that there will be approximately 15 laden trucks per day moving coastwards and an equal number undertaking the return trip. In addition, other trucks and vehicles carrying general freight and fuel supplies will travel to and from the project each day. This will equate to about 40 truck movements per day or about 1.5 trucks per hour in a 24-hour day.

The Environmental Protection Authority (EPA) determined the level of impact assessment for the potash project as a Public Environmental Review (PER). Terrestrial fauna and inland waters environmental quality were among the key factors to be addressed. The EPA objective for terrestrial fauna is to maintain representation, diversity, viability and ecological function at the species, population and assemblage level, while the objective for inland waters environmental quality is to maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected (EPA 2017).

Relevant aspects of assessment identified by the EPA (2017) included:

- clearing of fauna habitat for excavation and infrastructure;
- alterations and disruptions to surface water flows;
- vehicle movement;
- lighting;
- noise and vibration; and
- waste disposal.

Potential direct impacts and risks identified by the EPA (2017) are:

- loss and fragmentation of fauna and fauna habitat from vegetation clearing, changes to surface water patterns and abstraction of water;
- impacts to fauna from increased vehicle strikes, and as a result of construction and operation of the mine; and
- Direct impact through attraction of fauna to evaporation ponds, entrapment of fauna in open excavations.

Indirect impacts that may occur according to the EPA (2017) are:

- altered fire regimes due to clearing of native vegetation;
- groundwater drawdown;
- dust, noise and vibration;
- light impacts on nocturnal species;
- altered surface and groundwater regimes;
- changes to feral animal populations;
- introduction or spread of weed species; and
- restriction or removal of access to breeding habitat, foraging/dispersal habitat or water resources.

The requirements of the EPA (2017) include:

- studies and surveys in accordance with EPA guidance, including for terrestrial vertebrate fauna, invertebrate SRE fauna and aquatic invertebrate fauna, within areas to be impacted and in surrounding areas, including the haul road. Conduct Level 2 surveys in areas not previously surveyed that are likely to be directly or indirectly impacted as a result of the proposal;
- targeted surveys for conservation significant fauna and fauna that are known or likely to occupy restricted habitats in the project area [short range endemic (SRE) invertebrates, restricted reptile species] should be conducted in accordance with EPA guidance;
- comprehensive mapping of fauna habitats (including rare or unusual habitat types) in relation to the proposed disturbance and a comprehensive listing of fauna likely to occur in habitats within the areas to be cleared or indirectly impacted, with figures showing the likely extent of loss of the habitat types from both direct and indirect impacts;
- quantitative analysis of the extent of loss (worst-case) of habitat, including areas in hectares and percentages of habitat types to be impacted (directly or indirectly), to assist in the determination of significance of impacts to fauna. The analysis should include identification and mapping of the known regional distribution of conservation significant species and an evaluation of the impact activities, including assessment of condition, for conservation significant species;
- description (including figures) of the expected direct and indirect impacts to vertebrate and SRE invertebrate fauna and their associated habitat from all aspects of the proposal;
- discussion of the potential impacts on terrestrial fauna, as a result of implementation of the proposal, with particular regard to State listed threatened fauna and *EPBC Act* listed threatened and/or migratory species, and provision of quantitative data on impacts of the proposal to species of conservation significance;
- description of impacts resulting from fauna, both native and feral, that may be attracted to the evaporation ponds;
- detailed description of the potential direct and indirect (including downstream) impacts to species within the proposal area as a result of dewatering, alterations and disruptions to surface water flows, groundwater drawdown and change in water quality. Discuss proposed management, monitoring and mitigation methods to be implemented, and any statutory or policy basis for the methods and demonstrating that the design of the proposal has addressed the mitigation hierarchy in relation to impacts on fauna;
- an outline of the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plan(s), to ensure impacts (direct and indirect) are not greater than predicted; and
- a demonstration of how the EPA's objective for this factor (i.e. to maintain representation, diversity, viability and ecological function at species, population and assemblages level) can be met.

In particular, for each relevant conservation significant species, the following is to be provided (EPA 2017):

- baseline information on their abundance (including known occurrences), distribution, ecology, and habitat preferences at both the site and regional levels;
- information on the conservation value of each habitat type from a local and regional perspective, including the percentage representation of each habitat type on site in relation to its local and regional extent;
- if a population of conservation significant species is present on site, its size and the importance of that population from a local and regional perspective and potential percentage loss of the conservation significant species locally due to loss of habitat; and
- maps illustrating the known recorded locations of conservation significant species and short-range endemic invertebrates in relation to the proposed disturbance and areas to be impacted.

The status of SRE invertebrate species is assessed by Phoenix (2014) and Harewood (2017).

1.2 Terrestrial vertebrate fauna surveys

The following vertebrate fauna survey reports have been reviewed and considered in preparing this impact assessment:

- Harewood, G. (2012) *Targeted Fauna Survey Proposed Access Track, Camp Site and Borrow Pit Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Harewood, G. (2015) *Marsupial Mole Monitoring Survey Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Harewood, G. (2016) *Fauna Survey (Level 2) Phase 1 (May 2013) and Phase 2 (October 2013) Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Harewood, G. (2017a) *Conservation Significant Vertebrate Fauna Assessment Talawana Track Upgrade Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Harewood, G. (2017b) *Fauna Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Harewood, G. (Harewood 2017c) *Night Parrot Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

1.2.1 Summary of vertebrate survey reports

Harewood, G. (2012) *Targeted Fauna Survey Proposed Access Track, Camp Site and Borrow Pit Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

> This report provides the results of searches for burrows, tracks, scats, diggings and other definitive signs of the Great Desert Skink, Mulgara, Marsupial Mole and Bilby on three four-wheel motorcycles (ATVs). Areas searched included either side of the 28km access track from the Talawana Track to Lake Disappointment and along the fringe of the existing Talawana Track at the Parnngurr turnoff to the new access track. No evidence was found of the Great Desert Skink, Mulgara and Bilby, but tunnels created by Marsupial Moles were recorded in three trenches.

Harewood, G. (2015) *Marsupial Mole Monitoring Survey Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

> This report provides results of digging 20 trenches (120cm x 80cm x 40cm wide) along approximately 22km of the Willjabu Track near Lake Disappointment. A total of 76 tunnels with a diameter of greater than 20mm and attributed to Marsupial Moles were recorded. Two tunnels were considered fresh and three were considered recent.

Harewood, G. (2016) *Fauna Survey (Level 2) Phase 1 (May 2013) and Phase 2 (October 2013) Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

> This report provides results of two surveys (May 2013 and October 2013) for an area of 89,130ha (60,886ha is covered by Lake Disappointment) and included the Talawana Track, the Willjabu Track and the most northern and western sections of Lake Disappointment. There were eight trapping sites in four fauna habitats (interdunal swale, dune crest, riparian salt-lake edge, minor drainage line). Trapping

sites were clustered together near where the southern end of the Willjabu Track meets Lake Disappointment. For each survey period, there were 550/560 small aluminium box trap-nights, 110/112 large aluminium box trap or cage trap-nights, 1,110/1,200 funnel trap-nights and 550/560 pit-trap nights. In addition, there was a bird survey at each trapping site, 41 camera traps were deployed for approximately 170 camera-days, nocturnal spotlighting and non-systematic opportunistic observations. A summary of the fauna in higher taxonomic groups recorded in this survey are shown in Table 1.

Conservation significant species recorded in or near the potash project area (other than on the Talawana Track) include: *Ctenophorus nguyana* (Lake Disappointment Dragon; P1), *Diplodactylus fulleri* (Lake Disappointment Gecko; P1), *Lerista macropisthopus remota* (Unpatterned Robust Lerista; P2), *Merops ornatus* (Rainbow Bee-eater; Sch. 5), *Polytelis alexandrae* (Princess Parrot; P4), *Falco peregrinus* (Peregrine Falcon; other specially protected) and *Notoryctes caurinus* (Northern Marsupial Mole; P4).

Table 1. Number of vertebrate fauna species recorded in high order taxonomic groups

Taxa	Combined no. of species caught in Phase 1 and 2 surveys	Terrestrial species of conservation significant
Amphibians	5	0
Reptiles	50	2
Birds	98	3
Native non-volant mammals	11	1
Bats	7	0
Introduced mammals	4	0
Total	176	10

Harewood, G. (2017a) *Conservation Significant Vertebrate Fauna Assessment Talawana Track Upgrade Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

This report summarises conservation significant species potentially impacted by the Talawana Track upgrade. These are: *Macrotis lagotis* (Bilby; Vulnerable), *Lerista macropisthopus remota* (Unpatterned Robust Lerista; P2), *Merops ornatus* (Rainbow Bee-eater; Sch. 5), *Polytelis alexandrae* (Princess Parrot; P4), *Falco peregrinus* (Peregrine Falcon; other specially protected), *Notoryctes caurinus* (Northern Marsupial Mole; P4), *Dasycercus blythi* (Brush-tailed Mulgara; P4) and the *Pseudomys chapmani* (Western Pebble-mound Mouse; P4).

Harewood, G. (2017b) *Fauna Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

This report summarises the results of the following surveys:

- Targeted Fauna Survey (October 2012) - Proposed Access Track, Camp Site and Borrow Pit;
- Phase 1 Level 2 Fauna Survey (including targeted surveys) (May 2013) – Lake Disappointment and Willjabu Track;
- Phase 2 Level 2 Fauna Survey (including targeted surveys) (October 2013) - Lake Disappointment and Willjabu Track;
- Marsupial Mole Monitoring Survey (April 2014) – Willjabu Track.
- Phase 3 Level 2 Fauna Survey (including targeted surveys) (October 2016) – Borefield areas and some regional bat surveys (Durba Springs, McKay Range and Desert Queens Baths);
- Phase 4 Level 2 Fauna Survey (including targeted surveys) (March 2017) - Borefield areas and Lake Disappointment;
- Conservation Significant Vertebrate Fauna Assessment (Desktop Review) (February 2017) – Talawana Track; and
- Targeted Fauna Survey (June 2017) – Talawana Track, Willjabu Track and Lake Disappointment.

Phases 1 and 2 surveyed four fauna habitats (i.e. interdunal flats, riparian salt playa edge, dune crest, a minor drainage line). Surveys in Phases 3 and 4 added fauna habitats sand plain and a creek line to the list fauna habitats surveyed.

A summary of the fauna in higher taxonomic groups recorded are shown in Table 2.

Table 2. Number of vertebrate fauna species recorded in high order taxonomic groups

Taxa	Combined no. of species caught in Phase 1 and 2 surveys	Terrestrial species of conservation significant
Amphibians	9	0
Reptiles	59	2
Birds	116	11
Native non-volant mammals	12	2
Bats	10	0
Introduced mammals	6	0
Total	213	15

The report indicates that *Pezoporus occidentalis* (Night Parrot; Critically Endangered), *Macrotis lagotis* (Bilby; Vulnerable), *Lerista macropisthopus remota* (Unpatterned Robust Lerista; P2), *Merops ornatus* (Rainbow Bee-eater; Sch. 5), *Polytelis alexandrae* (Princess Parrot; P4), *Falco peregrinus* (Peregrine Falcon; other specially protected), *Notoryctes caurinus* (Northern Marsupial Mole; P4), *Dasycercus blythi* (Brush-tailed Mulgara; P4), *Amytornis striatus striatus* (Striated Grasswren; P4) and *Pseudomys chapmani* (Western Pebble-mound Mouse; P4) are either in or potentially in the project area / development envelope.

Harewood, G. (2017c) *Night Parrot Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

This reports summaries the methods and results of Night Parrot surveys from June 2017 to November 2017.

The June 2017 survey targeted various points along the Talawana and Willjabu Tracks, at the proposed processing plant site and around the edge of north western edge of Lake Disappointment, near sections of Savory Creek, and used automatic recording units (ARUs), listening surveys and searches around waterholes/bores. ARUs were located at 14 sites from one to eight nights and listening surveys, undertaken by Greg Harewood and George Swann, were undertaken at six locations. Night Parrot calls were recorded at a single location.

The August / September2017 surveys used ARUs at three sites [redacted] for eight nights and then the ARUs were moved to [redacted] and left for 12 nights. Three units were then moved to [redacted] and left for nine nights before again being moved and left for 11 nights. Night Parrot calls were recorded at six locations.

The September / October 2017 ARUs were left at eight locations for 12 nights. No Night Parrot calls were recorded.

1.3 Fauna habitats

Fauna habitats were mapped via a helicopter by Terrestrial Ecosystems, using the vegetation mapping as a guide. Seven broad habitat types were identified by Terrestrial Ecosystems (Table 3). These fauna habitats loosely correspond to the vegetation types as described by Botanica Consulting (2017). Considering the long-established tracks, fauna habitats are relatively undisturbed by anthropogenic activity in the development envelope; however, there is evidence of significant natural wildfires in many parts of the development envelope, but this impact is a part of the normal ecological process of this area. Overall the fauna habitats are in very good condition. The area calculations (Table 3) will vary slightly with Botanica Consulting (2017) as there are variations in the boundaries of mapped areas.

Table 3 Fauna habitats in the development envelope and project footprint

Habitat type	Distinguishing characteristics	**Development envelope (ha)**	**Project area (ha)**
Flat plain with few to numerous trees over scattered shrubs over spinifex	Flat plain where the density of trees (e.g. *Acacia* sp.) varies over few shrubs (e.g. *Eremophila/Senna* sp.) with or without hummocks of mostly sparse spinifex (e.g. *Triodia* sp.)	6.56	6.56
Flat plain with scattered shrubs over spinifex with few or no trees	Flat plain where there are very few trees but sparely vegetated with shrubs with or without hummocks of mostly sparse spinifex (e.g. *Triodia* sp.)	11.00	11.00
Swales and dune crests with shrubs over spinifex with few or no trees	Low dunes interspersed with swales that are vegetated with occasional trees (i.e. *Corymbia* sp,) low shrubs (*Acacia* sp. and *Grevillea* sp.) over spinifex (i.e. *Triodia* sp.) with few or no trees	3482.55	367.57
Creek or drainage line	Mostly dry creek or drainage lines that have an increased density of low trees (e.g. *Eucalyptus/Corymbia* sp.) relative to adjacent areas	107.12	10.41
Halophytic vegetation	Flat plain supporting low halophytic vegetation (i.e. *Tecticornia* spp.) mostly around the periphery of Lake Disappointment	30.87	0.83
Clay or salt pan mostly devoid of vegetation	Flat plain that has an elevation that is slightly lower than the adjacent area that is mostly devoid of vegetation	10.46	
Rocky area or breakaway	Rocky area or breakaway most little vegetation or sparsely vegetated with spinifex	58.76	2.41
Trees and shrubs over tussock grasses	Flat plain or shallow depression that supports relatively dense trees (e.g. *Acacia* sp.) dwarf shrubs (e.g. *Senna* sp.) over tussock grasses.	105.77	0.90
Cleared vegetation		167.21	167.21
Salt Lake		35,996.63	7,207.34

Figure 3 shows the location of the various fauna habitats in the development envelope, and it includes multiple images of the fauna habitats at various locations within the development envelope.

1.4 Wetland fauna surveys

The following aquatic fauna survey reports have been reviewed and considered in preparing this impact assessment:

- Harewood, G. (2017b) *Fauna Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.
- Bennelongia (2016a) *Ecological character of Lake Disappointment*. Report 266, Bennelongia Pty Ltd, Perth.
- Bennelongia (2017a) *Aquatic ecology and waterbirds at Lake Disappointment: additional studies.* Report 301, Bennelongia Pty Ltd, Perth.
- Harewood, G. (2017b) *Fauna Survey Report Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

1.4.1 Summary of aquatic fauna survey reports

Harewood, G. (2014) *Fauna Survey (Level 2) Phase 1 (May 2013) and Phase 2 (October 2013) Lake Disappointment Potash Project*, unpublished report for Reward Minerals Ltd, Perth.

> This report summarises the results of waterbird surveys in 2013, when there was a significant flooding of the main saline playa and adjacent claypans at Lake Disappointment. It also includes a list of conservation significant waterbird species that may occur in the area but have not been recorded.

Bennelongia (2016) *Ecological character of Lake Disappointment. Report 266*, Bennelongia Pty Ltd, Perth.

> This report summarises information on waterbird surveys prior to 2016 and presents results of waterbird and aquatic invertebrate surveys in 2016 on the main playa at Lake Disappointment and some claypans to the north. There was a small amount of flooding in 2016. Twenty-nine species of waterbird had been recorded at Lake Disappointment by 2016, with records of breeding of Banded Stilt in 2004, 2013 and 2015 considered to be the most conservation significant occurrence of waterbirds or shorebirds. Sixty-nine species of aquatic invertebrate were collected. Several species have been recorded only from Lake Disappointment but were considered likely to be more widespread.

Bennelongia (2017a) *Aquatic ecology and waterbirds at Lake Disappointment: additional studies. Report 301*, Bennelongia Pty Ltd, Perth.

> This report provides the results of waterbird and aquatic invertebrate surveys in 2017 after major flooding of the main saline playa and adjacent claypans at Lake Disappointment. A total of 109,812 waterbirds of 28 species were counted, including 94,336 adult Banded Stilt that were mostly breeding. It was estimated 70,000 nests were seen on 10 islands, although nest numbers of five islands were very small. In total, 35 species of waterbird have been recorded at Lake Disappointment in all surveys to date. Sampling in 2017 collected 148 aquatic invertebrate species. When added to the species collected in 2016, at least 193 species of aquatic invertebrate are known from the main playa lake and (mostly) surrounding claypans at Lake Disappointment (Table 4).

Table 4. Number of aquatic fauna species recorded in high order taxonomic groups

Taxa	Combined no. of species caught in Phase 1 and 2 surveys	Terrestrial species of potential conservation significance
Birds	35	8
Primitive worms etc	4	0
Rotifers	44	0
Mites	5	0
Crustaceans	70	18
Introduced mammals	70	0
Total	233	26

Some additional information about waterbirds is provided by Harewood (2016, 2017b).

2 ADEQUACY OF THE AVAILABLE FAUNA SURVEY DATA

Since the surveys for the potash project commenced, the EPA has issued new guidance for terrestrial fauna and inland water quality assessments and re-badged earlier reports. The relevant EPA documents are: *Statement of Environmental Principles, Factors and Objectives* (2016c); *Environmental Factor Guideline Terrestrial Fauna* (2016b) and *Technical Guidance Terrestrial Fauna Surveys* (2016c); and *Environmental Factor Guideline Inland Waters Quality* (2016a). The requirements for fauna surveys and assessments have, however, remained very similar to earlier guidelines.

The baseline fauna surveys undertaken for Reward in the project area provide limited information on the range of fauna habitats, other than to indicate habitat in which traps were deployed. Terrestrial Ecosystems mapped fauna habitat for the entire development envelope from a low and slow flying helicopter.

2.1 Terrestrial fauna species accumulation curves

Species accumulation curves are a method of measuring the adequacy of the trapping effort and the completeness of the species list for a project area (Thompson and Withers 2003, Thompson and Thompson 2007b, Thompson et al. 2007).

Species accumulation curves have been calculated for the trapping data at Lake Disappointment using the method described by Thompson and Thompson (2007b). Harewood (2017b) had a total of 12 trapping sites in five habitat types: swale (i.e. interdunal flat), riparian (or samphire flat), dune crest, creek line and minor drainage line. Species accumulation curves using the combined data for amphibians, reptiles and mammals for each of these five habitat types are shown in Charts 1-5. Table 5 provides a summary of the recorded and estimated species richness in each of the five habitats surveyed. Results estimate the proportion of trappable species recorded during surveys.

The efficiency of surveying Bilby, Mulgara and Great Desert Skink through searching for evidence of burrows, diggings or scats is discussed below.

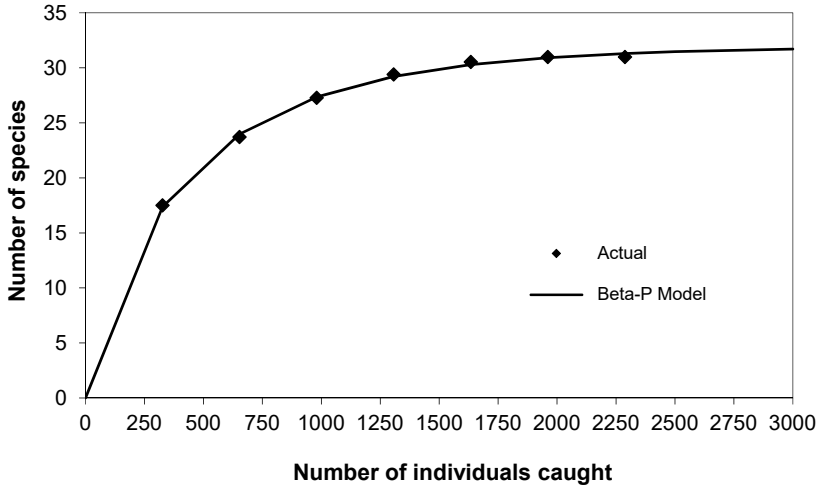

Chart 1. Species accumulation curve for creek line habitat.

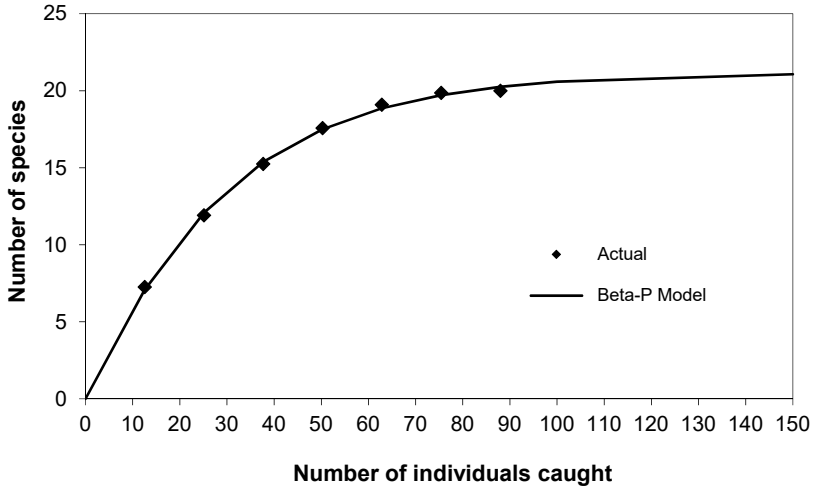

Chart 2. Species accumulation curve for drainage line habitat.

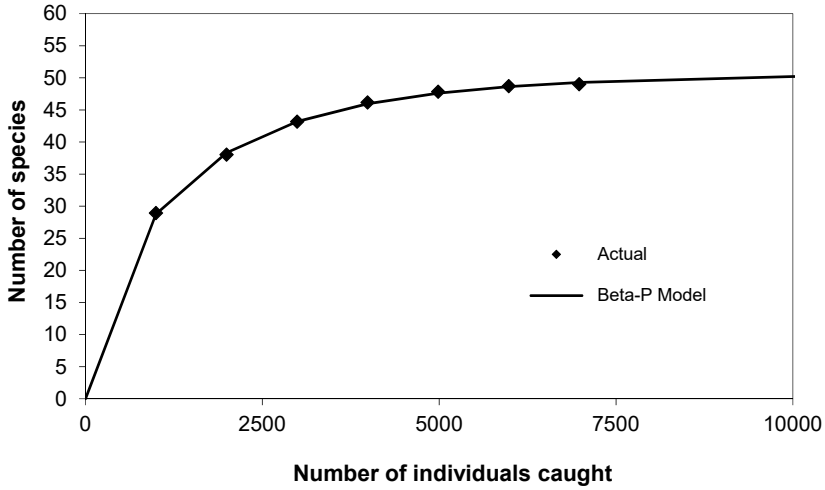

Chart 3. Species accumulation curve for dune crest habitat.

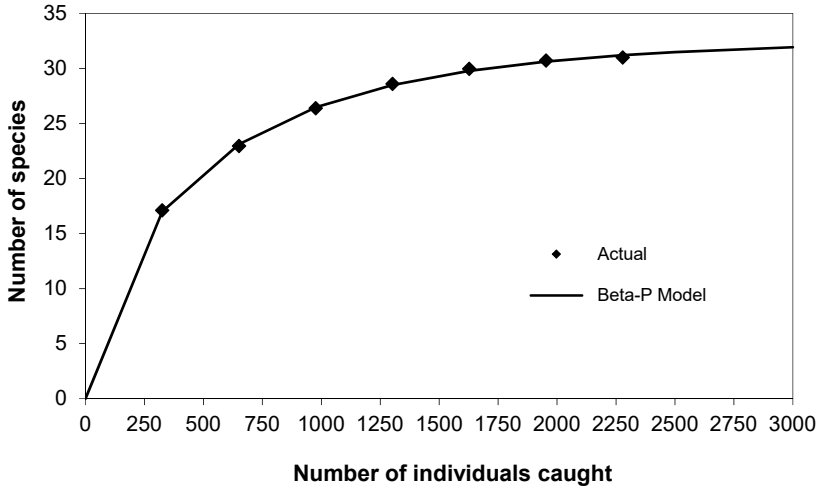

Chart 4. Species accumulation curve for swale habitat

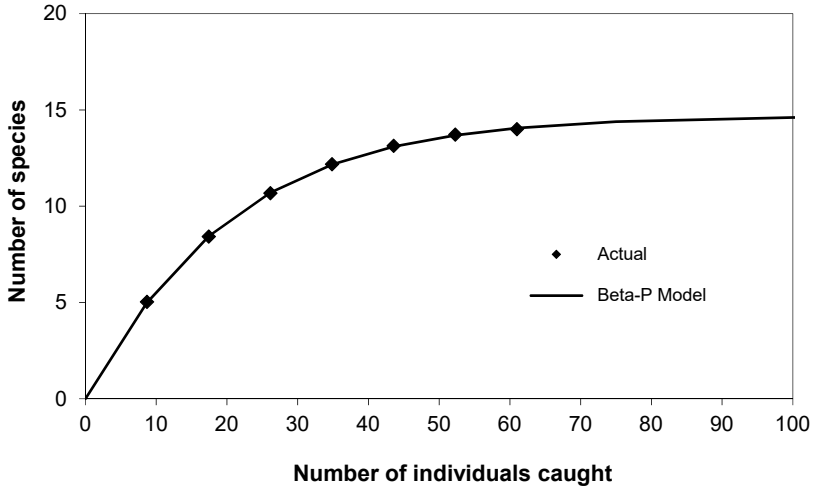

Chart 5. Species accumulation curve for riparian habitat

Table 5. Summary of species accumulation information for five fauna habitats

Habitat type	Recorded species richness	Estimated species richness at the asymptote
Creek line	31	32
Drainage line	20	21
Dune crest	49	51
Swale	31	33
Riparian	14	15

The data in Table 5 indicate that most of the terrestrial fauna species that were trappable were caught during the surveys in these five habitat types. Fauna habitat types used here are those used by Harewood (2017b). These roughly equate to the fauna habitats listed in Table 3 and the relationship with Harewood's (2017b) habitat types is shown in Table 6.

Table 6. Comparison of Harewood's fauna habitats and Terrestrial Ecosystems' mapped fauna habitats in the development envelope

Harewood's (2017b) fauna habitat type	Trapping site Nº	Fauna habitats mapped and used in this report
Creek line Drainage line	12	Creek or drainage line
Dune crest Swale	1, 3, 4, 5, 7, 8, 9, 10, 11	Swales and dune crests with shrubs over spinifex with few or no trees; flat plain with scattered shrubs over spinifex with few or no trees; and flat plain with few to numerous trees over scattered shrubs over spinifex.
Riparian	2, 6	Halophytic vegetation
		Clay or salt pan mostly devoid of vegetation
		Rocky area or breakaway
		Trees and shrubs over tussock grasses

2.1.1 Bilby, Mulgara and Great Desert Skink searches

Bilbies and Mulgara retreat to burrows during the day and are active at night. Bilbies leave characteristic diggings in their search for food under the soil and their scats are easily identified (Thompson and Thompson 2008, Dziminski and Carpenter 2017). The presence of Bilbies and Mulgara is normally determined by systematically searching the entire area for burrows, diggings or scats or undertaking numerous 2ha plot searches for scats, diggings and burrows; although the number of 2ha plots is not prescribed (Thompson and Thompson 2008, Dziminski and Carpenter 2017). Some of the potash project area was covered on foot, on ATVs, in vehicles and by helicopter, but there remain some areas in the development envelope that were not systematically searched for Bilbies or Mulgara (Harewood 2017b). Terrestrial Ecosystems used a helicopter flying low and slow to map fauna habitat on 14-15 November 2017, and in systematically mapping the fauna habitats from a low altitude, also used the opportunity to search for Bilby burrows.

The Great Desert Skink is a large social lizard that lives in an underground burrow complex, and accumulates scats in latrine sites near burrow entrances. They seldom venture large distances from their burrows, so they are unlikely to be caught in pit and funnel traps, unless these traps are placed near their burrow entrances, but they can be located by searching appropriate habitat for burrows and latrines. Some of the potash project area was covered on foot, on ATVs, in vehicles and by helicopter but there remain some areas in the development envelope that were not systematically searched for the Great Desert Skink.

2.2 Aquatic fauna survey adequacy

Most of the quantified information on the occurrence of waterbirds was gained by aerial survey from a helicopter in 2016 and 2017, backed up by ground survey (Bennelongia Environmental Consultants 2016, 2017b, a). The aim of these aerial surveys was to obtain a complete count of all waterbirds present at Lake Disappointment at the time of survey. Aerial surveys often do not provide species level identifications of most migratory shorebirds or the smaller Australian-resident shorebirds but provide overall numbers of birds and identifications of other species. On large, open waterbodies such as the main saline playa at Lake Disappointment, aerial surveys are efficient and both waterbird abundance and species richness can provide reliable estimates. This was confirmed for the count of Banded Stilt by a survey a month earlier counting adult (i.e. 93,455 birds represents 0.9% difference from the 2017 count; Bennelongia Environmental Consultants 2017b). This survey procedure has been confirmed by Kingsford and Porter (1999) and Halse et al. (1996).

The completeness of the list of waterbird species using the lake was increased by the surveys of Harewood (2017b) in 2013 and 2014. Unlike for terrestrial fauna, no formal analysis of survey adequacy was undertaken because of the large differences in the scope of individual surveys and varying areas surveyed.

Similarly, no formal analysis of survey efficiency was possible for the aquatic invertebrate surveys because most sites were sampled on only one occasion. Previous studies of the sampling technique used at Lake Disappointment has shown that survey usually collects about 60% of the species in the waterbody surveyed at the time of sampling and that this is sufficient to characterise the community (Halse et al. 2002, Pinder et al. 2010). The proportion of species collected in simplified, saline systems such as the main playa is usually higher.

Most importantly, in terms of the adequacy of surveys, there was very extensive flooding of the whole Lake Disappointment system in 2016 to an extent expected only every few decades. Conditions were optimal for aquatic fauna and it is likely the maximal conservation values of the system for these fauna have been documented.

3 ASSESSMENT OF IMPACTS AND MITIGATION STRATEGY

Species are potentially impacted by the potash project if they may occur in or near the project area and are either of conservation significance or otherwise significant (Table 7). In addition, the basis for recognising species as conservation or otherwise significant, and the processes potentially threatening them, must be relevant to the potash project. For all species meeting these criteria, there has been consideration of the likely impact of the potash project on the species status.

Table 7. Types of conservation significant and otherwise significant species

Types of species
Conservation significant
Listed under *Environment Protection and Biodiversity Conservation Act* (*EPBC Act*)
Listed under *Wildlife Conservation Act*
Listed informally by Department of Biodiversity, Conservation and Attractions as Priority species
Otherwise significant
Undescribed species with potentially restricted range
Species with limited range and high sensitivity to proposed development (e.g. range matches project area)
Widespread species with high sensitivity to proposed development in part of their lifecycle

3.1 Impacts and risks

The potential impacts of the potash project on terrestrial and aquatic fauna species were identified in the ESD (EPA 2017). They are summarised here and are discussed more fully in Appendix 2. The impacts can be grouped according to whether they mostly affect terrestrial or aquatic fauna:

Terrestrial

- Vegetation clearing, loss of habitat and habitat fragmentation;
- Vehicle strikes;
- Edge effects, affecting habitat and predation;
- Greater access of introduced feral and pest fauna;
- Altered fire regimes;
- Introduction and spread of weeds changing fauna habitat; and
- Anthropogenic activity (i.e. dust, noise, light spillage).

Aquatic

- Impacts to natural surface water flows because of the implementation and placement of infrastructure;
- Altered surface and groundwater regimes; and
- Contamination of surface and groundwater from waste landforms or brine.

The potential impacts listed above (and others discussed elsewhere in this report) frequently overlap in their nature and causes, as well as rarely acting in isolation on the receptor species. Rather than considering the severity of the impacts on individual receptor species in detail, this report assesses whether species may be significantly affected (i.e. to a non-trivial extent) by the potash project and then focuses on the effectiveness of management and mitigation in reducing that impact. Species affected to a trivial extent include those that have not been recorded in surveys, although there is some possibility that they may occur. When habitat preferences and ranges suggest it is likely the species occur, although not recorded, potential impacts are considered.

3.2 Mitigation to reduce risk

Minimisation, mitigation and rehabilitation strategies can partially reduce the severity of an impact, or completely compensate for an impact or can provide a net positive impact. For example, a feral and pest animal reduction program specifically targeting foxes and feral cats can result in the abundance of fauna and, in particular, conservation significant fauna increasing beyond pre-development levels. This increase in a population as a direct result of this management action would be considered as a net positive impact. The process is illustrated in Chart 6.

The interaction between the original impact and the managed / mitigated impact can be quantified using the scoring system and criteria shown in Table 8.

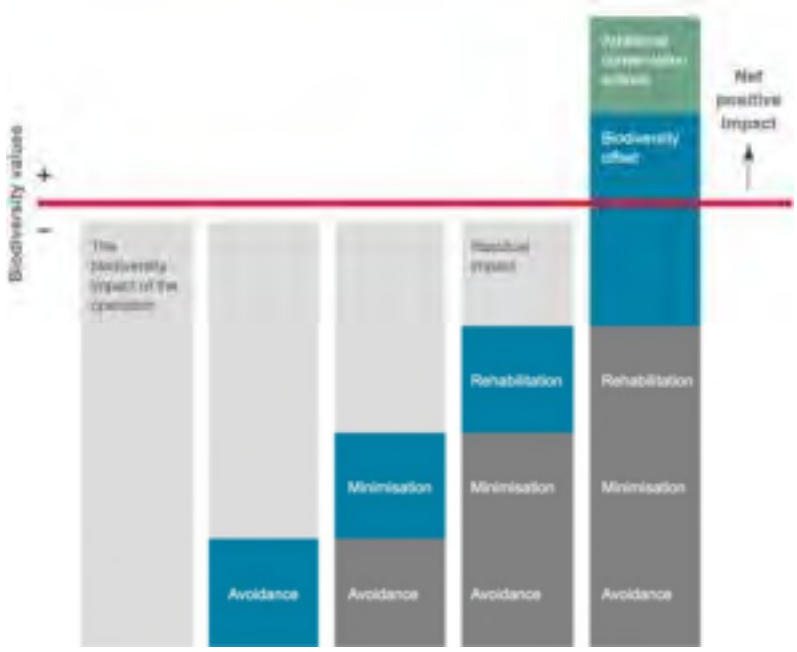

Chart 6. A hierarchy of management and mitigation actions to reduce a negative impact associated with a development proposal (Rio Tinto 2014).

Table 8. Scoring of population changes and the effectiveness of mitigation and management strategies

Extent of impact or effectiveness of the management / mitigation strategy[1]	Score
>75% loss of individuals in relevant population	-4
50-75% loss of individuals in relevant population	-3
25-50% loss of individuals in relevant population	-2
10-25% loss of individuals in relevant population	-1
-10 to + 10% change in the abundance relevant population	0
10-25% increase in the number of individuals in relevant population	+1
25-50% increase in the number of individuals in relevant population	+2
50-75% increase in the number of individuals in relevant population	+3
>75% increase in the number of individuals in relevant population	+4

[1] 'Relevant population' for terrestrial fauna is within the development envelope and the adjacent area, which will vary from a small area just outside the envelope (e.g. Great Desert Skink) to a much larger area outside the development envelope for species with larger home ranges (e.g. Bilbies).
'Relevant population' for waterbirds and shorebirds is the flyway population or the regional/Australian population.

3.3 Risk assessment

3.3.1 Key environmental factor

Scoping of relevant environmental factors was completed as part of the EPA process in preparing and finalising the Environmental Scoping Document (ESD) for this project. The ESD identified terrestrial fauna as a key environmental factor relevant to this project. The relevant aspects that contribute to this factor are shown in Table 9.

Table 9. Key environmental factors

Factor	EPA objective	Relevant aspects
Terrestrial fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	• clearing of fauna habitat for excavation and infrastructure • alterations and disruptions to surface water flows • vehicle movement • lightening (i.e. fires) • noise and vibration • waste disposal
Inland waters	To maintain the quality of groundwater and surface water so that environmental values are protected	• construction and operation of proposal, including abstraction of groundwater from the bore field

3.3.2 Potential impacts

The EPA (2017) considered potential impacts of this project that affect terrestrial and aquatic fauna are:

- loss and fragmentation of fauna and fauna habitat from vegetation clearing, changes to surface water patterns and abstraction of water;
- impacts to natural surface water flows as a result of implementation and placement of associated infrastructure;
- impacts to fauna from increased vehicle strikes, and as a result of construction and operation of the mine; and
- attraction of fauna to evaporation ponds and entrapment of fauna in open excavations.

Potential indirect impacts that must also be addressed are:

- altered fire regimes due to clearing of native vegetation;
- changes in groundwater levels and changes to surface water flows associated with the proposal;
- dust, noise and vibration;
- light impacts on nocturnal species;
- altered surface and groundwater regimes;
- changes to feral animal populations;
- introduction or spread of weed species; and
- restriction or removal of access to breeding habitat, foraging/dispersal habitat or water resources.

3.4 Likelihood of potential impacts

Definitions for likelihood terms used in this report are provided in Table 10.

Table 10. Likelihood definitions

Likelihood	Code	Definition
Rare	1	Extremely unlikely to occur in the project life (<5% in the next 20 years)
Unlikely	2	May occur in the project life (5-15% in the next 20 years)
Possible	3	May occur within the next 5–10 years (15-50% in the next 20 years)
Likely	4	Likely to occur in the next 5–10 years (50-75% in the next 20 years)
Almost certain	5	Expected to occur in next 5–10 years (75-100% in the next 20 years)

The definition of consequences of a potential impact on a conservation significant species or the generic fauna assemblage are shown in Table 11.

Table 11. Fauna consequences definitions

Conservation status of taxa	Slight (A)	Minor (B)	Moderate (C)	Major (D)	Severe (E)
Consequence for Critically Endangered and Endangered fauna	0 to 10% loss of the local population of conservation significant fauna over a period of five years.	10-15% loss of the local population of conservation significant fauna over a period of five years.	15-25% loss of the local population of conservation significant fauna over a period of five years.	25-40% loss of the local population of conservation significant fauna over a period of five years.	> 40% loss of the local population of conservation significant fauna over a period of five years.
Consequence for Vulnerable fauna	0 to 10% loss of the local population of conservation significant fauna over a period of five years.	10-20% loss of the local population of conservation significant fauna over a period of five years.	20-40% loss of the local population of conservation significant fauna over a period of five years.	40-60% loss of the local population of conservation significant fauna over a period of five years.	> 60% loss of the local population of conservation significant fauna over a period of five years.
Consequence for P1 fauna	0 to 10% loss of the local population of conservation significant fauna over a period of five years.	10-25% loss of the local population of conservation significant fauna over a period of five years.	25-45% loss of the local population of conservation significant fauna over a period of five years.	45-65% loss of the local population of conservation significant fauna over a period of five years.	> 65% loss of the local population of conservation significant fauna over a period of five years.
Consequence for P4 fauna	0 to 10% loss of generic fauna assemblage, when considered in a regional context.	10-25% loss of generic fauna assemblage, when considered in a regional context.	25-50% loss of generic fauna assemblage, when considered in a regional context.	50-75% loss of generic fauna assemblage, when considered in a regional context.	> 75% loss of generic fauna assemblage, when considered in a regional context.
Consequence for listed migratory and priority fauna	0 to 10% loss of the local population of conservation significant fauna over a period of five years.	10-25% loss of the local population of conservation significant fauna over a period of five years.	25-45% loss of the local population of conservation significant fauna over a period of five years.	45-65% loss of the local population of conservation significant fauna over a period of five years.	> 65% loss of the local population of conservation significant fauna over a period of five years.
Consequence for otherwise significant fauna	0 to 10% loss of regional population or breeding recruitment.	10-25% loss of regional population or breeding recruitment.	25-50% loss of regional population or breeding recruitment.	50-75% loss of regional population or breeding recruitment.	> 75% loss of regional population or breeding recruitment.
Consequence for the generic vertebrate fauna assemblage	0 to 10% loss of the local population of vertebrate fauna over a period of five years.	10-25% loss of the local population of vertebrate fauna over a period of five years.	25-50% loss of the local population of vertebrate fauna over a period of five years.	50-75% loss of the local population of vertebrate fauna over a period of five years.	> 75% loss of the local population of vertebrate fauna over a period of five years.

3.5 Residual impacts

The residual impact of the project for each environmental aspect has been assessed through a combination of the consequence of a potential impact and the likelihood that it will occur (following the application of mitigation and management measures). The description of various consequences are provided in Table 11. The relationship between the likelihood and consequence of a potential impact and the resulting residual impact is shown in Table 12.

A column titled 'Inconsequential' has been added to the long-established risk matrix. This column has been included, as there are actions and impacts that almost certainly will occur (e.g. likelihood = 5), yet the consequence will not be moderate, and most likely will be of little consequence. For example, the Unpatterned Robust Lerista is known to be present approximately 150km south-east of Newman (see Atlas of Living Australia records) but has been caught approximately 250km away in the project area. Given the abundance of suitable habitat in the intervening area, and therefore the potential number of individuals of this species in the intervening area, the loss of a few individuals during vegetation clearing in the project area is likely to be inconsequential (e.g. likelihood = 5 and consequence = A). This potential impact would best be described as low.

Considerations in the assessment of consequences and thus the residual impacts are:

- conservation status of the species;
- proportion of the population likely to be impacted after mitigation;
- duration of the potential impact;
- frequency of the potential impact; and
- the perceived community value of the species.

Table 12. Risk assessment matrix

Likelihood		Consequence					
		Inconsequential (A)	Slight (B)	Minor (C)	Moderate (D)	Major (E)	Severe (F)
Rare	**1**	Low	Low	Low	Moderate	Moderate	High
Unlikely	**2**	Low	Low	Low	Moderate	High	High
Possible	**3**	Low	Low	Moderate	Moderate	High	Extreme
Likely	**4**	Low	Low	Moderate	High	Extreme	Extreme
Almost Certain	**5**	Low	Moderate	Moderate	High	Extreme	Extreme

4 TERRESTRIAL FAUNA

The vertebrate species that are known to be present or are potentially present in the project area, excluding waterbirds, are listed in Appendix 1. This list is based on the fauna surveys undertaken for Reward Minerals, plus information contained in the Atlas of Living Australia (AoLA), Start et al. (2013), Turpin and Bamford (2015), McKenzie and Burbidge (1979), Read (1998), Syrinx Environmental (2006), Western Wildlife (2007), McKenzie and Burbidge (1979) and Cogger (2014).

4.1 Conservation significant fauna

A search of the Commonwealth Government's Protected Matters Search Tool was undertaken (12/9/2017) using a centre point of 23.3606ºS and 122.78685ºE and a radius of 250km to determine vertebrate fauna of conservation significance under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). DBCA's NatureMap has a search area restriction of a radius of 40km, which unfortunately does not include the whole of the project area. The DBCA's Threatened Species database was searched within a radius of 200km of the project area to provide a list of conservation significant species. There were no otherwise significant terrestrial fauna species but 26 conservation significant species (either listed under the *Wildlife Conservation* or *EPBC* Acts or a priority species for DBCA) were recorded. These are shown in Table 13, together with nature of their conservation significance and information on status at Lake Disappointment.

Table 13. Conservation significant species known to be or potentially in the proposed development envelope

Species	Common Name	*EPBC Act*	*Wildlife Conservation Act*	Priority species	Probability of being in the development envelope
Pezoporus occidentalis	Night Parrot	En	Cr		Recorded
Dasyurus hallucatus	Northern Quoll	En	En		Not recorded in the project area
Petrogale lateralis lateralis	Black-flanked Rock-wallaby	En	En		Not recorded in the project area
Leipoa ocellata	Malleefowl	Vu	Vu		Not recorded in the project area
Macroderma gigas	Ghost Bat	Vu	Vu		Not recorded in the project area
Macrotis lagotis	Greater Bilby	Vu	Vu		Recorded
Liasis olivaceus barroni	Olive Python	Vu	Vu		Not recorded in the project area
Liopholis kintorei	Great Desert Skink	Vu	Vu		Probably present
Polytelis alexandrae	Princess Parrot	Vu		P4	Infrequently present
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	Vu		P4	Not recorded in the project area
Apus pacificus	Fork-tailed Swift	IA	IA		Infrequently present
Hirundo rustica	Barn Swallow	IA	IA		Not recorded in the project area
Motacilla cinerea	Grey Wagtail	IA	IA		Not recorded in the project area
Motacilla flava	Yellow Wagtail	IA	IA		Not recorded in the project area
Peregrinus falco	Peregrine Falcon		OS		Recorded nearby
Falco hypoleucos	Grey Falcon		Vulnerable		Not recorded in the project area
Diplodactylus fulleri	Lake Disappointment Ground Gecko			P1	Recorded
Ctenophorus nguyarna	Lake Disappointment Dragon			P1	Recorded
Lerista macropisthopus remota	Unpatterned Robust Lerista			P2	Recorded
Typo novaehollandiae	Masked Owl			P3	Not recorded in the project area
Notoryctes caurinus	Northern Marsupial Mole			P4	Recorded
Dasycercus blythi	Brush-tailed Mulgara			P4	Probably present
Dasycercus cristicauda	Crest-tailed Mulgara	Vu		P4	Unlikely to be present
Amytornis striatus striatus	Striated Grasswren			P4	Recorded
Pseudomys chapmani	Western Pebble-mound Mouse			P4	Not recorded in the project area

ᵂ Incorrectly listed as marine migratory.
Cr – Critically endangered; En - Endangered; Vu - Vulnerable; OS - Other specially protected species; IA – Migratory; P - Priority species recognized by DBCA

4.2 Potential impacts on conservation significant species

Each conservation significant fauna species that has been recorded or has the potential to be recorded in the project area, has been assessed against the recognised threats for each species, the potential impacts of these threats and the residual impacts assessed after applying appropriate avoidance and mitigation strategies. Generic potential impacts are discussed in more detail in Appendix 2.

For each of the conservation significant species potentially impacted by the proposed project, a numerical rating has been provided of project related impacts and project related minimisation and mitigation strategies. As indicated in section 3.2, minimisation and mitigation strategies can partially reduce the severity of an impact, or completely compensate for an impact or can provide a net positive impact. For example, a feral and pest animal reduction program specifically targeting foxes and feral cats can result in the abundance of fauna and, in particular, conservation significant fauna increasing beyond pre-development levels. This increase in a population as a direct result of this management action would be considered as a net positive impact.

4.2.1 Night Parrot (*Pezoporus occidentalis*)

The Night Parrot is listed as Endangered under the *EPBC Act* and Critically Endangered under the *Wildlife Conservation* Act.

Harewood (2017c) deployed Wildlife Acoustic SM2+ and/or SM4 recorders at numerous locations in and near the development envelope (Harewood 2017c). Night Parrot were recorded in the development envelope at the locations shown in Table 14 and Figure 7.

Table 14. Recordings of Night Parrots

Date	Time (hrs)	Zone	[redacted]
20/06/2017		51	
21/06/2017		51	
12/08/2017	4:32	51	
14/08/2017	2:10	51	
13/08/2017	2:08	51	
14/08/2017	4:55	51	
15/08/2017	1:32	51	
13/08/2017	19:06, 02:08; 02:09	51	
15/08/2017	01:32, 01:47, 05:51	51	
16/08/2017	17:34, 05:49	51	
22/08/2017	3:07	51	
21/08/2017	6:00	51	
22/08/2017	3:07	51	
23/08/2017	17:42, 20:52	51	
22/08/2017	6:08	51	
23/08/2017	20:42, 05:58	51	

The fauna habitat in which each of the automatic recording units was set and recorded Night Parrot calls is shown in Table 15, along with a description of the vegetation type.

Table 15. Habitat descriptions and images of the ARU locations where Night Parrot calls were recorded
(taken from Harewood 2017c)

Habitat description and location	Image of the habitat
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) Willjabu Track Zone 51 480619mE 7432717mN	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea*	

Habitat description and location	Image of the habitat
spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	
Sand Dunes/Swales - Open low woodland of *Corymbia opaca* over low scrub of *Acacia/Grevillea* spp. and mid-dense hummock grass of *Triodia basedowii* adjacent to open mixed herbs in clay-loam depression. (D-HG1) (CD-OGHSR1) [redacted]	

All calls were recorded in a single swale (Figure 7) where the dunes run east-west and are approximately 1km apart. Based on the images in Table 15 and Figure 7, the habitat is mature seeding spinifex interspersed with freshwater clay pans. The ARUs that recorded Night Parrot calls were spread over approximately 2.5km.

Calls were heard in June and again in August 2017. ARUs were placed at other locations, including the [redacted] (Harewood 2017c).

Based on the time of the calls (Table 15), it appears that the area in which the Night Parrots were heard calling is both a roosting and a foraging site. Roosting because there are calls at around 1700hrs and 0600hrs which presumably have been made as the birds fly to and from their roosting site, and foraging because there are multiple calls throughout the night when Night Parrot typically feed. It could also be a nesting site, as calls in the middle of the night may be when parent birds are returning to feed each other or chicks in the nest.

There is a record in the DBCA threatened species database of 12 Night Parrots at a pool approximately 150km north-west of the project area in 2003. The confidence level for this sighting is low.

The Night Parrot was probably originally distributed over much of the semi-arid and arid Australia (Garnett et al. 2011, Threatened Species Scientific Committee 2016). Sightings in north-west Queensland in the early 1990s were in a broad cross section of the habitats available (Garnett et al. 1993). There have been recent sightings in the Pilbara in 1980, 2005 and 2017, central WA in 1979, north-eastern South Australia in 1979, western Queensland (including Pullen-Pullen-Mt Windsor-Diamantina population) in 1980, 1990, 1993, 2006 and 2013-17 (Davis and Metcalf 2008, Garnett et al. 2011, Palaszxzuk and Miles 2017), Pilbara in 2017 (Jones 2017) and near Lake Eyre in 2017 (McCarthy 2017). Garnett et al. (2011) suggested that there were between 50-250 mature individuals in less than 5% of its previous range.

Wilson's (1937) summary of observations provided information on the early records of Night Parrots' preferred habitat and breeding sites. Recent information indicates its preferred habitat appears to be in *Triodia* grasslands, chenopod shrublands, shrubby samphire and floristically diverse habitats dominated by large-seeded species (Threatened Species Scientific Committee 2016, McCarthy 2017, Murphy et al. 2017b). It nests under *Triodia*

and has a runway and a tunnel entrance with an apron of dead *Triodia* sp. leaves. It has clutches of two to four sub-elliptical, white eggs with a lustrous appearance (Murphy et al. 2017a). Breeding followed significant rains in March for the observations in Pullen-Pullen Reserve, but it is thought that breeding generally occurs between April and October (Murphy et al. 2017a).

Of particular relevance to this assessment are two observations of what is believed to be Night Parrots by Hamilton et al. (2017) and calculations of the need for access to free water by Kearney et al. (2016). The first observation by Hamilton et al (2017) was a bird crouching on the road, 1-1.5m from the road edge. This bird did not fly when approached, but ran under a slow-moving vehicle. The second observation is of a bird emerging from the base of a group of *Eremophila* shrubs that was surrounded by small grasses and other plants. This bird ran across the road, then hopped over the edge into another group of thick *Eremophila*. These observations suggest that the Night Parrot will be prone to vehicle strikes, if it is breeding or foraging near roads or tracks in or near the project area.

Kearney et al.'s (2016) extrapolations and modelling suggest that Night Parrots can persist on dry seed during winter conditions without exceeding dangerous levels of dehydration, but would need access to water or succulents during summer. These data have significant implications for where Night Parrot might be found, and its preferred habitat.

4.2.1.1 *Data deficiency*

There is still much we do not know about Night Parrots in and adjacent to the project area, e.g. are Night Parrots transient, are they only present between June and August, are they roosting and foraging in the areas in which they have been detected, are they breeding in the areas in which they have been recorded, do they have habitat preferences, and if so what are they, are they still present in the area, where else are they present in the development envelope and beyond, is access to free freshwater important in determining where they forage, nest and roost; the number of Night Parrot in the development envelope), and this knowledge is important if they are to be adequately protected in the project area.

Additional surveys to address the questions listed above and perhaps others will be undertaken to inform management of Night Parrots occurring in the development envelope (see Lake Disappointment Potash Project; Vertebrate Fauna Management Plan).

4.2.1.2 *Threats*

Threats identified by the Threatened Species Scientific Committee (2016) and Murphy et al. (2018) that are relevant to the potash project are:

- predation by feral cats and foxes;
- loss of habitat due to erosion and feral herbivores;
- human induced and increased fires;
- degradation or reduced watering points;
- fences;
- collection of eggs; and
- bird watching activities.

Although, not listed by the committee, clearing of roosts or foraging habitat, if birds are relatively sedentary, is also likely to be a threat. Clearing of a nest with eggs or chicks would be a significant impact. Furthermore, if Night Parrots are prone to sitting and running on roads, rather than flying when disturbed, then they are likely to be struck by moving vehicles. A wildfire through an area containing eggs or chicks will almost certainly result in the loss of these eggs or birds and would be of concern.

Given the status of Night Parrots with bird watching enthusiasts, the Lake Disappointment project area may be visited by numerous bird watchers wishing to add the Night Parrot to their observed list.

4.2.1.3 *Assessment of potential impacts*

Potential impacts on Night Parrots in the project area are bird strike by vehicles, particularly at night, and during vegetation clearing. The loss of viable eggs or chicks in a nest due to vegetation clearing or fire would be a significant impact. Bird watchers seeking to locate nests or record Night Parrots in the project area are a potential risk.

4.2.1.4 *Recovery plan – Night Parrots*

There is no recovery plan for Night Parrots, as the Threatened Species Scientific Committee's (2016) advice to the Minister is currently considered adequate and provides sufficient information about threats and research priorities.

4.2.1.5 *Avoidance and mitigation*

Prior to vegetation clearing, all mature spinifex and chenopod shrub land within the proposed clearing footprint will be surveyed to determine whether it is possible that Night Parrots are nesting under the vegetation. This will be done by deploying ARUs for a period of five nights within two weeks of the scheduled vegetation clearing program to determine if Night Parrots are in the area. All recordings will be examined by a person knowledgeable in the Night Parrot calls. If calls are recorded, then a thorough search of the area will be undertaken to determine whether nests are present. If nests are present, then all habitat within 300m of the nest will not be disturbed until the chicks have fledged. Eastern Ground Parrot egg incubation is 21-24 days, and fledging takes another 23-25 days to leave the nest, but can range from 18-28 day (McFarland 1991); so it is likely to be the same for Night Parrots.

The chair of the Night Parrot Recovery team will be notified of the presence of Night Parrot eggs or chicks.

Even slow-moving vehicles have the potential to impact Night Parrots on the roads at night (Table 16). The proposed 40 truck / vehicle movements per day along the access tracks through habitat that is suitable for Night Parrots will increase the likelihood that Night Parrots will being killed on the roads. There are no suitable practical mitigation strategies to minimise this potential impact.

Bird watching enthusiasts may endeavour to visit the Lake Disappointment project area, hoping to add this species to their observed list. These people have the potential to impact on nesting, roosting and foraging activities if Night Parrot are still in the area when these people visit the area.

A fox and feral cat reduction program should reduce predation on Night Parrots, their eggs and chicks. A complimentary large feral herbivore control and management program should also be undertaken to reduce the impacts of habitat degradation. The overall impact of the potash project on the Night Parrot, if resident or frequently using the area, after mitigation is likely to be positive.

Table 16. Summary of project threats, mitigation and level of impact on the Night Parrot

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	-1	• Preclearing surveys	+1	
• Vehicle strikes	-1			
		• Fox and feral cat reduction program	+3	
	Risk: Moderate (likelihood = 3; consequence = D); **Residual risk: +ve** outcome with mitigation			+2

Based on the information in Tables 8, 10-12, the potash project could have a moderate impact on Night Parrots, but with mitigation, this impact will be neutralised and converted to a positive outcome.

4.2.2 Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is listed as Endangered under the *EPBC* and the *Wildlife Conservation Acts*.

Recent modelling of the distribution of Northern Quolls in north-western Australia does not extend to the Lake Disappointment area (Molloy et al. 2015), so their presence and abundance in rocky areas is largely unknown in the sandy deserts. Turpin and Bamford (2015) provided records of Northern Quoll in the Throssell and Broadhurst Ranges 125km and 170km north-west of the project area on the northern margins of the Karlamilyi National Park (formerly Rudall River National Park) in undulating rocky uplands of Coolbro sandstone surrounded by extensive spinifex sandplains. There are also records of Northern Quoll in the Trainor Hills, approximately 100km south-south-west of the project area.

It is highly unlikely there are Northern Quolls in the development envelope due to a lack of suitable habitat. Given that it is unlikely that Northern Quolls will be seen in the project area, there are no project-related threats to this species, so no avoidance or mitigation strategies are proposed.

4.2.3 Rock-Wallaby (*Petrogale lateralis lateralis*)

The Rock-Wallaby is listed as Endangered under the *EPBC* and the *Wildlife Conservation Acts*. The species was not recorded in surveys of the project area and is unlikely to occur in this area.

Pearson and Kinnear (1997) reported that Rock-Wallabies occurred in the Calvert Range in the Little Sandy Desert, and a survey in 1985 found abundant signs of wallabies to suggest the existence of a relatively large population. Pearson and Kinnear (1997) reported that a subsequent visit to the same area in June 1991 found the population had declined and subsequent surveys in July 1992 and August 1994 indicated the populations had remained low. Records provided by the Kanyirninpa Jukurrpa community (Figure 5) and DBCA threatened species database (Figure 6) indicate that they are present in the Calvert Range, Durba Hills and an area west of Lake Disappointment.

It is highly unlikely there are Rock-Wallaby in the development envelope due to a lack of suitable habitat. Given that it is unlikely that Rock-Wallaby will be seen in the project area, there are no project-related threats to this species, so no avoidance or mitigation strategies are proposed.

4.2.4 Ghost Bat (*Macroderma gigas*)

The Ghost Bat is listed as Vulnerable under the *EPBC* and the *Wildlife Conservation Acts*. This species was not recorded in the project area, although it occurs at Desert Queens Baths, some 105km north-north-west of the project area.

Armstrong and Anstee (2000), in their summary of the geographic distribution of *M. gigas* in the Pilbara, reported that they had been present in the Abydos Plain, Chichester Plateau, Gascoyne Ranges, George Ranges, Hamersley Plateau and Oakover Valley. However, more recently McKenzie and Bullen (2009) reported it as being more common in the Pilbara than previously thought despite detectability constraints caused by its cryptic call. Its preferred habitat in the Hamersley Ranges was caves beneath bluffs of low rounded hills composed of Marra Mamba geology and granite rock piles in the eastern Pilbara (Armstrong and Anstee 2000). Armstrong and Anstee (2000) reported that while the Marra Mamba iron formation was a good predictor of the occurrence of *M. gigas* in the Hamersley Range, essentially any cave beneath a bluff with sufficient depth could be considered a potential roost. It is highly unusual to find this bat in a spinifex plain unless it is near a rocky area containing suitable roosting caves.

Given that it is unlikely Ghost Bats will be seen in the project area, there are no project-related threats to the species, so no avoidance or mitigation strategies are proposed.

4.2.5 Bilby (*Macrotis lagotis*)

The Bilby is listed as Vulnerable under the *EPBC* and the *Wildlife Conservation Acts*. A single animal was recorded by Reward personnel on the Talawana Track near Lake Disappointment. The DBCA Threatened species database has multiple records of Bilby east of Lake Dora, approximately 150km north of the project area, in 2012-2014 (Figure 6). There are other records to the north of Karlamilyi National Park and some from near Trainor Hills which is approximately 100km south-south-west of the project area and others near Well 12 on the Canning Stock Route, which is approximately 170km south-west of the project area. People from the Kanyirninpa Jukurrpa community have indicated that they know of Bilbies to the north, north-east and south-west of the project area (Figure 5). It is therefore possible that Bilby will be recorded in or near the project area, but as they move around, they may come and go.

This nocturnal, medium sized, omnivorous, burrow dwelling marsupial was once wide-spread in Australian arid and semi-arid areas. Its geographical distribution has now contracted to a few small populations in southern Northern Territory, south-eastern Queensland, the Pilbara and sandy deserts of Western Australia. Bilby distribution is now largely restricted to two broad habitat types: mulga woodlands with lateritic red earth and spinifex grasslands with high fire frequency, again with the red earth (Johnson 1989, Southgate 1990). Its distribution appears limited by access to suitable burrowing habitat and areas of high plant and food production. Southgate et al. (2007) reported that the distribution of Bilbies in the Tanami Desert was related to substrate type, which is probably also true for around the project area in the Little Sandy Desert.

The Commonwealth Government Species Profile and Threats Database (SPRAT) provides a map of the geographic distribution of Bilby in Western Australia (Plate 1), however this grossly exaggerates its distribution, as there are only small and scattered populations spread sparsely across central Western Australia.

Plate 1. Geographic distribution of Bilby in Western Australia
(taken from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=282)

4.2.5.1 *Threats*

Bilby numbers appear to be in significant decline, with only a few small scattered populations existing in the Pilbara and in the adjacent sandy desert areas. Pavey (2006) identified various potential threats, with those relevant to the potash project being:

- predation, particularly of juveniles, by foxes, feral cats (Lollback et al. 2015), wild dogs and dingoes and Abbott (2001) reported fox predation as the primary reason for the long-term reduction in this species;
- competition with herbivores, in particular rabbits;
- habitat degradation and destruction, especially vegetation clearing, where Bilbies are killed in their burrows; and
- vehicle strikes.

4.2.5.2 *Recovery Plan*

There is an old recovery plan for this species (Pavey 2006). There have been numerous publications on the Bilby since this recovery plan was prepared, so it is now considered to be dated and in need of updating.

The relevant recommended recovery actions for Bilbies are:

- control of predators;
- monitor predators and bilbies at priority sites;
- reintroductions into predator free or predator controlled sites; and
- evaluate genetic diversity in reintroduced and wild populations.

4.2.5.3 *Avoidance and mitigation*

All areas are to be inspected by a zoologist within two weeks of vegetation clearing. Ideally, any areas supporting Bilbies will not be cleared until the Bilbies have left the area. If, however, the area must be cleared, then the Bilbies will be caught and relocated with a soft-release.

Staff on-site to be are advised of the possible presence of Bilbies on roads at night, and where practical they are avoided without putting people's lives at risk. All observations of Bilbies will be recorded.

A feral cat and fox reduction program will be implemented in the project area and surrounds. With the proposed management and mitigation, the overall impact of the potash project on the Bilby is expected to be positive (Table 17).

Table 17. Summary of project threats, mitigation and level of impact on the Bilby

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Trapping and relocation plan prior to and during vegetation clearing	0	
• Vehicle collisions on the haul road	-1			
		• Fox and feral cat reduction program	+2	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve** outcome with mitigation			+1

Based on the information in Tables 8, 10-12, the potash project is likely to have a moderate impact on Bilby, but with mitigation, this impact has been neutralised and converted to a positive outcome.

4.2.6 Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python is listed as Vulnerable under the *EPBC* and the *Wildlife Conservation Acts*. It was not recorded during surveys and is not recorded near the project area in the DBCA Threatened Species database, so it is unlikely to occur near the development envelope.

Kendrick (2001) reported this species as common and wide-spread in the Pilbara and one that should not be listed as threatened or declining. Pilbara Olive Pythons are found throughout the Pilbara and north as far as the Gregory Range. Given that it is unlikely that Pilbara Olive Pythons will be recorded in the project area, there are no project-related threats to the species, so no avoidance or mitigation strategies are proposed.

4.2.7 Great Desert Skink (*Liopholis kintorei*)

The Giant Desert Skink is listed as Vulnerable under the *EPBC* and the *Wildlife Conservation Acts*. The species was not recorded in surveys in the project area, but may occur within the development envelope. Pearson (2001)

reported that Otto Lipfert collected six specimens along the Canning Stock Route that runs along the western edge of Lake Disappointment in the 1930s. People from the Kanyirninpa Jukurrpa community have indicated that they know of Great Desert Skinks to the west, north and east of the project area (Figure 5). The DBCA threatened species database indicates there are multiple records east of Lake Dora, which is approximately 130km to the north of the project area (Figure 6).

The Commonwealth SPRAT database-derived distribution of the Great Desert Skink (Plate 2) is somewhat inaccurate because there are additional records closer to Laverton and north of the Karlamilyi National Park (Terrestrial Ecosystems unpublished data).

The species occurs in low abundance and small populations that are widely distributed, so any populations around Lake Disappointment are particularly important.

4.2.7.1 *Threats*

Moore et al. (2015) reported that *L. kintorei* is adversely affected by fire and predation (including by dingoes, foxes and cats). The now outdated recovery plan (McAlpin 2001) for the Great Desert Skink indicated the potential threats are:

- cessation of traditional land management practices, and particularly the creation of new fire regimes;
- predation by foxes and feral cats; and
- rabbits destroying and occupying burrow systems.

Plate 2. Geographic distribution of Great Desert Skink in Western Australia
(taken from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83160)

McAlpin (2001) suggested that relevant recovery actions should include:

- an identification fact sheet is produced and disseminated to Aboriginal communities, wildlife management agencies, ecotourism operators, mining industry to make them aware of the importance of this skink; and
- re-establishment of the patch burning system to create a mosaic of habitats with different burn histories.

4.2.7.2 *Avoidance and mitigation*

The most likely impacts of the potash project on Great Desert Skinks, if the species is present in the project area, are:

- vegetation clearing, where Great Desert Skinks are killed in their burrows; and
- predation by feral cats, foxes and wild dogs.

All areas are to be inspected by a zoologist within four weeks of vegetation clearing. Areas supporting Great Desert Skinks, where practical, should not be cleared. If an area supporting the Great Desert Skink must be cleared,

then the skinks are to be captured and relocated using a soft-release. The soft-release in this case, is in suitable habitat that is fenced to exclude predators and to stop the skinks escaping the compound until they have dug a series of burrows. When the skinks have dug an appropriate burrow system and the population has become stable, the fence is removed. The success of all relocations should be monitored.

A feral cat and fox reduction program is implemented in the development envelope and surrounds. With the proposed mitigation, the overall impact of the potash project on the Great Desert Skink is expected to be positive (Table 18).

Table 18. Summary of project threats, mitigation and level of impact on the Great Desert Skink

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Trapping and relocation plan prior to and during vegetation clearing	0	
		• Fox and feral cat reduction program	+1	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve** outcome with mitigation			+1

Based on the information in Tables 8, 10–12 the potash project is likely to have a moderate impact on the Great Desert Skink, but with mitigation, this impact will be neutralised and converted to a positive outcome.

4.2.8 Princess Parrot (*Polytelis alexandrae*)

The Princess Parrot is listed as Vulnerable under the *EPBC Act* and Priority 4 with DBCA. A flock of four birds was observed flying overhead in May 2017 (Harewood 2017). The species is found mostly in the inland arid areas of Australia, and in Western Australia in the Gibson, Little Sandy and Great Victoria Deserts (Johnstone and Storr 1998, Pavey et al. 2014; Plate 3). However, they occasionally occurred in lightly wooded areas adjacent to the sandy deserts (e.g. see Moriarty 1972).

Plate 3. Geographic distribution of Princess Parrot in Western Australia (taken from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=758)

4.2.8.1 *Threats*

Pavey et al. (2014) indicated that a loss of Marble Gums (*Eucalyptus gongylocarpa*) would have an impact on this species as hollows in these trees appeared to be the preferred nesting sites. Unless nesting, these birds are likely to move away from a disturbance area.

4.2.8.2 *Avoidance and mitigation*

There is no recovery plan for the Princess Parrot. Despite the likely infrequent occurrence of this species and its relatively wide range, every effort should be made to avoid clearing Marble Gums, and if Princess Parrots are breeding in Marble Gums, then clearing should be suspended until all chicks have fledged. With the low likelihood of the species breeding in the project area and the proposed avoidance actions if species breed there, the overall impact of the potash project on the Princess Parrot is expected to be neutral (Table 19).

Table 19. Summary of threats, mitigation and level of impact on the Princess Parrot

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Avoid clearing Marble Gums, if Princess Parrots are nesting in them	0	
	Residual risk: Low (likelihood = 1; consequence = A)			0

Based on the information in Tables 8, 10–12, the potash project is likely to have a low impact on the Princess Parrot.

4.2.9 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

The Pilbara Leaf-nosed Bat is listed as Vulnerable under the *EPBC Act* and the *Wildlife Conservation Acts*. The species was not recorded during surveys in the project area, but has been recorded in a survey of Desert Queens Baths, approximately 100km to the north, north-west of the project area.

Plate 4. Geographic distribution of Pilbara Leaf-nosed Bat in Western Australia
(taken from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82790)

Armstrong (2001) reported populations of *R. aurantia* at various locations in the Pilbara (e.g. around Marble Bar, Nullagine, Hillside station, Soansville, Tom Price, Paraburdoo, Red Hill, Millstream, Fortescue and the Barlee Range, Yarrie, Pannawonica, Paraburdoo and Mt Vernon). He went on to suggest that its geographic distribution in the Pilbara was divided into three distinct areas: mines of the eastern Pilbara–George Ranges, Hamersley Ranges in small colonies, and in the Gascoyne Ranges (Armstrong 2001). More recently, McKenzie and Bullen (2009) reported that *R. aurantia* is more common than previously thought because of detectability constraints caused by their cryptic calls. The Commonwealth Government's (2010) Survey Guidelines for Australian Threatened Bats reported known roost sites at Bamboo Creek mine, Klondyke Queen mine, Comet mine, Lalla Rookh mine, Copper Hills mine and caves in Barlee Range Nature Reserve.

Given that there is no evidence of the occurrence of the Pilbara Leaf-nosed Bat in the project area and that project activities are unlikely to threaten the conservation status of the species, no specific mitigation strategies are proposed.

4.2.10 Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed as Migratory under the *EPBC Act* and the *Wildlife Conservation Acts*. It breeds in Asia and northern Australia and winters in Australia and New Guinea. Asian birds occur in Australia from spring through to autumn. While the Fork-tailed Swift is an infrequent visitor to arid regions, the DBCA Threatened species database has a few records of this species in the general vicinity of Lake Disappointment (Figure 6), and a single Fork-tailed Swift was recorded during the fauna surveys of the project area.

As this is an aerial species that rarely comes to the ground, vegetation clearing, and infrastructure development will not impact this species (although it may affect abundance of their prey). No specific avoidance and mitigation strategies are proposed.

4.2.11 Barn Swallow (*Hirundo rustica*)

The Barn Swallow is listed as Migratory under the *EPBC Act* and the *Wildlife Conservation Acts*. There are no records of the Barn Swallow near Lake Disappointment in the DBCA Threatened Species database, and vegetation clearing, and infrastructure development will not impact the species directly. No specific avoidance and mitigation strategies are proposed.

4.2.12 Grey Wagtail (*Motacilla cinerea*)

The Grey Wagtail is listed as Migratory under the *EPBC Act* and the *Wildlife Conservation Acts*. It is considered a vagrant in Australia (Birdlife International 2016). No specific avoidance and mitigation strategies are proposed.

4.2.13 Yellow Wagtail (*Motacilla flava*)

The Yellow Wagtail is listed as Migratory under the *EPBC Act* and the *Wildlife Conservation Acts*. It breeds in northern Asia and Siberia and some birds over-winter in Australia during the austral summer (Johnstone and Storr 2004). The Yellow Wagtail prefers damp short-grass flats, swamp edges and grazed or mowed areas. It is highly unlikely to be seen in the project area due to a lack of suitable habitat, so no specific avoidance and mitigation strategies are proposed.

4.2.14 Peregrine Falcon (*Falco peregrine*)

The Peregrine Falcon is listed as a Schedule 7 species (Otherwise specially protected) under the *Wildlife Conservation Act*. One bird was recorded about 25km from the project area in the Durba Hills, so the species may occasionally fly over the project area.

4.2.14.1 *Threats*

Loss of foraging habitat is the most significant threat for Peregrine Falcons, however, given its very large activity area, vegetation clearing in the project area is unlikely to significantly impact on this species.

4.2.14.2 *Avoidance and mitigation*

Minimising the area of native vegetation that is cleared will minimise the threat.

4.2.15 Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is listed as Vulnerable under the *Wildlife Conservation Act*.

The Grey Falcon is a moderately large raptor that is found in the northern half of Western Australia, mostly in lightly wooded, coastal or riverine areas.

The DBCA Threatened Species database contains records of the Grey Falcon in the Karlamilyi National Park and along the Canning Stock Route in the Gibson Desert (Figure 6). This raptor is only going to be found in areas where there are substantial trees, so it is highly unlikely to be recorded in the project area immediately north of Lake Disappointment, but they may infrequently be seen near trees on the tracks that access the project area.

Vegetation clearing, and infrastructure development are unlikely to impact on this species, so no specific avoidance and mitigation strategies are proposed.

4.2.16 Lake Disappointment Gecko (*Diplodactylus fulleri*)

The Lake Disappointment Gecko is listed as Priority 1 by DBCA. It was recorded on six occasions during surveys of the project area, all in trapping site 2 on the lake edge.

Diplodactylus fulleri was recently reviewed by the International Union for Conservation of Nature (IUCN) and its conservation status may be upgraded to Vulnerable based on plausible future threats. If so, DBCA is likely to follow the IUCN and upgrade its classification of this species to Vulnerable. It should be known in December 2017 whether the IUCN will upgrade its classification.

All known records of the Lake Disappointment Gecko are from the periphery of Lake Disappointment (Figure 6). The actual size of the population is not known, but even if it is only found on the margins of Lake Disappointment, the proposed project will only impact less than 1% of the available fauna habitat for this species. However, due to its limited geographic distribution, the species has conservation importance.

4.2.16.1 *Threats*

Vegetation clearing, and predation are likely to be the most significant threats to this small gecko.

4.2.16.2 *Avoidance and mitigation*

A reduction in predation pressure by feral cats and foxes will mitigate potential impacts on this species, such that the development may have a positive impact on the species (Table 20).

Table 20. Summary of project threats, mitigation and level of impact on the Lake Disappointment Gecko

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0			
		• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve** outcome with mitigation			+1

Based on the information in Tables 8, 10–12, the potash project is likely to have a low impact on the Lake Disappointment Gecko, but with mitigation, this impact will be positive.

4.2.17 Lake Disappointment Dragon (*Ctenophorus nguyana*)

The Lake Disappointment Dragon is listed as Priority 1 by DBCA. It was recorded at trapping site 2 and opportunistically (Figure 6).

Diplodactylus nguyana was recently reviewed by the IUCN and its conservation status may be upgraded to Vulnerable based on plausible future threats. If this happens, DBCA is likely to follow the IUCN and upgrade its classification of this species to Vulnerable. It should be known in December 2017 whether the IUCN will upgrade its classification.

All known records are from the periphery of Lake Disappointment. Cogger (2014) reports it is primarily found in the saline samphire surrounding the lake edge and Doughty et al. (2007) reported it excavates its burrow below the salt crust. Burrow entrances are typically adjacent to vegetation. Males are often observed perched on the crowns of clumps of vegetation, while females are active on the ground running from one clump of vegetation to another.

The size of C. *nguyana* population is unknown and not able to be estimated based on the available information, but because the species is known from a single location, it is of conservation importance. However, even if it is only found on the margins of Lake Disappointment, the proposed project will only impact less than 1% of the available fauna habitat for this species.

4.2.17.1 *Threats*

Vegetation clearing, and predators are likely to be the most significant threats to this dragon lizard.

4.2.17.2 *Avoidance and mitigation*

A zoologist being present during the vegetation clearing program may be able to collect a small number of individuals disturbed during the clearing program and relocate them to suitable habitat in an adjacent area. This, together with predator control, is likely to result in the project having a positive impact on the Lake Disappointment Dragon (Table 21).

Table 21. Summary of project threats, mitigation and level of impact on the Lake Disappointment Dragon

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Pre- and during vegetation clearing fauna relocation programs	0	
		• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve** outcome with mitigation			+1

Based on the information in Tables 8, 10–12 the potash project is likely to have a low impact on the Lake Disappointment Dragon, but with mitigation, this impact will be neutralised and converted to a positive outcome.

4.2.18 Unpatterned Robust Lerista (*Lerista macropisthopus remota*)

The Unpatterned Robust Lerista is listed as Priority 2 species by DBCA. It was recorded on 12 occasions at trapping sites 3, 4 and 12.

Cogger (2014) reports *L. macropisthopus* inhabiting woodlands and semi-arid scrubs, with the subspecies *remota*, being one of four sub-species from the central interior of Western Australia. When Storr (1991) originally described this sub-species it was known from a single location 40km north-east of Jigalong. The Atlas of Living Australia now has multiple records of this subspecies approximately 250km to the west-south-west of the project area.

The population size of *L. m. remota* is unknown, as there are likely to be numerous individuals between the population shown south-east of Newman in the Atlas of Living Australia and Lake Disappointment (Figure 6). As additional records are recorded from surveys in the region, it is likely that the conservation status of this species will be downgraded.

4.2.18.1 *Threats*

Vegetation clearing, and predators are likely to be the most significant threats to this small fossorial skink.

4.2.18.2 *Avoidance and mitigation*

A predator control program is likely to result in the project having a positive impact on the Unpatterned Robust Lerista (Table 22).

Table 22. Summary of project threats, mitigation and level of impact on the Unpatterned Robust Lerista

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0			
		• Fox and feral cat reduction program	0	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: neutral** outcome with mitigation			0

Based on the information in Tables 8, 10–12, the potash project is likely to have a low impact on the Unpatterned Robust Lerista, but with mitigation, this impact will be neutralised.

4.2.19 Masked Owl (*Typo novaehollandiae*)

The Masked Owl is listed as Priority 3 by DBCA. There is a record from 1942, near Well 17 at Killagurra Gorge on the Canning Stock Route in the DBCA Threatened species database. It is unclear to which subspecies the record belongs and it is concluded the bird was a vagrant.

4.2.20 Northern Marsupial Mole (*Notoryctes caurinus*)

The Northern Marsupial Mole is listed as Priority 4 by DBCA. Back-filled subterranean tunnels created by Marsupial Moles were recorded in 19 of 20 trenches dug to find these burrows and surface tracks were observed on dunes crests (Harewood 2015). The DBCA Threatened Species Database contains multiple records of Marsupial Moles around the project area, including Trainor Hills, Telfer mine and parts of the Canning Stock Route (Figure 6). People from the Kanyirninpa Jukurrpa community have indicated that they have records of Marsupial Moles at numerous locations to the west and north-west of the project area (Figure 5).

The Northern Marsupial Mole is known to occur in the Great Sandy Desert, Little Sandy Desert and the northern section of the Gibson Desert. Its listing under the *EPBC Act* was changed in 2015 from Endangered to data deficient (Threatened Species Scientific Committee 2015).

The Northern Marsupial Mole inhabits sand dunes and the adjacent swales where there is deep loose soil (Woinarski et al. 2014, Threatened Species Scientific Committee 2015). When present on the surface they are likely to be eaten by feral cats, foxes and wild dogs and probably raptors. The currently favoured method for surveying for marsupial moles; a) is to dig trenches in the ground and look for their subterranean tunnels but there is no way of knowing how old these tunnels are, so it is unclear whether marsupial moles are currently present or moved through the area at an earlier time; or b) to examine fox and feral cat scats collected from the area for Marsupial Mole hairs. If hairs are located, then this method will confirm their presence in the area.

4.2.20.1 *Threats*

Vegetation clearing, grading the Talawana and the Willjabu Tracks and predators are likely to be the most significant threats to this small fossorial marsupial (Table 23).

4.2.20.2 *Avoidance and mitigation*

A zoologist being present during the vegetation clearing program may be able to collect a small number of individuals disturbed during the clearing program and relocate them to suitable habitat in an adjacent area. It is considered that the benefit of predator control is likely to counteract the impacts of project development.

Table 23. Summary of project threats, mitigation and level of impact on the Northern Marsupial Mole

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Relocating individuals during the vegetation clearing program	0	
• Grading tracks	-1			
		• Fox and feral cat reduction program	+1	
	Risk: Moderate (likelihood = 5; consequence = B); **Residual risk: neutral** outcome with mitigation			0

Based on the information in Tables 8, 10-12, the potash project is likely to have a moderate impact on the Marsupial Mole, but with mitigation, this impact will be neutralised.

4.2.21 Crest-tailed Mulgara (*Dasycercus cristicauda*) and Brush-tailed Mulgara (*Dasycercus blythi*)

The Crest-tailed and Brush-tailed Mulgara are listed as Priority 4 by DBCA and *D. cristicauda* is listed as Vulnerable under the *EPBC Act*.

Woolley (2005) has recognised two species of 'Mulgara'; *Dasycercus blythi* and *D. cristicauda*. *Dasycercus blythi* has a non-crested tail, two upper premolars and six nipples; *D. cristicauda* has a crested tail, three upper premolars and eight nipples. Both species have a wide and overlapping distribution in arid Australia (Department of Sustainability Environment Water Population and Communities 2012). Woolley et al. (2013) indicated that both *D. blythi* and *D. cristicauda* had been caught along the Canning Stock route in the vicinity of the project area (see Plate 5). The records for *D. cristicauda* in the DBCA Threatened Species database along the Canning Stock Route are all 1930 or earlier. People from the Kanyirninpa Jukurrpa community have indicated that they have records of 'Mulgara' to the north-east, west and south-west of the project area (Figure 5).

Although neither of the two Mulgara species were caught during the fauna surveys in the project area, based on the available data it is possible that one or both species are present in the spinifex sand plain adjacent to Lake Disappointment and thus the project area. In the Pilbara, Thompson and Thompson (2007a, 2014) reported catching nine Mulgara in an area of 22ha and 50 in 210ha, and indicated that about 200 trap-nights were required to catch Mulgara in areas with a relatively high density. This trapping effort far exceeds the trapping effort used in the fauna surveys around the northern end of Lake Disappointment, so that Mulgara may be present and not caught in the surveys. Significant population fluctuations appear to be a characteristic of the ecology of Mulgara (Pearson 2003-04). It has therefore been presumed that there is a population of Mulgara (most probably *D. blythi*) in the project area, and the impact assessment has been done on this basis.

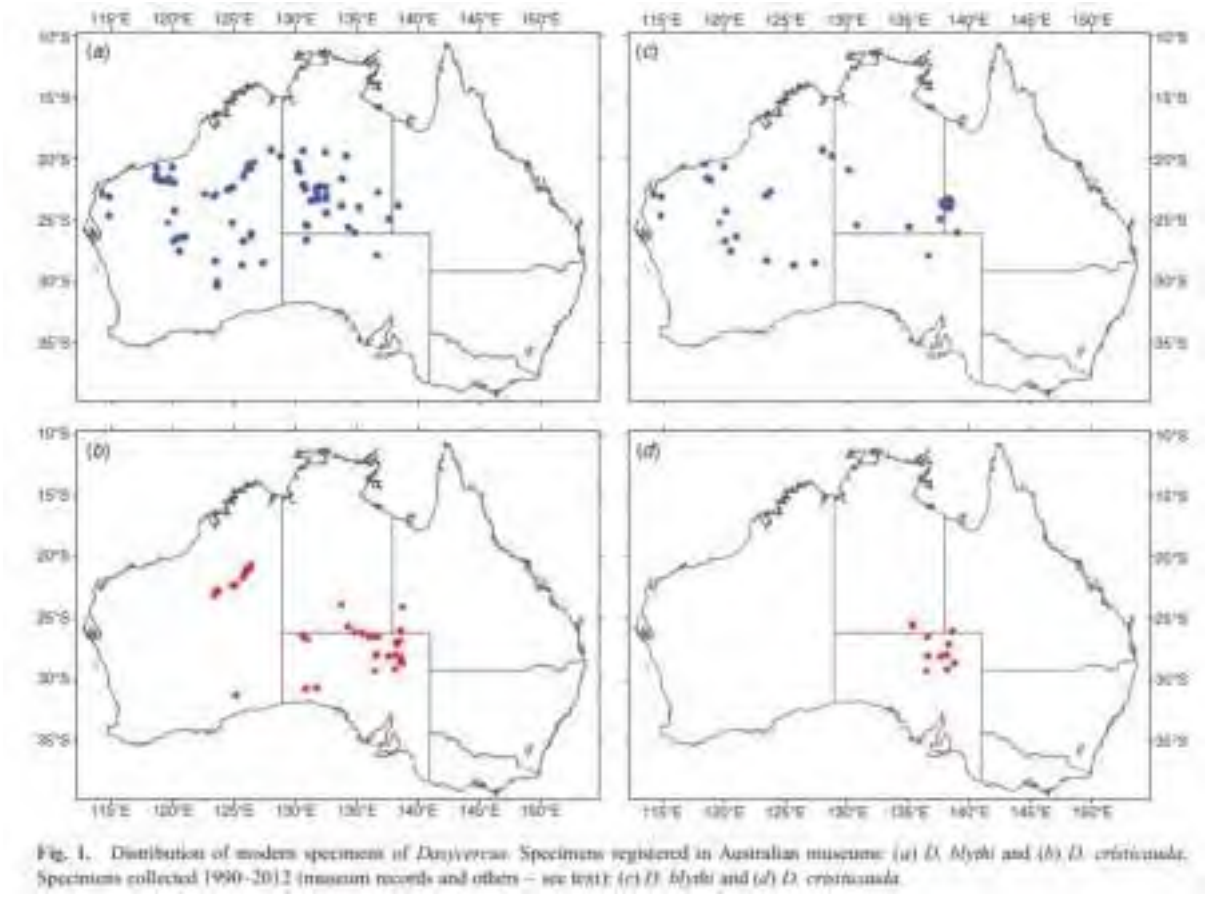

Fig. 1. Distribution of modern specimens of *Dasycercus*. Specimens registered in Australian museums: (*a*) *D. blythi* and (*b*) *D. cristicauda*. Specimens collected 1990–2012 (museum records and others – see text): (*c*) *D. blythi* and (*d*) *D. cristicauda*.

Plate 5. Distribution of Mulgara
(taken from Woolley et al. 2013)

4.2.21.1 *Threats*

Vegetation clearing, and predators are likely to be the most significant threats to Mulgara.

4.2.21.2 *Avoidance and mitigation*

A zoologist is present during the vegetation clearing program to search all areas for Mulgara burrows before they are cleared. When active burrows are found, the Mulgara will be trapped / dug out and relocated to suitable habitat in an adjacent area. It is considered that the benefit of predator control will more than counteract any impacts of project development (Table 24).

Table 24. Summary of threats, mitigation and level of impact on the Mulgara

Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
• Vegetation clearing	0	• Searching for burrows, and trapping and relocating individuals before vegetation clearing	0	
		• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 3; consequence = A); **Residual risk: +ve** outcome with mitigation			+1

Based on the information in Tables 8, 10–12, the potash project is likely to have a low impact on Mulgara, but with mitigation, it will be a positive outcome.

4.2.22 Striated Grasswren (*Amytornis striatus striatus*)

The Striated Grasswren is listed as Priority 4 by DBCA. The species was recorded north of Lake Disappointment near the Willjabu Track in May 2013 and the DBCA Threatened Species database contains records of them near Well 24 on the Canning Stock Route, which is approximately 60km to the east of the project area (Figure 6).

Its preferred habitat is spinifex meadows with or without low shrubs (*Thryptomene* sp.) or *Acacia* sp. on sandy or loamy substrate. *Amytornis s. striatus* known distribution is the sandy deserts (i.e. Great Victoria, Gibson and Great Sandy) in central and eastern Western Australia (Johnstone and Storr 2004).

4.2.22.1 *Threats*

The two most significant threats to this species are predation, particularly of eggs and chicks by foxes, feral cats and wild dogs, and inappropriate fire regimes.

4.2.22.2 *Avoidance and mitigation*

A feral cat and fox reduction program will reduce predation pressure on this species. A reduction in predation by feral cats and foxes will also mitigate any potential impacts on this species associated with vegetation clearing, so that development may have a neutral overall impact (Table 25).

Table 25. Summary of threats, mitigation and level of impact of the Striated Grasswren

Significant threats and impacts	Impact score	Mitigation	Impact score	Residual impact
• Vegetation clearing	0		0	
		• Fox and feral cat reduction program	0	
	Residual risk: Low (likelihood = 2; consequence = A)			0

Based on the information in Tables 8, 10–12, the potash project is likely to have low impact on Striated Grasswrens.

4.2.23 Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse is listed as Priority 4 by DBCA. All the records of Western Pebble-mound Mouse in the DBCA Threatened Species database are in hills or ranges, and it is wide spread in the Pilbara. This preferred habitat is not present in the project area to the north of Lake Disappointment, although the habitat does occur in rocky areas adjacent to the Talawana Track. Despite this, it is highly improbable that the species will be present in any of those rocky areas or breakaways and thus impacted by the proposed development, so threats and mitigation strategies are not discussed.

4.2.24 Potential impacts and mitigation strategies for the vertebrate fauna assemblage in the impact areas

4.2.24.1 *Threats*

The vertebrate fauna assemblages will be mostly impacted in the following ways by the proposed development:

- clearing vegetation;
- predation by foxes and cats because of increased access to their habitat;
- vehicle strikes crossing the tracks
- fires; and
- habitat degradation due to large feral herbivores.

Clearing vegetation

It is likely that many of the small reptiles, mammals and amphibians will be lost during the vegetation clearing process. Some of the large goannas and snakes, and other medium and large mammals will attempt to flee the area once vegetation clearing commences, particularly if it is in the warmer months and they are surface active. However, some will not be able to escape, or they will flee in an inappropriate direction and be injured or killed by machinery or predated on by raptors, corvids, cats and foxes.

Having a zoologist present during the vegetation clearing program to catch and relocate all live animals, and euthanase injured fauna will reduce the loss of vertebrate fauna and improve the animal welfare during the vegetation clearing program.

Feral cats and foxes

Feral cats and foxes are abundant around the project area and a reduction program for these introduced predators will result in a significant increase in the abundance of small mammals and reptiles.

Anthropogenic impacts

Unnatural noises, vibrations, artificial light sources and vehicle and human movement associated with vegetation clearing, construction and project operations have the potential to disturb and displace a very small number of vertebrate fauna living adjacent to the proposed development areas.

4.2.24.2 *Avoidance and mitigation*

The potential impact associated with vegetation clearing can be reduced by minimising areas of native vegetation to be cleared and rehabilitating areas once they are no longer required.

A fox and feral cat reduction program will reduce predation pressure on the small vertebrate fauna assemblage.

Table 26. Summary of threats, mitigation and level of impact of the generic fauna assemblage

Significant threats and impacts	Impact score	Mitigation	Impact score	Residual impact
• Vegetation clearing	-1			
• Vehicle collisions on the haul road	-1			
• Unnatural noises, vibrations, artificial light sources	0			
		• Fox and feral cat reduction program	+2	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: neutral** outcome with mitigation			0

Based on the information in Tables 8, 10–12 the potash project is likely to have a low impact on the generic fauna assemblage, but with mitigation, this impact will be neutral.

4.3 Summary of threats and mitigation strategies

Table 27 provides a summary of the potential adverse changes to population numbers of key terrestrial fauna species as a result of project development. It also shows the extent to which these changes may be counteracted by the management and mitigation that will be put in place. The residual impact of project development is assessed, with most species likely to show positive changes in abundance as a result of management and mitigation.

Table 27. Summary of extent of threats and impacts on terrestrial fauna and results of management and mitigation

(Scores in the columns titled 'Impact score' come from Table 8. The assessed residual risk and associated scores in the 'Residual risk' rows come from Table 12, which is based on the information in Table 10 and 11)

Species	Status	Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
Night Parrot (*Pezoporus occidentalis*)	En/Cr	• Vegetation clearing	-1	• Preclearing surveys	+1	
		• Vehicle strikes	-1			
				• Fox and feral cat reduction program	+3	
	Risk: Moderate (likelihood = 3; consequence = D); **Residual risk: +ve outcome with mitigation**					+2
Bilby (*Macrotis lagotis*)	Vu	• Vegetation clearing	0	• Trapping and relocation plan prior to and during vegetation clearing	0	
		• Vehicle collisions on the haul road	-1			
				• Fox and feral cat reduction program	+2	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve outcome with mitigation**					+1
Great Desert Skink (*Liopholis kintorei*)	Vu	• Vegetation clearing	0	• Trapping and relocation plan prior to and during vegetation clearing	0	
				• Fox and feral cat reduction program	+1	
	Risk: Moderate (likelihood = 3; consequence = C); **Residual risk: +ve outcome with mitigation**					+1
Princess Parrot (*Polytelis alexandrae*)		• Vegetation clearing	0	• Avoid clearing Marble Gums, if Princess Parrots are nesting in them	0	
	Residual risk: Low (likelihood = 1; consequence = A)					0
Lake Disappointment Ground Gecko (*Diplodactylus fulleri*)	P1	• Vegetation clearing	0			
				• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**					+1
Lake Disappointment Dragon (*Ctenophorus nguyana*)	P1	• Vegetation clearing	0		0	
				• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**					+1
Unpatterned Robust Lerista (*Lerista*	P2	• Vegetation clearing	0			

Species	Status	Project related significant threats and impacts	Impact score	Project related mitigation strategies	Impact score	Residual impact
macropisthopus remota)				• Fox and feral cat reduction program	0	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: neutral outcome with mitigation**					0
Northern Marsupial Mole (*Notoryctes caurinus*)	P4	• Vegetation clearing	0	• Relocating individuals during eth vegetation clearing program.	0	
		• Grading tracks	-1			
				• Fox and feral cat reduction program	+1	
	Residual risk: Moderate (likelihood = 5; consequence = B); **Residual risk: neutral outcome with mitigation**					0
Brush-tailed Mulgara (*Dasycercus blythi*) / Crest-tailed Mulgara (*D. cristicauda*)	P4/Vu	• Vegetation clearing	0	• Searching for burrows, and trapping and relocating individuals before clearing	0	
				• Fox and feral cat reduction program	+1	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: +ve outcome with mitigation**					+1
Striated Grasswren (*Amytornis striatus striatus*)	P4	• Vegetation clearing	0			
				• Fox and feral cat reduction program	0	
	Residual risk: Low (likelihood = 2; consequence = A)					0
Generic fauna assemblage		• Vegetation clearing	-1			
		• Vehicle collisions	-1			
				• Fox and feral cat reduction program	+2	
	Risk: Low (likelihood = 5; consequence = A); **Residual risk: neutral outcome with mitigation**					0

Cr Critically Endangered; En Endangered; Vu Vulnerable; P Priority species recorded by DBCA

4.4 Habitat value for conservation significant fauna

Eight broad fauna habitats were recorded in the development envelope, and not all of these are suitable for all conservation significant species. Table 28 indicates which conservation significant species are likely to be found in each of the fauna habitats.

Table 28. Habitat value for conservation significant fauna

Habitat type	Habitat value for conservation significant fauna
Flat plain with few to numerous trees over scattered shrubs over spinifex	This habitat could be used by Bilby (*M. lagotis*), Great Desert Skink (*L. kintorei*) and Princess Parrot (*P. alexandrae*). Night Parrots (*P. occidentalis*) could roost, breed and foraging in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40cm high.

Flat plain with scattered shrubs over spinifex with few or no trees	This habitat could be used by Bilby (*M. lagotis*) and the Great Desert Skink (*L. kintorei*). Night Parrots (*P. occidentalis*) could roost, breed and foraging in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40cm high.
Swales and dune crests with shrubs over spinifex with few or no trees	This habitat could be used by Bilby (*M. lagotis*), Northern Marsupial Mole (*N. caurinus*), Unpatterned Robust Lerista (*L. m. remota*), Striated Grasswren (*A. s. striatus*) and the Great Desert Skink (*L. kintorei*). Night Parrots (*P. occidentalis*) could roost, breed and foraging in this habitat if the spinifex is mature, as nest and roosting sites are typically in old circular spinifex hummocks greater than 40cm high.
Creek or drainage line	This habitat could be used Princess Parrot (*P. alexandrae*), Unpatterned Robust Lerista (*L. m. remota*) and the Great Desert Skink (*Liopholis kintorei*).
Halophytic vegetation	This habitat could be used by Night Parrot (*P. occidentalis*) for foraging, and Lake Disappointment Dragon (*C. nguyana*) and Lake Disappointment Gecko (*D. fulleri*).
Clay or salt pan mostly devoid of vegetation	Night Parrot (*P. occidentalis*) could drink from freshwater clay pans when they contain water.
Rocky area or breakaway	
Trees and shrubs over tussock grasses	This habitat could be used by Princess Parrot (*P. alexandrae*) and Bilby (*M. lagotis*).

4.5 Mitigation for terrestrial species

4.5.1 Vertebrate fauna management plan

The Reward tenements near Lake Disappointment support multiple vertebrate fauna, some of which are of conservation significance. It is therefore important that Reward accepts responsibility for the long-term management, protection and mitigation of impacts on the vertebrate fauna. A vertebrate fauna management plan is being prepared, and will be implemented and regularly updated (i.e. at least annually) based on the best available information. The vertebrate fauna management plan will cover the entire operations and will describe the management practices associated with vegetation clearing and infrastructure development, and ongoing project operations.

This plan will have specific and measurable objectives, triggers for specific actions and the specific actions that will be implemented as and when required. The plan will also detail an annual vertebrate feral and pest reduction program and a monitoring program to measure the health and relative abundance of conservation significant vertebrate fauna species. This plan will detail the adaptive management processes to be implemented by the project's management.

4.5.2 Fox and cat reduction

The most significant threats to vertebrate fauna in and around the Lake Disappointment project, in particular the conservation significant fauna species, is the abundance of cats and foxes and vegetation clearing.

Broad-landscape scale baiting programs for cats and foxes have been undertaken with mixed success. The two primary problems with broad-scale aerial baiting programs are uncontrolled uptake of baits by non-target species and unpredictable ambient weather conditions prior to and during the distribution of the bait. For example, Dundas et al. (2014) reported that 99% of the 1080 baits laid to control foxes in the northern Jarrah Forest and monitored by cameras were taken by non-target species; and in a field trial to compare the efficacy of Eradicat and Curiosity baits in the Cape Arid National Park and Nuytsland Nature Reserve inappropriate weather resulted in poor bait uptake due to reduced bait attractiveness/palatability (Algar et al. 2011). At the Lake Disappointment project, non-target species such as *Varanus gouldii* (Sand Monitor), *Varanus giganteus* (Perentie), *Tiliqua multifasciata* (Central Blue-tongue lizard), *Corvus bennetti* (Little Crow), *Corvus orru* (Torresian Crow), emus (*Dromaius novaehollandiae*) and multiple raptors would potentially take most of the meat-based baits laid on the surface.

Cat and fox numbers should be significantly reduced to enable recovery of small mammal and reptile populations, and increase the success for ground nesting avifauna. A well planned and implemented program should have a significant impact on fox numbers, however, it is possible that a reduction in the fox population will result in the increased impact of cats (i.e. meso-predator release) on native fauna. It is therefore important that a concurrent cat reduction program is implemented. The following strategies will be implemented:

a. large baited cage traps are deployed across the Reward tenements;
b. buried 1080 baits are laid across the tenements; and
c. a shooting program is implemented.

One hundred and fifty baited large wire cage traps will be deployed adjacent to disused and low use tracks targeting feral cats. These traps will be left *in-situ* between trapping events and opened concurrently with the 1080 baiting program at weeks 2, 4 and 6. The trapping program should be completed twice in the first year (autumn/early winter and late winter), then in winter in the following years. The use of other wide-spread baiting strategies will be investigated.

In the first year, the fox baiting program will involve the widespread distribution of buried 1080 baits (~500 depending on access) with a follow-up distribution at 2, 4 and 6 weeks in autumn and early winter. Camera traps will be used to monitor bait uptake at selected sites. Burying 1080 meat baits reduces the bait uptake by non-targeted species such as ravens and raptors, and deploying the baits in autumn and winter will reduce up-take by varanids.

The baiting program will be complemented by a shooting program for foxes and cats. The use of thermal spotting scopes will be considered, as it will increase the number of cats observed as they rarely present themselves in front of spotlights in spinifex meadows.

This integrated feral and pest animal reduction methodology is based on our knowledge of an abundance of feral cats and foxes currently on the Reward tenements. A significant reduction program of these feral pest species is initially required, but once the initial knock down of fox and cat numbers is achieved, then an annual maintenance program can be implemented, which will be less intensive.

The effectiveness of this cat and fox management program will be reviewed after each baiting program to determine bait uptake. The annual fauna monitoring program should show an increase in small mammals, reptiles and amphibians if the number of cats and foxes is reduced. It would be anticipated that it would take at least three years to see an increase in the abundance of small mammals, reptiles and amphibians, if the cat and fox baiting, trapping and shooting program is successful.

4.5.3 Water pipeline bridges

Water pipelines laid on the ground are a barrier to movement for small vertebrate fauna. All water pipelines should be lifted off the ground at least 100mm approximately every 100m to enable snakes, goannas, other reptiles and small mammals to pass the barrier. Plate 6 shows an example of a raised water pipeline.

Plate 6. Raised water pipeline

4.5.4 Night Parrot recording program prior to vegetation clearing

Because of a lack of information about the ecology and behaviour of Night Parrots north of Lake Disappointment and within or adjacent to the development envelope, prescriptive management plans are, at best, educated guesses. The management of Night Parrot should be based on the best available science. If for example, Night Parrot are shown to be transient and only utilise the project area opportunistically and infrequently, then no action is probably required, however, if there is a breeding population with the offspring being a source population for other areas, then it will be important that detailed and specific management actions are developed and implemented.

Knowledge of:

- whether they are transient;
- the number of Night Parrots in the project envelope;
- when they are present in the development envelope;
- the importance of significant rains and spinifex seeding events;
- whether they are only roosting and foraging in the areas;
- whether they are breeding in the area;
- habitat preferences for roosting, foraging and breeding; and
- the importance of access to free water.

and possibly other questions is essential if this species is to be effectively managed at the local scale.

Surveys should be designed and implemented to answer specific management questions, and then the management plan progressively amended to protect the species.

Prior to vegetation clearing, automatic recording units (ARUs) will be placed a maximum of 500m apart in all areas of mature spinifex and chenopod shrubland for five nights within two weeks of the scheduled vegetation clearing. Should a recording of a Night Parrot be obtained, then all habitat within 300m of the call area will be thoroughly searched for nests. A non-disturbance barrier of 300m will be placed around any Night Parrot nest, and the vegetation will not be cleared until the chicks have fledged. The Night Parrot Recovery team will be advised of all Night Parrot observations.

4.5.5 Bilby, Mulgara and Great Desert Skink burrows

All areas of spinifex scheduled for vegetation clearing will be searched for Bilby, Mulgara and Great Desert Skink burrows by a zoologist immediately before vegetation clearing. Ideally, areas supporting Bilbies will not be cleared until Bilbies have left the area. If, however, the area must be cleared, then the Bilbies will be caught and relocated into a soft-release enclosure.

Where practical, areas supporting Great Desert Skinks should not be cleared. If an area supporting the Great Desert Skink must be cleared, then the skinks are to be captured and relocated using a soft-release technique. The soft-release in this case is suitable habitat that is fenced to exclude predators and to stop the skinks escaping and releasing the skinks into the compound. When the skinks have dug an appropriate burrow system and the population has become stable, the fence is removed. The success of all relocations will be monitored and reported.

Mulgara can be caught and relocated to suitable habitat away from the disturbance area.

4.5.6 Clearing trees with hollows that could provide nests for birds, including Princess Parrots

There are very few trees in the project area that are large and old enough to have hollows that would provide suitable nesting sites for Princess Parrots. However, all trees large enough and old enough to contain suitable nesting hollows in areas scheduled to be cleared will be inspected for parrot nests. Where possible, trees containing hollows that provide suitable nesting sites for parrots will not be cleared. If they must be cleared, then hollows need to be checked to ensure they do not contain eggs or chicks. This can be done by looking down the hollow and photographing its contents or using a camera which is attached to a long flexible cord or a small camera on a long light-weight extension pole.

4.5.7 Marsupial Moles and their burrows

A zoologist will be present during vegetation clearing catch and relocate any Marsupial Moles disturbed during the clearing process.

4.5.8 Fire management plan

It is likely most of fires in the development and adjacent areas will be caused by lightning. With suitable temperature and wind conditions, these fires can cover large sections of the landscape, and are impossible for the proponent to control or put out. It is known that altered fire regimes in conjunction with habitat fragmentation and predation by introduced predators have had a significant impact on the vertebrate fauna. Previous fires near the project area through the long unburnt habitat appear to have been intense and wide spread, with the likely consequence that many of the small vertebrate fauna would have perished. Many of the animals remaining after a fire would have quickly been predated on by feral cats, raptors and corvids.

Reward's fire management plan will focus on fires not being caused by project related activities and when a fire occurs, then its impact on the project is minimised. It is not anticipated that Reward would endeavour to control fires in the vegetation outside the project area.

4.5.9 Fauna access to freshwater

During extended periods when there is little freshwater available, camels, donkeys and horses may be attracted to freshwater ponds created by the proponent. Camels will attempt to destroy fences and infrastructure to get access to the water. All freshwater ponds, turkey nests and camp infrastructure will be appropriately fenced to stop large feral animals accessing the freshwater.

An abundance of camels, donkeys and horses near the project area will also be a hazard for vehicles on the tracks around the project area and the access tracks and roads to the coast.

The fauna management plan should include details of a ground-based large feral herbivore control program to be run concurrently with the feral cat and fox control program.

4.6 Putrescible waste

Putrescible waste will attract native and non-native fauna to the infrastructure, if it is not suitably contained. An abundance of small mammals as a direct result of the putrescible waste will also attract cats, foxes, wild dogs, dingoes and Silver Gulls.

All rubbish storage facilities will be fenced to exclude fauna, and all putrescible waste will be placed in containers not accessible to animals.

4.6.1 Feeding wildlife

Feeding wildlife will be prohibited as it can lead to fauna (including cats, foxes, wild dogs, dingoes, large goannas and Silver Gulls) becoming partially habituated to humans and remaining around the infrastructure. This can lead to safety issues with fauna harassing staff for food.

4.7 Threat Abatement Plans

4.7.1 Threat abatement plan for feral cats

The *Threat abatement plan for predation by feral cats* (Department of the Environment 2015, p9) indicates that 'Control of cats is difficult as they are found in very low densities and have large home ranges, making them difficult to locate. They are also extremely cautious in nature, making them hard to cost-effectively control with traditional measures such as shooting and trapping.' The threat abatement plan indicates the feral cat population can be reduced by shooting and the use of cage traps, or broad scale baiting. Feral cats prefer live prey and will only take carrion (baits) when other resources are scarce (Christensen et al. 2012), so often broad scale baiting programs fail to have a significant impact because feral cats do not take the aerially dispersed baits.

Feral cats are relatively abundant around the Lake Disappointment project area and would be having a significant impact on the terrestrial vertebrate fauna. Reducing feral cat numbers can result in an increase in the introduced house mice and black rats, as well as native reptiles, amphibians, mammals and birds. The management strategies and recommendations in this report are consistent with the *Threat abatement plan for predation by feral cats* (Department of the Environment 2015).

4.7.2 Threat abatement plan for foxes

The *Threat abatement Plan for predation by the European red fox* (Department of the Environment 2008) indicates that 'Control of foxes is difficult; control methods include baiting, shooting, trapping, den fumigation or destruction, and exclusion fencing.' Foxes are a significant predator on reptiles, amphibians and small native mammals (Department of the Environment 2008) and are having a significant negative impact on the vertebrate fauna in Reward tenements.

The management strategies and recommendations in this report are consistent with the *Threat abatement Plan for predation by the European red fox* (Department of the Environment 2008).

4.8 Terrestrial vertebrate fauna attraction to evaporation ponds

The salinity of water in the evaporation ponds will mostly be near 300 ppm. This is far beyond that able to be tolerated by any terrestrial birds, reptiles, mammals and amphibians.

It is therefore highly unlikely that terrestrial birds, reptiles, mammals and amphibians will be attracted to evaporation ponds, and in doing so will become struck or will die drinking the brine.

5 WETLAND FAUNA

The lake development envelope covers part of the main saline playa at Lake Disappointment and project impacts on aquatic fauna will be limited to the main saline playa. However, aquatic fauna values of the whole Lake Disappointment system, including the surrounding less saline and fresh claypans, have been documented to provide context for assessment.

Thirty-five species of waterbird (including the Swamp Harrier, which is treated here as wetland-dependent) have been recorded in surveys of the whole Lake Disappointment system (Appendix 3). Some other birds may potentially occur, including possibly some listed species, but all species using the system regularly are likely to

have been recorded. The count of 109,812 waterbirds (mostly Banded Stilt) at the saline playa and surrounding claypans in March 2017 (Bennelongia Environmental Consultants 2017a) represents a significant concentration of waterbirds. Only 18 other arid zone wetland systems were identified by Kingsford and Halse (1998)) as supporting >100,000 waterbirds at any time. Detailed information about waterbird values is presented in Section 6.2.

At least 193 species of aquatic invertebrate were collected from the Lake Disappointment system as a whole in 2017 (including the surrounding claypans, where nearly all the species richness was found) (Bennelongia Environmental Consultants 2017a). The number of species recorded in the Lake Disappointment system is almost twice as high as in any other similar ephemeral arid zone lake system This results from a combination of factors, including high survey effort and expertise, favourable rainfall, and a suite of surrounding claypans of varying salinities. It also matches the picture provided by waterbird data that the Lake Disappointment system is a biologically rich arid zone wetland (Table 29).

Table 29. Comparison of aquatic invertebrate species richness at various inland Australian lake systems (Bennelongia Environmental Consultants 2017a)

System	Location	No. of species		Salinity Range ($\mu S\ cm^{-1}$)	Sites	Samples
		Overall	Main Saline Playa			
Lake Disappointment	Pilbara, WA	195	14	66–99,300	51	52
Lake Carey	Goldfields, WA	107	10	313–83,300	31	66
Lake Wells	Goldfields, WA	53	10	48–195,200	9	9
Lake Torrens	SA	27	27	20,300–427,500	5	25
Lake Eyre	SA	17	17	39,100–422,000	1	15
Lake Weelarrana	Pilbara, WA	14	14	59,400	1	1
Lake Cowan	Wheatbelt, WA	7	6	184,000–234,000	4	4
Lake Way	Goldfields, WA	3	3	Dry (hatching expt)	6	18

Eighteen of the aquatic invertebrate species recorded at Lake Disappointment and surrounding claypans are known only from this area (Table 30). All 18 'new' species were found outside the lake development envelope, with the ostracod *Heterocypris* sp. BOS898, which occurred in Savory Creek as well as claypans, being the only new species recorded in the development envelope.

As project development will be restricted to the main saline playa (in which the lake development envelope lies), it is very unlikely that the conservation status of any of these species will be affected by project development, despite the species being known only from the local area.

Table 30. Aquatic invertebrate species known only from the immediate vicinity of Lake Disappointment

Higher Classification	Species	Recorded Locations	
		Habitat(s)	Sites
Conchostraca			
Cyzicidae	*Eocyzicus* nr *argillaquus*	Turbid claypan, tannin-stained claypan	REM038
	Eocyzicus sp. B02	Claypan fringed by samphire	REM051, REM055, REM056
	Eocyzicus sp. B04	Turbid claypan, tannin-stained claypan	REM039, REM052, REM054, REM057, REM059, REM060, REM062, REM063
	Ozestheria sp. B01	Claypan fringed by samphire	REM051, REM055
Limnadiidae	*Eulimnadia* nsp. B01	Turbid claypan	REM038
	Paralimnadia sp. B01 (nr *flava*)	Tannin-stained claypan	REM057
Cladocera			
Moinidae	*Moina* sp. B01	Turbid claypan	REM039
Anostraca			
Thamnocephalidae	*Branchinella* sp. B02 (nr *proboscida*)	Turbid claypan	REM017
	Branchinella sp. B03	Turbid claypan	REM039, REM060, REM062, REM063
Ostracoda			
Cyprididae	*Bennelongia* sp. BOS565	Turbid claypan, tannin-stained claypan	REM017, REM038, REM039, REM040, REM057
	Cypretta sp. BOS902	Tannin-stained claypan	REM057
	Cypricercus sp. BOS843	Turbid claypan	REM039
	Cyprinotus sp. BOS899	Claypan fringed by samphire	REM055
	Cyprinotus sp. BOS946	Tannin-stained claypan ringed by *Melaleuca*	REM057
	Heterocypris sp. BOS898	Savory Creek, claypan fringed by samphire	REM050, REM055
	Strandesia sp. BOS914	Turbid claypan	REM039
Limnocytheridae	?*Limnocythere* sp. BOS901	Claypan fringed by samphire	REM055
	Limnocythere sp. BOS900	Claypan fringed by samphire	REM055

The 10 aquatic invertebrate species found in the main saline playa, where some hydrological changes may occur, comprised:

- two semi-aquatic beetle species on the shoreline (including the widespread *Megacephala murchisona*);
- four widespread, described species of rotifers, copepod and brine shrimp as well as a juvenile copepod probably belonging to a widespread described species;'
- a widespread undescribed ostracod species; and
- a fly larva and a nematode that were not identifiable to species level, but which are likely to be widespread, based on the life history characteristics of these groups.

It is either known, or highly likely, that all aquatic or semi-aquatic invertebrate species in the main saline playa are widespread, so that any changes in lake hydrology are unlikely to affect the conservation status of the saline playa species (Bennelongia Environmental Consultants 2017a). As shown by Knight Piesold (2017), it is expected that any changes to lake hydrology will be small and of a nature that is unlikely to affect invertebrate persistence Accordingly, no further assessment of impacts on aquatic invertebrate species has been undertaken.

5.1 Waterbird species of conservation or other significance

The 35-waterbird species recorded in the Lake Disappointment system are listed in Appendix 3. In addition, four listed migratory shorebird species (i.e. Wood Sandpiper, Common Sandpiper, Curlew Sandpiper and Caspian Tern) that have not been recorded in the system were identified by Harewood (2017b) as possibly occurring on the main saline playa or associated waterbodies. It is considered, however, that these species have low likelihood of occurrence and the species with greatest reliance on system will have been recorded in surveys and, accordingly, those are the only waterbird species considered in the assessment.

The seven-conservation significant and one otherwise significant waterbird species recorded during surveys are listed in Table 31. All seven-listed species were originally recognised as migratory species, although as a result of taxonomic changes the Great Egret (and possibly Gull-billed Tern, see Section 5.1.7) is no longer listed under international agreements. None of these migratory species were recorded within the lake development envelope.

Five of the species are shorebirds, for which EPBC Policy 3.2.1 lays out an assessment framework (Department of Environment and Energy 2017).

Table 31. Listed waterbird species occurring, or possibly occurring, at Lake Disappointment

Common name	Species	WC	EPBC[1]	No.	Flyway[2]	%
Recorded during surveys						
Marsh Sandpiper	*Tringa stagnatilis*	S5	B, C, J, R	3	130000	<<0.1
Common Greenshank	*Tringa nebularia*	S5	B, C, J, R	4	110000	<<0.1
Pectoral Sandpiper	*Calidris melanotos*	S5	B, J, R	1	c. 1500000	<<0.1
Sharp-tailed Sandpiper	*Calidris acuminata*	S5	B, C, J, R	354	85000	0.4
Red-necked Stint	*Calidris ruficollis*	S5	B, C, J, R	26	475000	<<0.1
Gull-billed Tern	*Gelochelidon nilotica*	S5	C	823	-	-
Great Egret	*Ardea modesta*	S5	-	1	-	-
Possibly present occasionally						
Wood Sandpiper	*Tringa glareola*	S5	B, C, J, R	-	130000	-
Common Sandpiper	*Actitis hypoleucos*	S5	B, C, J, R	-	190000	-
Curlew Sandpiper	*Calidris ferruginea*	S5	B, C, J, R	-	90000	-
Caspian Tern	*Sterna caspia*	S5	J	-	-	-

[2] B, Bonn Convention; J, Japanese Australia Migratory Bird Agreement; C, Chinese Australia Migratory Bird Agreement; R, Republic of Korea Australia Migratory Bird Agreement

[1] http://www.environment.gov.au/biodiversity/migratory-species/migratory-birds

The Lake Disappointment system has national value for migratory shorebirds on one criterion (namely >0.1% of the flyway population of a species present) as a result of 0.4% of the flyway population of Sharp-tailed Sandpiper being present in March 2017. The lake development envelope, which is too saline to be regularly used by Sharp-tailed Sandpiper in isolation of other areas (Higgins and Davies 1996) had 0.2% of the flyway population at the time of survey. The system does not meet the other two criteria of national importance, namely that >15 shorebird species are present (only five species recorded) or that >2000 shore individuals are present (a maximum of 388 birds recorded at any one time).

The one otherwise significant species (i.e. Banded Stilt), is an Australian shorebird that occasionally breeds on the main saline playa at Lake Disappointment.

5.1.1 Banded Stilt (*Cladorhynchus leucocephalus*)

While not formally listed as a species of conservation significance, the March 2017 survey by Bennelongia recorded 94,046 adult birds, 49,321 nests on 10 islands, and 7,388 young chicks on the main saline playa (i.e. Lake Disappointment itself). Most of the nests were on five islands (Figure 8). This aligns closely with the 93,455 adult Banded Stilt observed at Lake Disappointment (mostly at eight nesting colonies) in February 2017 (Bennelongia Environmental Consultants 2017a). These numbers represent more than 46% of the entire species' population, based on Watkins' (1993) estimate of 206,000 birds, or approximately 25% of the population based on more recent estimates (Wetlands International 2017).

A summary of key facets of the biology of Banded Stilt is provided by Pedler et al. (2017), together with some records of breeding attempts since 2011, including attempts at Lake Disappointment in 2013 and 2015. Only one attempt reported by Pedler et al. (2017), at Lake Torrens in 2011, had the potential to produce significant recruitment although there was a major, successful breeding attempt in 2010. The history of Banded Stilt breeding events is reviewed by Collard et al. (2013) and Pedler et al. (2017). While it is difficult to determine whether some events produced fledged young capable of surviving, since 1930 significant species recruitment appears to have occurred at only nine wetlands. The more important of these are Lakes Torrens Eyre North in South Australia and Lakes Barlee, Ballard, Marmion and Disappointment in Western Australia with major breeding events mostly occurring at intervals of about a decade. Pedler et al. (2017) provide data showing breeding attempts are much more frequent than the above summary suggests. In addition, breeding attempts occur in a greater range of wetlands (Collard et al. 2013) and sometimes low or even moderate levels of recruitment may result.

In addition to the 2017 data, breeding has been recorded, or inferred, at Lake Disappointment in 1971, 2004 (Clarke et al. 2004), March 2013 and June 2015 (Harewood 2017b). It appears the playa dried too soon in 2015, resulting in death of the chicks that had hatched in a colony of about 10,000 nests. This may also have happened

in 2013, after February rainfall, with many dead fledglings among the 455 birds seen in May. In 2004, about 1000 fledgling birds were found dead on the playa but a small number of juveniles were seen at the coast, 1000km away, suggesting some recruitment occurred (Clarke et al. 2004). It also appears that some recruitment occurred in 1971.

More than 8,000 Banded Stilt were observed in the main playa at Lake Disappointment in January 2016 after a small amount of inflow. Breeding displays were observed but there was no evidence of nesting.

Banded Stilt breeding occurred in two other Western Desert lakes in 2017 (Bennelongia 2017b). A total of 24,484 adult stilt were recorded at Lake Dora (in the Karlamilyi National Park, 120km north of Lake Disappointment) where it estimated there was one colony of 20,000 breeding birds and a possible second colony of 200 breeding birds. At Lake Mackay, 7,392 adult stilt were recorded with one colony of 5,000 breeding birds and one of 1,500 breeding birds (Bennelongia Environmental Consultants 2017a). It is considered that the Lake Mackay colonies were unlikely to produce fledged birds because of predation and lake drying. Pedler et al. (2017) reported 6,500 nests at Lake Mackay in 2014 but it is unknown whether this breeding was successful. As in 2017, Silver Gull (*Chroicocephalus novaehollandiae*) were also nesting in the lake.

5.1.1.1 *Threats*

Nine of the 10 islands used for breeding by Banded Stilt in 2017 (including the island used in 2015) lie within the development envelope housing the drains to collect brine (Figure 8).

The major threats to Banded Stilt breeding success centre around water depth, water quality and predation. Disturbance from people moving about on the playa has the potential to threaten breeding success, but this will not occur when the playa is flooded, because it will not be trafficable under these conditions, and so disturbance is not considered further here. The Banded Stilts require an ephemerally flooded, hypersaline wetland to provide abundant brine shrimp and ostracod food sources. Such lakes usually flood after cyclonic flooding events (or the associated southern rainfall). The wetland must have islands for breeding colonies to form, presumably to isolate the breeding colony from surrounding land where terrestrial predators occur and perhaps to assist in keeping breeding birds cool. The depth of water after flooding must be sufficient to keep the island isolated until after hatching and parts of the wetland must be flooded deeply enough to produce brine shrimps and ostracods until the young have fledged and have sufficient body reserves to move to the coast.

Based on data in Marchant and Higgins (1993), the period required by Banded Stilt to pair up, find a nest site, lay eggs, incubate them and for the chicks to fledge is about 80 days. The equivalent period is about 70 days for the Black-winged Stilt (*Himantopus himantopus*; Marchant and Higgins 1993), and this figure may be a better estimate of the time required by Banded Stilt. There must be plenty of water present even as fledging occurs to ensure food remains plentiful. A flooding period of more than 80 days is probably necessary to ensure most young birds survive. There is ample evidence that, under natural conditions, Banded Stilt begin unsuccessful breeding events when water will not last this long.

Control of predation is also important. It has been shown both anecdotally and through management intervention in South Australia that predation by Silver Gull frequently causes breeding failure of Banded Stilt colonies (Pedler et al. 2017). Small numbers of Silver Gulls were recorded at Lake Disappointment in 2017. Although the number of birds was too few to affect the very large stilt colonies present, any establishment of Silver Gulls around project infrastructure and fresh water supplies would increase the threat to Banded Stilt breeding success.

5.1.1.2 *Assessment of potential impacts*

None of the islands in Lake Disappointment known to support breeding colonies of Banded Stilt will be directly disturbed by the proposed development of the potash project. However, major potential impact on the breeding success of Banded Stilt in the saline playa could occur as a result of altered surface water flow and flooding patterns across the lake as a result of the bunding along the network of drainage channels and, to a lesser extent, the rapid recharge of initial flood waters into the lakebed to replace groundwater removed (by the drainage trenches) for brine production. It is considered this recharge may account for up to 7% of major inflows (calculations by Reward Minerals) and hence may slightly reduce the duration of flooding. However, small rainfall events prior to those flooding the lake may achieve recharge of the lakebed.

Surface water inflow has main three sources: direct precipitation (rainfall) on the main saline playa and its immediate surrounds, inflow from the Savory Creek catchment and inflow from the Disappointment palaeoriver catchment (Knight Piesold 2017). It is modelled that most inflow will come from direct precipitation and that there is at least 0.1 m of water in the deeper parts of the playa for at least 80 days only during floods with a 1 in 100-year frequency (Chart 7). The apparent success of at least three Banded Stilt breeding events in the last 46 years (1971, 2004, 2017) is somewhat at odds with the frequency of flood events modelled in Chart 7, perhaps because of high recent rainfall and necessary approximations in the assumptions underlying the hydrological calculations, Alternatively, in some years the required flooding is perhaps achieved by multiple rainfall events. While the data show that success of Banded Stilt breeding events at Lake Disappointment are likely to be sensitive to any reduction in flood duration, many factors appear to influence the duration of flooding. Water will evaporate faster, and sensitivity to flood conditions, will be greater early in summer than after later, autumn cyclones.

In 2017, the playa flooded in mid-January (there was further rain in mid-February) and it was nearly dry by mid-April (a period of about 85 days from peak flooding to when just a channel of water remained), before more rain (in April) caused extensive re-flooding that kept water in the playa until June (Hydrobiology 2017).

Small numbers of Silver Gull were recorded at Lake Disappointment in 2017, although they were not breeding. Any increase would pose a threat to breeding stilts.

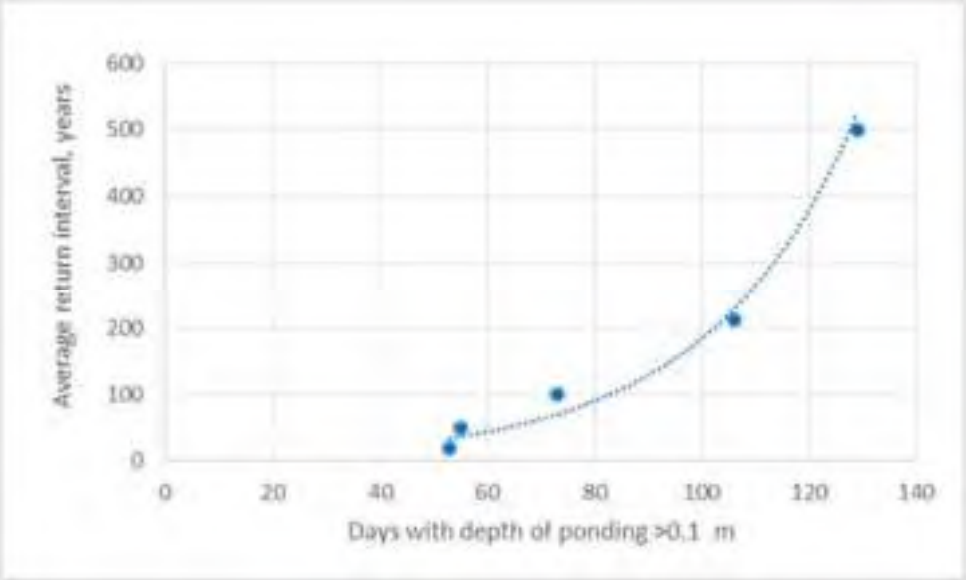

Chart 7. Duration of flooding in deepest part of lake of >0.1m associated with different magnitude flooding events (expressed as return frequencies) (plotted from data in Knight Piesold 2017)

5.1.1.3 *Avoidance and mitigation*

A series of pipes and culverts are planned to enable incoming flood waters to pass through the bunded drainage channels so that the existing hydrological regime (and periods of inundation) will be maintained around the Banded Stilt breeding islands to protect the colonies against predation by terrestrial species and more widely across the saline playa to provide an abundance of brine shrimp and ostracod food sources (Knight Piesold 2017). Alterations will be made to the design of trenches, pipes and culverts to ensure the occurrence of appropriate hydroperiods and depths and salinities of water are maintained through an adaptive management process. For example, it is already recognised that the eastern drainage channels may need to be shortened to ensure there is no compartmentalisation of flooding around islands (see Knight Piesold 2017). Through proactive management the bunding beside the drainage trenches may assist in retaining water around islands after flooding and increase the duration of flooding for breeding Banded Stilt and, thus, their likelihood of breeding success.

Lake water salinity and quality will be unaffected by project operations (Hydrobiology 2016, Knight Piesold 2017), so that the abundance and composition of brine shrimp and ostracod food sources during flooding events should remain unchanged.

Management action will ensure that no food waste from the camp is available to birds and that no fresh water sources are provided that may facilitate the build-up of Silver Gull numbers at Lake Disappointment. If numbers do increase, approval will be sought from DBCA to cull the birds. Similarly, there will be no movement of people and equipment on the lake during periods of flooding to minimise disturbance to nesting birds. Pumping of brine from the collection trenches will also not occur because of the low potash content of brine at this time.

5.1.2 Marsh Sandpiper (*Tringa stagnatilis*)

This is essentially a species of freshwater habitats and is seen commonly in Australian wetlands, mostly in small numbers. Three birds were seen in a single sighting in a freshwater claypan that will not be affected by project development (Harewood 2014). The occurrence of such a low number of birds outside the project, and the widespread distribution of Marsh Sandpiper in Australia, make it unlikely the project will have any impact on the species.

5.1.3 Common Greenshank (*Tringa nebularia*)

While using saline water to a greater degree than Marsh Sandpiper, Common Greenshank is essentially a freshwater species seen regularly in Australian wetlands. Three birds were seen in freshwater claypans in May 2013, two in October 2013 and two in 2017 (Harewood 2014, Bennelongia Environmental Consultants 2017a) that will not be affected by project development. The occurrence of such a low number of birds outside the project, and the widespread distribution of Common Greenshank in Australia, make it unlikely the project will have any impact on the species.

5.1.4 Pectoral Sandpiper (*Calidris melanotos*)

Pectoral Sandpiper is uncommon in Australia and have the status of an oddity; most of the species overwinters in South America (Watkins 1993). Within Australia, they occur in the same type of habitat as the more common Sharp-tailed Stint. A single Pectoral Sandpiper was observed using a man-made island in the main saline playa in 2017 (Bennelongia Environmental Consultants 2017a). While this structure is within the project impact area, the habitat it provides is not expected to change with project development and the island is likely to have been used transiently because it is atypical habitat for the species. The occurrence of a single bird at the Project, in atypical habitat, compared with the annual count of >100 birds in Australia (Watkins 1993) and 1.5 million birds in South America make it unlikely the project will have any impact on the species.

5.1.5 Sharp-tailed Sandpiper (*Calidris acuminata*)

Sharp-tailed Sandpiper is a common species in fresh and moderately saline wetlands in Australia. The estimated size of the Australasian flyway population has halved during the last 20 years. In comparison with the count of 10,000 Sharp-tailed Sandpiper in March 1988 (Halse et al. 1998), the maximum count of 364 birds at Lake Disappointment in 2017 is small but it is 0.4% of the flyway population and, thus, Lake Disappointment may be classified as a nationally important site for this listed species under EPBC Policy 3.21. About half the birds in 2017 were observed within the lake development envelope; the remainder were at surrounding claypans. Fifteen birds were seen in freshwater claypans in October 2013 and a single bird was seen at a claypan in 2016. Nationally important levels of use are likely to be infrequent and project development is considered unlikely to alter the habitat used by this shoreline-feeding bird. Consequently, project development is unlikely to have any impact on species abundance.

5.1.6 Red-necked Stint (*Calidris ruficollis*)

Red-necked Stint occurs commonly at saline, as well as fresh, wetlands in Australia. It is often found in conjunction with Sharp-tailed Sandpiper, but it is more salt tolerant. A maximum of 26 birds were recorded in 2017 on moist mud amongst samphire. Twenty-one birds were recorded in May 2013, and six birds were recorded on the lake in 2016. The most recent estimate of the size of the Australasian flyway population of Red-necked Stint is 475,000 (Table 31). Project development is considered unlikely to alter habitat greatly for this salt-tolerant bird and is unlikely to have any impact on species abundance

5.1.7 Gull-billed Tern (*Gelochelidin nilotica*)

Gull-billed Tern are listed as an EPBC migratory species, with the Chinese Australian Migratory Bird Agreement cites as the reason (www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl). However, Gull-billed Tern do not appear to be included in this agreement.

Two subspecies of Gull-billed Tern occur in northern Australia. These are the resident *Gelochelidon nilotica macrotarsa* and the migratory *G. n. affinis* from northern Asia. While formal identification of subspecies was not undertaken, based on what is known of the behaviour, all birds at Lake Disappointment would have been the Australian resident *G .n. macrotarsa* (Rogers et al. 2005). A total of 823 birds were recorded in 2017, with 214 nests and 93 chicks recorded on 10 small islands, in both the saline playa and associated claypans of varying salinity (Figure 8). It appeared breeding had occurred at an eleventh, unmapped island prior to the survey. This represents a significant concentration of breeding Gull-billed Terns although, by way of context, 6590 birds and an estimated 1,750 nests were recorded at Mandora Marsh, north of Port Hedland, in the winter of 2000 (Halse et al. 2005) and 1,537 in birds were recorded in Lake Blanche in February 1991 (with 50 nests in December), after flooding of Cooper Creek (Kingsford et al. 1999). Overall information of Gull-billed Tern numbers and colony sizes in Australia is limited.

Much of the feeding of Gull-billed Tern probably occurs in the claypans around the main saline playa, as well as a significant proportion of the nesting. While reductions in water depth during flood events within the project impact area may potentially reduce breeding effort in that part of the lake, breeding in claypans should be unaffected. The extent of the potential impact of project development on Gull-billed Tern is difficult to quantify but it is considered most likely to be moderate at most. Gull-billed Terns were also recorded breeding at Lakes Percival (three colonies of six, 100, 35 nests), Mackay (one colony of 125 nests) and Dora (one colony of 50 nests) in February 2017 (Bennelongia Environmental Consultants 2017a).

5.1.7.1 *Avoidance and mitigation*

Avoidance and mitigation measures for Banded Stilt should also reduce any impact of development on Gull-billed Tern.

5.1.8 Great Egret (*Ardea modesta*)

The single Great Egret seen in March 2017 was in a freshwater claypan (Bennelongia 2017b) that will be unaffected by project development. Great Egret are common through Australia; one was also seen in freshwater claypan in February 2017 (Bennelongia Environmental Consultants 2017a).

5.2 Summary of threats and mitigation strategies for water birds

Table 32 provides a summary of the potential adverse changes to population numbers or breeding recruitment of key aquatic fauna species as a result of project development. It also shows the extent to which these changes may be counteracted by the management and mitigation that will be put in place. The residual impact of project development is assessed.

There is limited capacity to assess impacts on breeding in a quantitative way and the figures below should be treated as indicative and precautionary. Altered surface flow patterns associated with project development may have the potential to reduce breeding success of Banded Stilt through reduced flooding (and a shorter period of inundation) by >75%. However, this level of impact would probably be confined to years when flooding resulted only from a large summer rainfall event. In this circumstance, even lake-fill flood events barely retain water long enough for successful fledging, so success is very sensitive to flood volume and the way water is retained in the playa. In years of multiple inflow events or autumn filling, when water is retained longer, breeding success will be less sensitive to hydrological changes.

Reduced groundwater level associated with operation of the trenches (independent of the effects of altered surface flow) may also reduce breeding success. The reduction in success will perhaps be 10-25% in years when there have been no smaller rainfall events prior to the one causing major flooding and subsequent breeding. If there has been prior rainfall, the lakebed is likely to be saturated and inflow from the main flooding event will not be used bringing the water table to the surface and there will be no impact on breeding success. Breeding may also be

adversely affected by increased Silver Gull predation (50-75%), while any disturbance from presence of people on the lakebed potentially may have the same negative effect.

Without mitigation and management, the impact on Banded Stilt would be high or even extreme, depending on the importance of Lake Disappointment breeding for maintenance of the species' population. Banded Stilt should be regarded as having a national population rather than a series of regional ones; work by Pedler et al. (2017) has shown that there is a single Australia-wide population that moves between wetlands to breed and that this national population breeds at a number of arid zone wetlands. When proposed mitigation and management is taken into account, the residual impact of the project on Banded Stilt is likely to be moderate. With adaptive management of surface water flow and management of the pumping of groundwater brine in drainage channels, as well as management of predators and disturbance, there is only a possible (score of 3) likelihood of reduced breeding success and the consequences of the reduced breeding on the population will probably have only moderate consequence (score of C) on the species population. Given that failure of Banded Stilt to breed in large numbers is a common event, the resultant reduction on in the population size of the species will usually be low. It would only be after many years of no successful breeding anywhere in Australia that failure of a breeding event at Lake Disappointment would be likely to have a substantial reduction (25-50%; moderate consequence score of C) in the regional or national population. Consequently, the calculated residual impact of the project on Banded Stilt is moderate (Table 32).

The potential changes in numbers of listed migratory Sharp-tailed Sandpiper at Lake Disappointment as a result of project development are considered to be inconsequential (<10%). It would be rare (score of 1) for any changes to occur. Consequently, the calculated residual impact of the project on Sharp-tailed Sandpiper is low (Table 31).

The types of potential effects on breeding success of listed migratory Gull-billed Tern are similar to those for the Banded Stilt but the percentage reduction in breeding would be considerably lower because not all Gull-billed Tern colonies at Lake Disappointment are on the playa and all breeding on the playa occurs outside the development envelope. The calculated residual risk of the project for Gull-billed Tern is low because, while impact is possible (score of 3) it would have only slight consequences for the Gull-billed Tern population (Table 32).

Table 32. Summary of the extent of threats and impacts on aquatic fauna and the results of management and mitigation

Species	Status	Project related significant threats and impacts	Impact score	Project relates mitigation strategies	Impact score	Residual impact
Banded Stilt (*Cladorhynchus leucocephalus*)	-	• Surface hydrology	-4	• Culverts, pipes, design changes to ensure free flow of water	+2	
		• Groundwater drawdown	-1			
		• Predation	-3	• Minimisation of habitat suitable for Silver Gull	+3	
		• Disturbance	-3	• No people of vehicle movement on lake during flooding	+3	
	Risk: Extreme (likelihood = 3; consequence = E); **Residual risk: Moderate (likelihood = 3; consequence = D)**					-2
Sharp-tailed Sandpiper (*Calidris acuminata*)	S5	• No threats envisaged	0			
	Risk: Low (likelihood = 1; consequence = A); **Residual risk: Low (likelihood = 1; impact = A)**					0
Gull-billed Tern (*Gelochelidin nilotica*)	S5	• Surface hydrology	-2	• Culverts, pipes, design changes to ensure free flow of water	+1	