

Cutters Ridge Dewatering Works Approval Application

August 2020

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- D. AQ2 Hydrogeological Investigations – Cutter’s Ridge, Rayjax and Ridgeback Deposits
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- F. Spectrum Calandrinia Survey
- G. Phoenix Fauna Survey

1.0 Premises Details

1.1 Occupier of the Premises

Name of Occupier:

Evolution Mining (Mungari) Pty Ltd
ACN: 002 124 745

Address of Occupier:

Kundana Road
PO Box 10398
Kalgoorlie WA, 6430

Contact Details of Occupier:

Evolution Mining (Mungari)
PO Box 10398
Kalgoorlie WA, 6430
Phone: (08) 9268 4000

Australian Business Number (ABN):

90 002 124 745

1.2 General Company Description

Evolution Mining (Mungari) Pty Ltd is a wholly owned subsidiary of Evolution Mining Limited. The Mungari Mill is located 20 km west of Kalgoorlie-Boulder, has a planned annual capacity of 100,000 ounces of gold annually from 1.7 million tonnes (Mt) of ore, and is a mid-tier gold mining and processing operation in Western Australia.

Evolution Mining's Mungari Operations' current projects include the Cutter's Ridge Open Pit, Whitefoil Open Pit and Frogs Leg Underground operations, all located between approximately 20-25 km west of Kalgoorlie-Boulder in the Goldfields region of Western Australia.

All the ore produced from Evolution's Mungari Operations is processed through the Mungari Mill and all tailings are deposited into the Mungari Tailings Storage Facility (TSF).

1.3 DWER Environmental Operating Licences

Evolution Mining's Whitefoil and Frogs Leg open pit projects, and the Mungari Mill and TSF all currently operate under L7750/2001/9 with the Department of Water and Environmental Regulation (DWER).

This document is provided as supporting information to apply for a Works Approval to construct a dewatering pipeline from the Cutters Ridge project to the Mungari Mill where water will be discharged to a water storage dam.

Operating License L7750/2001/9 will then be amended to incorporate the pipeline into dewatering operations, which will see excess water not used within the Mungari Mill pumped to the Pope John

Pit, currently owned and operated by Northern Star Resources under an agreement.
No change to total discharge is proposed.

1.4 Name and Location of Premises

Premises Name

Cutters Ridge Open Pit Project

Tenements

Tenements relevant to this application include:

- M15/1827
- M15/829
- M15/830
- M15/1287
- L15/387
- E15/965

Location

The Cutters Ridge Project is located approximately 25 km west of the city of Kalgoorlie-Boulder. The premise for dewatering discharge is located at the northern end of the White Foil Open Pit, approximately 5 km east of the Cutters Ridge Project.

Figure 1-1 shows the regional location of Cutters Ridge.

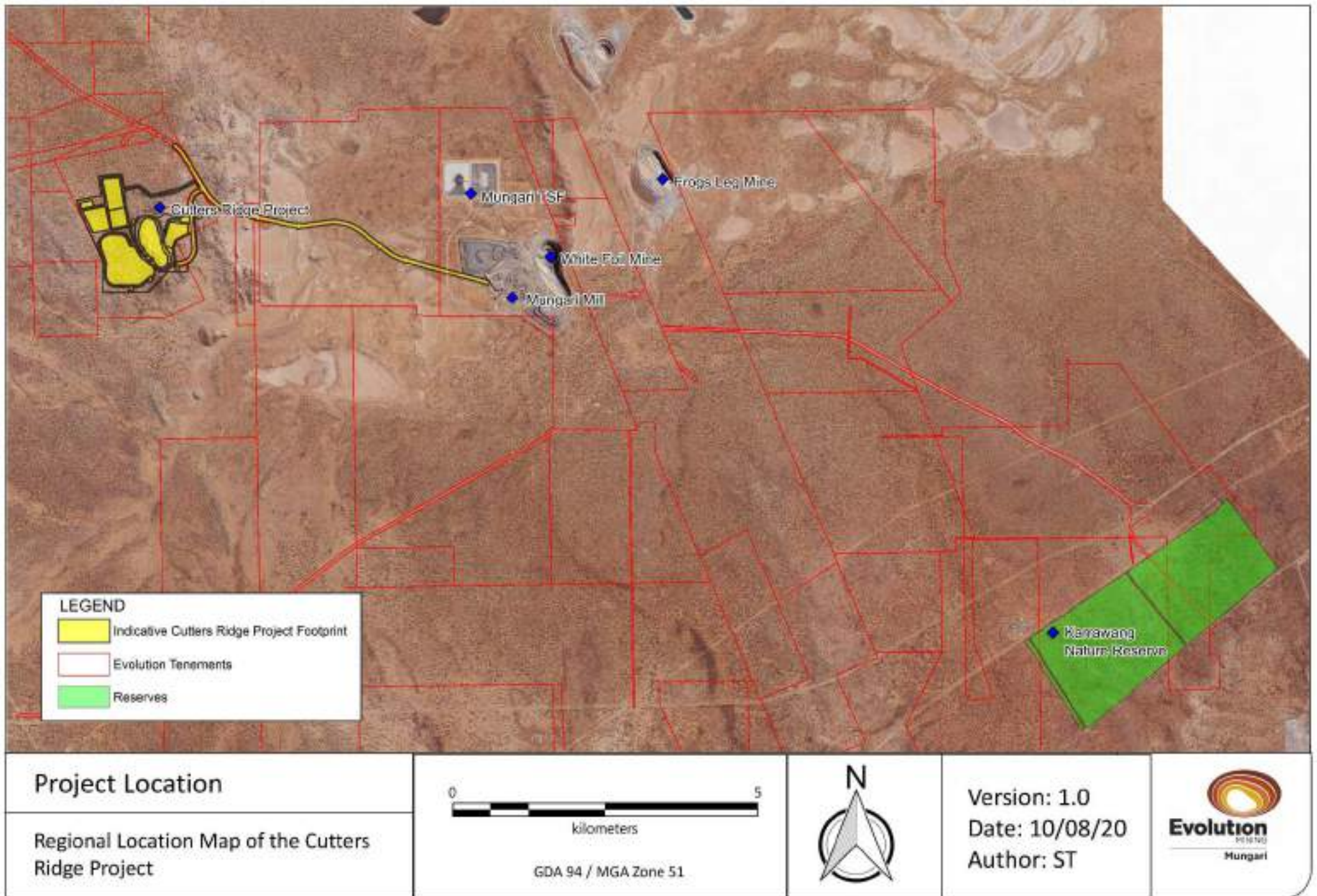


Figure 1-1: Regional Location Map of Cutters Ridge

2.0 Prescribed Premises Category

Table 2-1: Prescribed Premises Category Details

Category Number	Category Description	Category Production or Design Capacity	Nominated Rate of Throughput	New/ Existing
06	Mine dewatering: premises on which water is extracted and discharged into the environment to allow mining of ore.	More than 100,000 tonnes but not more than 500,000 tonnes per year	Not more than 100,000 tonnes per year	New

This Works Approval application is to support the construction of a 8.2km pipeline from the Cutters Ridge open pit project, to the Mungari Mill, where excess groundwater will be stored in an already established and operational water storage dam.

The Works Approval aims to precede an amendment to L7750/2001/9 to include dewatering activities into the currently operational license.

The activity falls under Category 06: Mine Dewatering (premises on which water is extracted and discharged into the environment to allow mining of ore), with a design capacity of more than 100,000 tonnes but not more than 500,000 tonnes per year and a nominated rate of throughput of not more than 100,000 tonnes per year (Table 2-1). Any future amendment to L7750/2001/9 will be added to this abstraction point, and no increase to the approved premise production or design capacity is expected. This is based on:

- The nominated throughput of this Cutters Ridge pipeline being a negligible 2% of the total premise capacity of 5,000,000 tonnes; and
- Discharge under L7750/2001/9 in 2019 was only 1,651,873kL.

3.0 Description of Activity

3.1 Existing Activities

The Mungari Gold Environmental Group (MGO) is located approximately 20 km west of the City of Kalgoorlie-Boulder and 20 km east of the Township of Coolgardie in the Goldfields region of Western Australia. The operation consists of the White Foil Open Pit Project, the Frogs Leg Underground (UG) Project, the Cutters Ridge Open Pit Project, and also comprises the Mungari Gold Processing Plant (Mungari Mill) and the Mungari Tails Storage Facility (TSF). The White Foil, Frog's Leg and Cutters Ridge Projects are actively mined at present. Operations at the site commenced in 2002 and were originally operated by separate controlling bodies and joint venture interests before being consolidated by La Mancha Resources Australia Pty Ltd in 2013, then subsequently acquired by Evolution Mining in August 2015. Dewatering of these operations occurs under L7750/2001/9, where groundwater is utilised for gold processing and dust suppression. Excess groundwater that is not

utilised is sent via a 450 mm pipeline to Northern Star's Kundana Gold Mine where it is discharged to the transfer dam and Pope John Pit.

An agreement between Northern Star and Evolution clarifies the responsibility and management of the adjoining pipeline route. Management and responsibility for the pipeline resides with Evolution and is covered by L7750/2001/9. However, management of the discharge point at the transfer dam and the Pope John Pit is managed by Northern Star and is captured on the Kundana Gold License L7323/1998/12. Therefore, monitoring conditions for the discharge point of Pope John Pit is not included in Evolution's Operating License.

3.2 Proposal Description

3.2.1 Discharging water into the Pope John Pit

MGO seek to ensure dewater yield is reused within the processing plant, the paste plant, underground activities and on-site dust suppression as required, with excess raw water discharged via pipeline to the established White Flag Lake discharge system, by Northern Star Resources Pty Ltd on behalf of the Kundana and Mungari Gold operations.

Groundwater from the Cutters Ridge pit will be transferred via a new dewatering pipeline that travels along the Cutters Ridge Haul Road to the Mungari Mill. Groundwater will then be discharged to a lined pond located at the northern end of the White Foil pit, before being used in the mill for dust suppression or processing activities. Excess groundwater will then travel the existing pipeline to Pope John via a transfer pond. Northern Star monitor discharge volumes into the pit to ensure a sufficient freeboard is maintained.

The pipeline may be moved to optimal positions within the pit as mining commences and progresses. The pipeline will be placed in an earthen v-drain bund with sufficient capacity to contain spillage in the event of a pipeline failure. Scour pits will be constructed along the pipeline route at approximate 500 m intervals at low points, with sufficient capacity to contain discharges during maintenance activities. Air release valves will be positioned at relevant high points.

The discharge pipeline to Pope John pit has been buried and fitted with leak detection and containment systems. Should any leak be detected, the pumping system will be shut down until the leak has been verified and/or repaired. The containment system is sufficient to contain leakage that might occur from a breach in the pipeline system.

The following general principles will be followed to ensure compliance to likely license conditions and to ensure Evolution maintain a high standard of environmental practices during dewatering activities:

- Pipeline constructed where possible adjacent to busy roads to increase visibility;
- Service and maintenance of pumps, breathers, isolation valves and flow meters;
- Bund and sump maintenance and upgrades when required;
- Daily pipeline inspections;
- Site training and induction of all personnel working in the area; and
- Dust suppression used on haul roads and, as applicable, access tracks.

Standard dewatering pipeline used by Evolution has been previously constructed of 160MM PN12.5x 100M SDR13.6 HDPE piping that meets:

- AS/NZS 2033:2008: Installation of polyethylene pipe systems;
- AS/NZS 4129:2008 Fittings for polyethylene (PE) pipes for pressure applications;
- AS/NZS 4130:2009 Polyethylene (PE) pipes for pressure applications; and
- AS/NZS 4131:2010 Polyethylene (PE) compounds for pressure pipes and fittings.

Groundwater license GWL178353(4) is retained for abstraction operations. This is included in Appendix A.

3.3 Premises Boundary

Tenements M15/1827, M15/829, M15/227 and L15/387 are relevant to this Works Approval. The pipeline will start at the Cutters Ridge pit and follow the Cutters Ridge Haul Road toward White Foil operations. The pipeline will travel around the White Foil Northern Waste Rock Dump (WRD) to be discharged in the northern White Foil pond, with excess water to then go on to Northern Star's Kundana Operation.

Two possible pipeline routes are shown in Figure 3-1 at the Mungari Mill end of the route to enable flexibility in operational requirements during mining and milling operations. No extra clearing will be required to construct the pipeline as a v-drain will be constructed within the already cleared road boundary. Figure 3-1 shows the location of the tenements, the proposed prescribed boundary and prescribed activity, and identifies the proposed discharge point into the water storage dam.

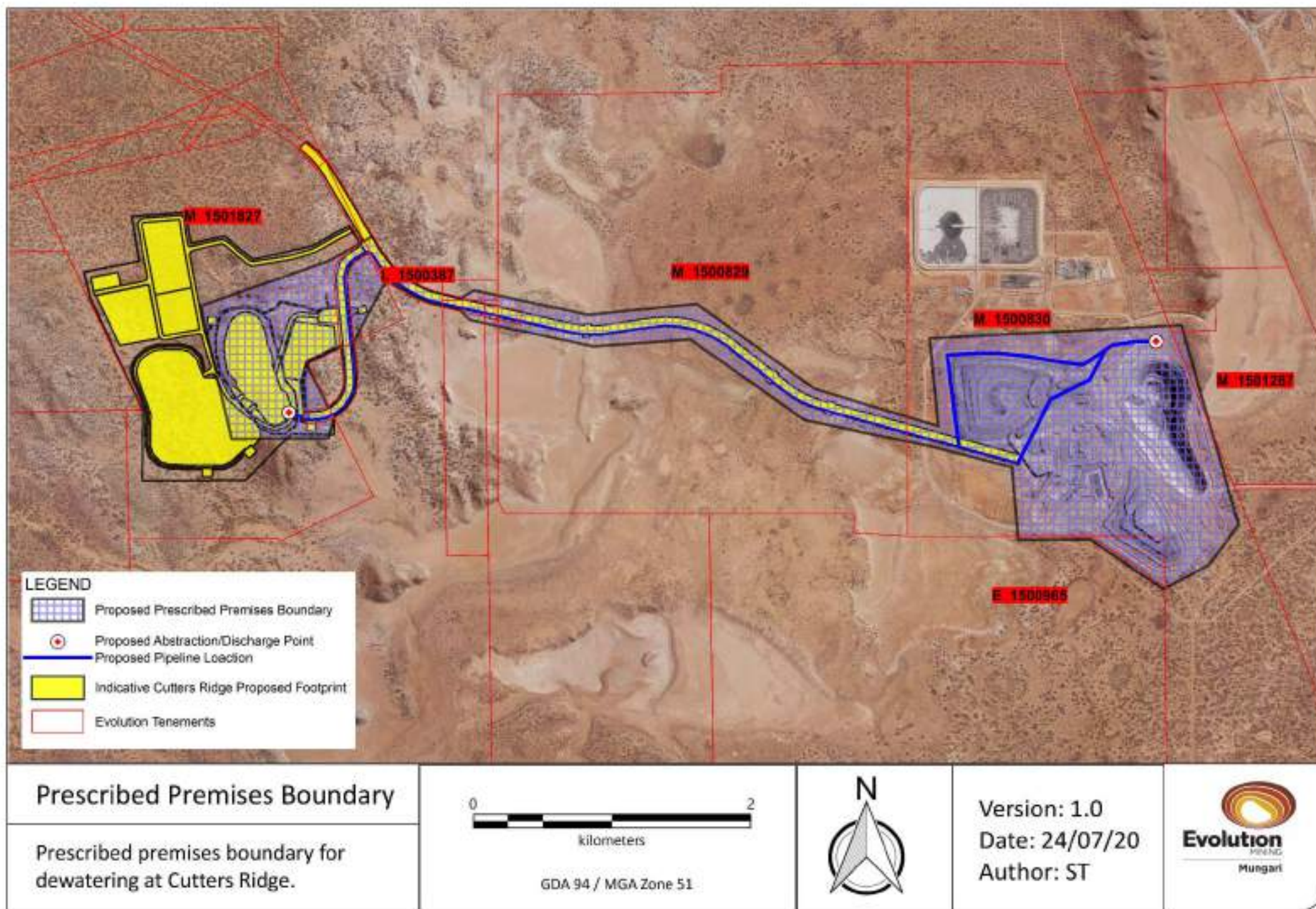


Figure 3-1: Prescribed Premises Boundary, Tenure and Proposed Activities

4.0 Other Approvals

4.1 Environmental Impact Assessment

This discharge of mine dewater is deemed a low risk and an Environmental Impact Assessment or referral to Office of Environmental Protection Authority is not required.

4.2 Other Decision-Making Authorities

The Cutters Ridge Mining Proposal was submitted to DMIRS on 26 November 2019, with a revision submitted on 24 February 2020, and the mining proposal was subsequently approved on 28 February 2020.

Evolution Mining has submitted a recent amendment of the “Cutters Ridge Mining Proposal” in alignment with DMIRS Mining Proposal Guideline 2020, submitted on 23 July 2020 and currently under assessment.

In addition, Evolution recently submitted an application to amend the Clearing Permit (CPS 8549/2) at Cutters Ridge to accompany the expanded mine design. This amendment will include the additional disturbance described in the “Cutters Ridge Mining Proposal”. No additional clearing is required for the construction of the dewatering pipeline from the Cutters Ridge pit to Mungari.

4.3 Other Legislation and Guidance Material

Evolution Mining will comply with the provision in applicable Acts and Regulations which include the following, but may not be restricted to:

- Aboriginal Heritage Act 1972;
- Biodiversity Conservation Act 2016;
- Conservation and Land Management Act 1984;
- Environmental Protection Act 1986;
- Environmental Protection Regulations 1987;
- Environmental Protection (Noise) Regulations 1997;
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004;
- Environmental Protection (Controlled Waste) Regulations 2001;
- Environmental Protection (Unauthorised Discharge) Regulations 2004;
- Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth);
- Explosives and Dangerous Goods Act 1961;
- Heritage of Western Australia Act 1990;
- Land Administration Act 1997;
- Land Drainage Act 1925;
- Local Government Act 1995;
- Local Government (Miscellaneous Provisions) Act 1960;
- Mining Act 1978 and Regulations 1981;
- Mines Safety and Inspection Act 1994, Mines Safety and Inspection Regulations 1995;
- Native Title Act 1973 (Commonwealth);
- Occupation Safety and Health Act 1984; and
- Rights in Water and Irrigation Act 1914 particularly licence to Take Water GWL178353(4)

5.0 Description of the Environment

5.1 Climate

Table 5-1: Climate data for the Cutters Ridge project

Month	Average Temperature		9am Conditions			3pm Conditions		
	Min	Max	Temp	Humidity (%)	Wind Speed (km/hr)	Temp	Humidity (%)	Wind Speed (km/hr)
Jan	18.8	33.9	24.2	44	17.3	32.6	23	16.2
Feb	18.4	32.3	23.1	51	17.5	31.1	30	16.2
Mar	16.4	29.2	21.1	53	16.5	28.2	32	14.9
Apr	13.3	25.7	18.6	58	14.2	24.6	37	13.5
May	9.2	21.2	14.8	64	12.5	20.4	42	13.6
Jun	6.6	17.9	11.3	71	12.0	16.9	45	15.3
Jul	5.6	17.5	10.7	70	12.9	16.5	43	16.1
Aug	6.3	19.4	12.3	61	14.6	18.3	36	16.7
Sep	8.5	22.7	15.2	53	16.9	21.4	30	18.1
Oct	11.9	26.8	18.5	44	17.4	25.3	23	17.6
Nov	14.7	29.5	21.0	43	17.1	27.8	24	17.5
Dec	16.9	32.1	22.7	43	17.2	30.4	23	16.9
Annual	12.2	25.7	17.8	54	15.5	24.5	32	16.0

Sourced from BOM, 1991-2020 data, Kalgoorlie-Boulder Airport #012038 (2020)

5.1.1 Temperature

Mungari falls within the semi-arid region of WA, characterised by hot summers and mild winters. Mean annual maximum temperature is 25.7°C and mean annual minimum is 12.2°C. The coldest month is July and diurnal temperature variations are commonly high throughout the year.

5.1.2 Rainfall

The area is arid and the annual average rainfall at Kalgoorlie-Boulder is 283.5mm. Most of the rain falls between February and July, and this amount varies greatly both seasonally and annually (Figure 5-1).

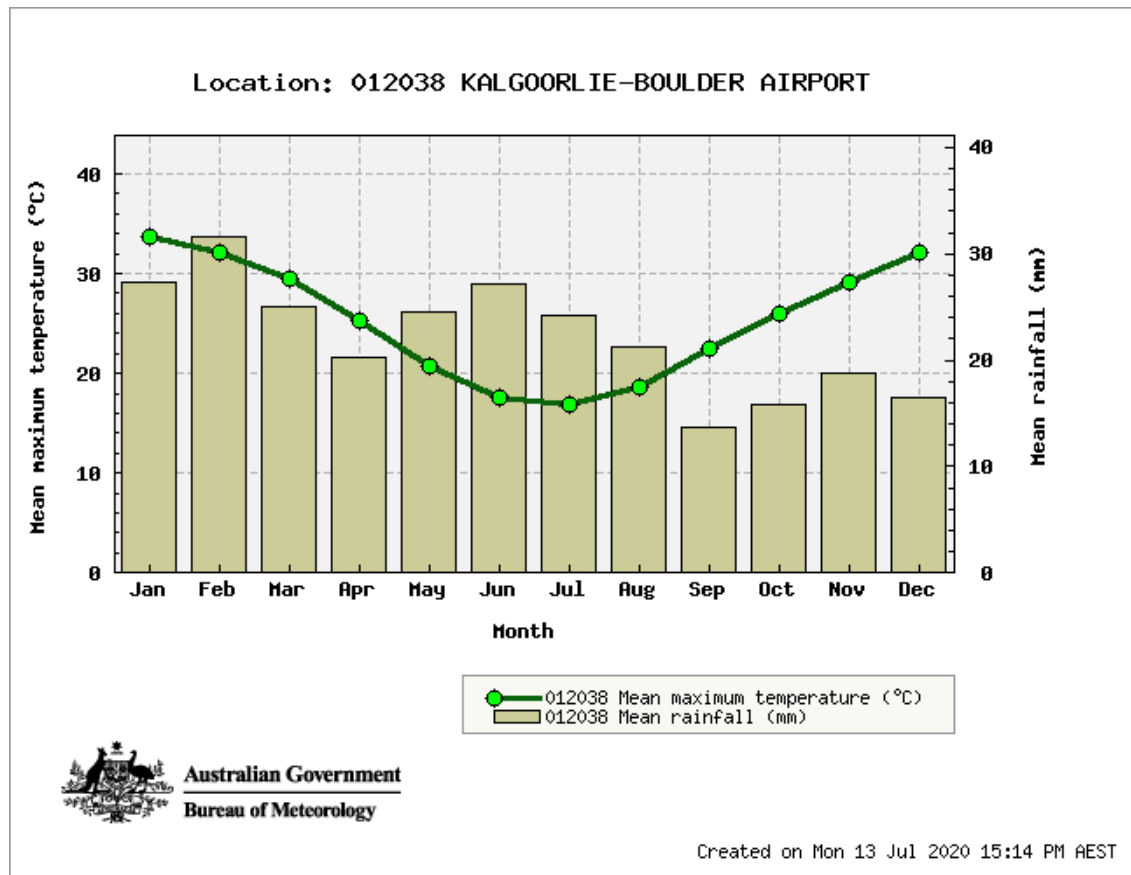


Figure 5-1: Mean monthly maximum temperature and rainfall at weather station

Sourced from BOM, 1991-2020 data, Kalgoorlie-Boulder Airport #012038 (2020)

5.1.3 Winds

The average wind speeds at Kalgoorlie-Boulder vary throughout the year from 12.0–17.5 km/h in the morning to 13.5–18.1 km/h in the afternoon.

5.1.4 Evaporation

Annual potential evaporation is approximately ten times higher than rainfall, and evaporation greatly exceeds average rainfall during each month of the year. The annual evaporation rate is approximately 2,600 mm (BOM, 2020), compared to the annual rainfall of 283.5 mm. Figure 5-2 shows the average annual evaporation rate ranges throughout Australia.

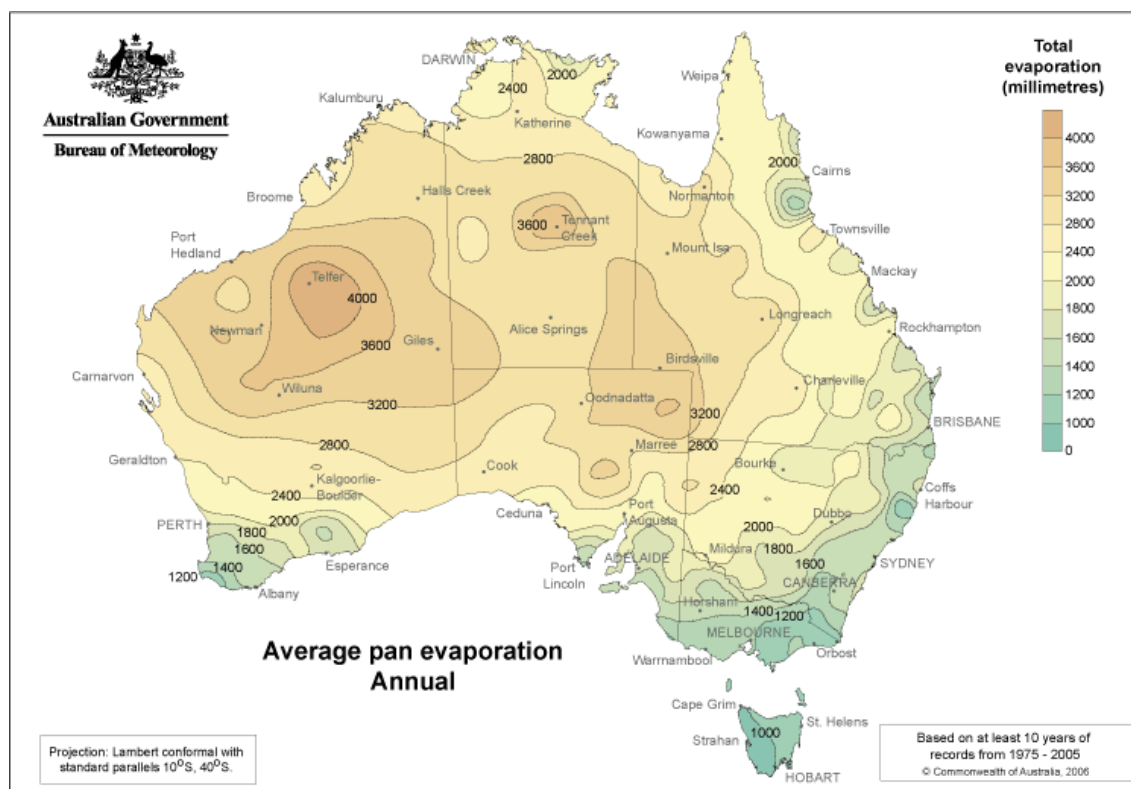


Figure 5-2: Average annual evaporation

Sourced from BOM (2020)

5.2 Geology

5.2.1 Regional Geology

The Project Area is situated within the 2.7 Ga Archaean Eastern Goldfields Superterranean (EGS) of the Yilgarn Craton. The area comprises a 700 km north-northwest trending range of thin arcuate greenstone belts, collectively characterised as the regional Norseman-Wiluna Belt. This Belt lies within the Kalgoorlie Terrane, comprising lithologically distinct greenstones, thick sequences of ultramafic and mafic rock, fine-grained volcanics, and sedimentary rock. The belt is characteristically embedded with rich mineralisations, often in gold and nickel, and Banded Iron Formation (BIF).

5.2.2 Local Geology

The Cutters Ridge gold deposit is hosted within the southern portion of the Kunanalling Shear Zone, occurring within a sequence of fine-grained sediments and volcanics. The Project overlies a deeply weathered profile of 20-30 m of saprolitic material and basement rock comprising of gabbro, quartz gabbro, dolerite intrusives, fine-grained volcanics and sedimentary sequences (Appendix B).

The Kalgoorlie Province is divided into six soil-landscape zones, with the survey area located within the Kambalda Zone (265). The Kambalda Zone is characterised by flat to undulating plains (with hills, ranges and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton. Soils are comprised of calcareous loamy earths and red loamy earths with salt lakes soils and some red brown hardpan shallow loams and red sandy duplexes.

5.3 Landforms

The underlying geology is of gneisses and granites eroded into a flat plane covered with tertiary soils and with scattered exposures of bedrock. Calcareous earths are the dominant soil group and cover much of the plains and greenstone areas. A series of large playa lakes in the western half are the remnants of an ancient major drainage line.

5.4 Hydrology

5.4.1 Surface Hydrology

Surface water resources around the Golden Cities dewatering project area are scarce, with surface water only being evident following continuous and heavy periods of rainfall. Surface water throughout the region is drained by series of creeks, running south into major drainage channels that traverse flood plains and eventually feed into salt lake systems. Surface drainage is internal with significant sheet and rill flow occurring immediately following rainfall. Local flooding may occur particularly after summer thunderstorms.

During construction and operations, unconsolidated surfaces such as overburden storages, stockpiles, embankment faces and unsealed roads may contribute to sediment loads in the runoff water. V-drains and spoon drains will be used to manage surface water runoff and limit the emissions of sediment into the natural environment.

5.4.2 Groundwater

Groundwater flow is towards the major palaeodrainages and modern playa lakes where the water-table is at or near the surface. Groundwater discharge occurs mainly by evaporation from playa lakes, with comparatively small volumes discharged through palaeochannels.

Groundwater from the region is drawn from the Roe Paleochannel System which is highly saline with major ions strongly dominated by sodium and chloride and to a lesser extent magnesium and sulphate. Ground water quality in the project area is slightly alkaline and concentrations of heavy metal contaminants are relatively low; however, a high level of manganese was identified.

To determine the simple groundwater parameters and flow models, two test bores and a monitoring bore were drilled at the Cutters Ridge Pit.

Water was found to be saline to hypersaline, with the total dissolved solids (TDS) ranging from 46,900 – 89,800 mg/L, and pH ranging from 4.8 – 7.10, as measured from three bores in April 2019 and as shown in Table 5-2. Given the highly saline nature of the groundwater, it is considered to have uses suitable for the mining industry only. Table 5-2 presents the most recent data of the Total Dissolved Solids (TDS) with more information found in Appendix C.

Table 5-2: Groundwater Parameters of Cutters Ridge

Parameter	Result
pH (pH Units)	4.8 – 7.10
Total Dissolved Solids (mg/L)	46,900 – 89,800
Electrical Conductivity (mS/cm)	62,400 – 105,000

AQ2 were commissioned in Q1 2019 to install three bores (two test bores and a monitoring bore) at the Cutters Ridge deposit, as shown below in Figure 5-3. The bores were drilled using conventional RC drilling techniques under the direction of AQ2 hydrogeologist, appointed by Evolution. Two bores were constructed in the main aquifer zone, with the monitoring bore established outside the pit boundary, but still targeting the main aquifer zone. One hole was drilled to 60m depth before collapse, with the other two drilled to 80m depth. All three holes showed minor amounts of water intersected, which dried up quickly.

Modelling was also run to predict groundwater inflows against a high uncertainty scenario and a low uncertainty scenario. The high uncertainty case predicted a groundwater inflow of up to 10 L/s, with a more likely low uncertainty case of 1 L/s. Table 5-3 below shows the predicted groundwater inflows (uncertainty runs) into the pit are very low, and is consistent with the drilling and hydraulic testing results.

Table 5-3: Predicted Groundwater Inflows - Uncertainty Runs

Pit	Base Case		Uncertainty Case (High)		Uncertainty Case (Low)	
	Adopted K (m/d)	Predicted Inflow (L/s)	Adopted K (m/d)	Predicted Inflow (L/s)	Adopted K (m/d)	Predicted Inflow (L/s)
Cutters Ridge	0.005	2	0.05	10	0.001	1

The Production or Design Capacity has therefore been estimated using the worst-case scenario of 10 L/s which would yield 315,360kL per annum.

The actual discharge is expected to be no more than 100,000 kL per annum as based on a more likely predicted scenario of 2 L/s, as per Table 2 in the AQ2 investigation and depicted below in Table 5-4. This would yield 63,072 kL per annum, with dust suppression activities also undertaken during the project utilising a proportion of the groundwater water yielded.

Table 5-4: Predicted Groundwater Inflows – Base Case

Pit	Adopted Bulk Permeability (m/d)	Simulated Final Pit		Predicted Groundwater Inflow (L/S)
		Time Period (months)	Pit Base (mBGL)	
Cutters Ridge	0.005	12	250	2

The AQ2 hydrogeological investigation report is attached as Appendix D.

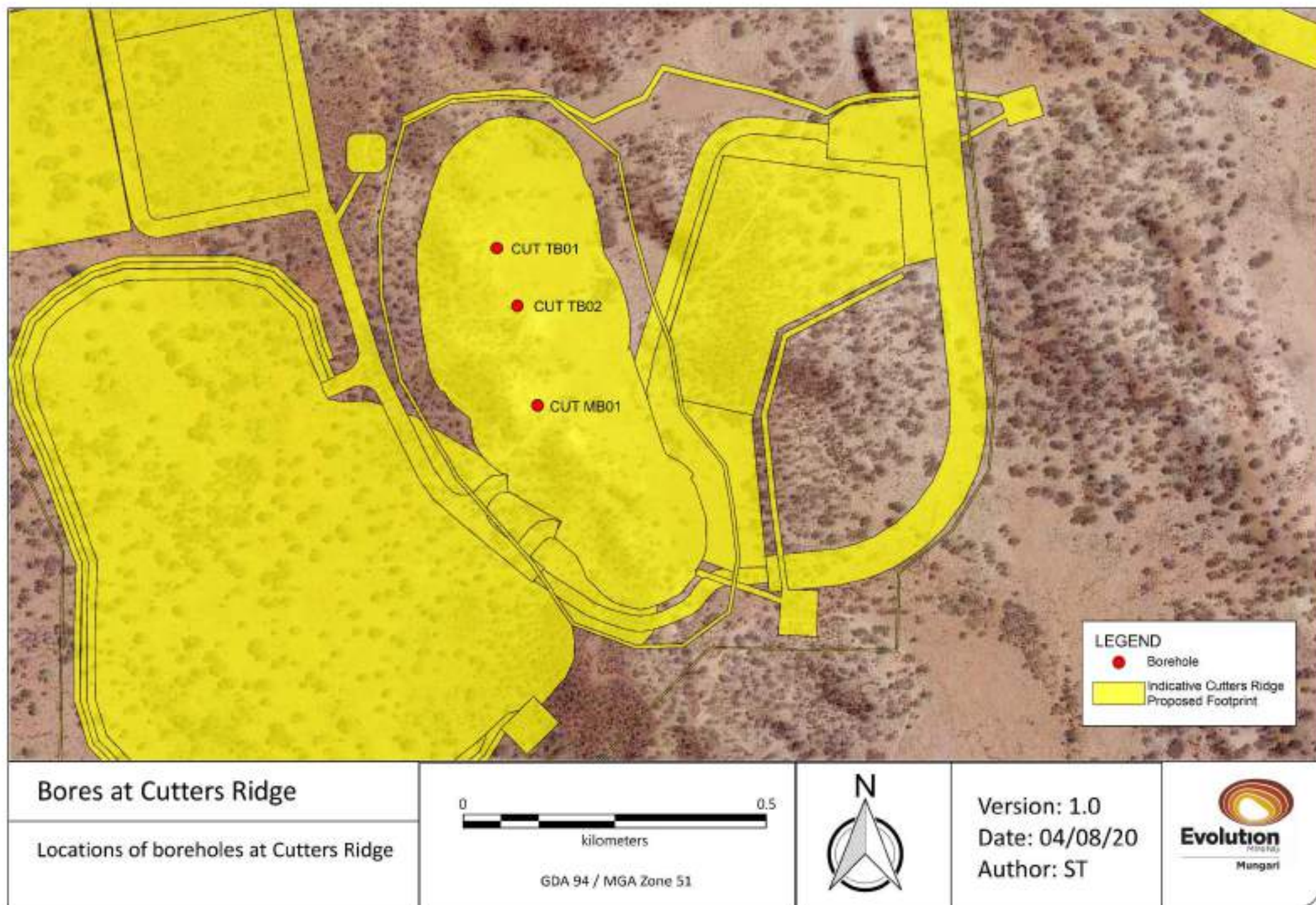


Figure 5-3: Bores at Cutters Ridge

5.5 Flora and Vegetation

Evolution's Mungari operations are located within the Coolgardie Botanical District of the South-western Interzone. This botanical district is predominantly Eucalypt woodland, becoming open towards the more calcareous soils, where a cover of saltbush-bluebush understorey is evident. Dominant plant families within the Coolgardie Botanical District include *Mimosaceae*, *Myrtaceae*, *Chenopodiaceae* and *Myoporaceae*. A gently undulating topography within this Botanical District is broken up with occasional ranges of low hills. Principally, the soils are brown calcareous earths.

A flora and vegetation survey was undertaken by Phoenix Environmental Sciences (Phoenix) in 2019 within a 176.5 ha study area (Appendix E). Five Priority species were recorded during Phoenix's field survey. Individuals of *Allocasuarina eriochlamys* subsp. *grossa* (P3), *Austrostipa blackii* (P3) and *Calandrinia* sp. *Gypsum* (P3) were identified along with two unidentified species of *Calandrinia* (P1) (*quartzitica/lefroyensis*). The specimens of unknown *Calandrinia* were recorded by Phoenix to the east of the Project footprint, at the western end of the Cutters Ridge Haul Road. They have been subsequently identified as *C. lefroyensis* (Spectrum Ecology 2019). *C. lefroyensis* is a P1 species but it is not believed to occur within M15/1827 and will not be affected by the open pit development.

Calandrinia sp. *Gypsum* (F. Obbens and L. Hancock FO 10/14) was observed to the south east of the Project footprint which represents a ~110 km northern range extension for the species. A targeted *Calandrinia* survey was conducted in 2019 along the Cutters Ridge Haul Road (Appendix F). All records made from within the Cutters Ridge Haul Road, to widespread species (*Calandrinia eremaea*, *Calandrinia disperma* and *Calandrinia ?hortiorum*). No Priority Flora was found during the Targeted searches. The previous records of *Calandrinia ?lefroyensis/?quartzitica* (Phoenix 2018) were not found again at the original locations during the Targeted survey (Spectrum Ecology 2019). No Threatened Ecological Communities, Priority Ecological Communities or Environmentally Sensitive Areas were recorded in the survey area. A total of seven introduced flora species were identified during the field survey, none of which were Declared Plants or Weeds of National Significance (WoNS) (Phoenix, 2019a). These are listed in Table 5-5.

Overall, the vegetation condition within the Project footprint ranges from "Very Good" to "Pristine" on the Keighery Vegetation Scale. Vegetation across the Project Area is, for the most part, in Very Good condition. Classifications of vegetation conditions are provided in Table 5-6

Table 5-5: Introduced flora species identified

Family	Species	Common Name
Convolvulaceae	<i>*Cuscuta epithymum</i>	Clover dodder
Geraniaceae	<i>*Erodium cicutarium</i>	Redstem filaree
Primulaceae	<i>*Lysimachia arvensis</i>	Scarlet pimpernel
Fabaceae	<i>*Medicago minima</i>	Little bur-clover
Asteraceae	<i>*Monoculus monstrosus</i>	Stinking roger
Oxalidaceae	<i>*Oxalis corniculata</i>	Creeping woodsorrel
Lamiaceae	<i>*Salvia verbenaca</i>	Wild sage

Table 5-6: Keighery Vegetation Scale classifications

Vegetation condition	Description
Pristine	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

(Keighery, BJ (1994) Bushland Plant Survey)

5.6 Fauna

Phoenix undertook a fauna assessment of the Project Area in October 2018 assessing a total of 31 sites over nine consecutive days, attached as Appendix G. The assessment involved habitat assessment, active searches, avifauna surveys, bat echolocation recordings, targeted Malleefowl transect surveys, and targeted Short-Range Endemic (SRE) species searches (Phoenix, 2019b).

Seventy-five fauna species were recorded during the field survey, equating to approximately 27% of the total species potentially occurring within the area. Avian taxa were the most abundant during the field survey with 52 species recorded in total. Thirteen mammals were recorded, including three introduced species (Phoenix, 2019b).

Records for a total of 22 threatened or conservation significant fauna taxa were identified within 40 km of the Project Area during a recent desktop review, comprising nineteen birds and three mammals (Table 5-7). Eighteen bird species are listed as either Threatened or Migratory under State or Commonwealth legislation, with two species listed as Priority flora by the DBCA.

No Threatened or Priority fauna species were identified within the proposed Project footprint; however, 22 threatened species have the potential to occur within the area including *Leipoa ocellata* (Malleefowl), which was observed crossing existing access tracks during the field survey, occurring to the north-west of the Project Area. One Malleefowl mound was observed within a small patch of tall thick scrub; however, it appeared to be in poor condition as a result of recent rainfall, surface water movement, and visible mammal diggings. The local area provides optimal foraging habitat for this species, which is known to occur widespread throughout the Goldfields and Wheatbelt regions; however, nesting habitat is sparse in the project area (Phoenix, 2019b). Proposed clearing in the project area is unlikely to have a significant impact on these species in a bioregional context.

There were no SRE species recorded during Phoenix's field survey, nor are any previous SRE records located within close proximity to the Project Area. Numerous Mygalomorph spider burrows were recorded at multiple locations. Only one burrow contained a live specimen of *Gaius villosus* (Armoured Trapdoor Spider) which is widespread and is not classified as an SRE species.

Table 5-7: Conservation significant fauna potentially occurring at the project (Phoenix, 2019b)

Species	Common name	Conservation status		
		EPBC Act	BC Act	DBCA
Birds				
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI	
<i>Thinornis rubricollis</i>	Hooded Plover	-	-	P4
<i>Falco peregrinus</i>	Peregrine Falcon	-	SP	
<i>Glareola maldivarum</i>	Oriental Pratincole	MI	MI	
<i>Leipoa ocellata</i>	Malleefowl	VU	VU	
<i>Motacilla cinerea</i>	Grey Wagtail	MI	MI	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	EN	EN	
<i>Pezoporus occidentalis</i>	Night Parrot	EN	CR	
<i>Actitis hypoleucos</i>	Common Sandpiper	MI	MI	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MI	MI	
<i>Calidris alba</i>	Sanderling	MI	MI	
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/MI	VU/MI	
<i>Calidris melanotos</i>	Pectoral Sandpiper	MI	MI	
<i>Calidris ruficollis</i>	Red-necked Stint	MI	MI	
<i>Calidris subminuta</i>	Long-toed Stint	MI	MI	
<i>Tringa brevipes</i>	Grey-tailed Tattler	MI	MI	P4
<i>Tringa glareola</i>	Wood Sandpiper	MI	MI	
<i>Tringa nebularia</i>	Common Greenshank	MI	MI	
<i>Plegadis falcinellus</i>	Glossy Ibis	MI	MI	
Mammals				
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	
<i>Myrmecobius fasciatus</i>	Numbat	EN	EN	
<i>Macrotis lagotis</i>	Bilby	VU	VU	

5.7 Aboriginal Heritage

The surrounding land is registered to the Native Title Claimants, the *Maduwongga* people (Tribunal file no. WC2017/001) and the *Marlinyu Ghoorlie* people (Tribunal file no. WC2017/007) under the *Native Title Act 1993* (National Native Title Tribunal, 2019). Representatives of the *Maduwongga* people took part in an ethnographic survey of the Project Area on 31 November 2018, conducted by anthropologist and archaeologist Wayne Glendenning (Glendenning, 2018).

A “Registered” site has been identified on tenement M15/1827. Evolution mining will ensure the site is not disturbed during any operations or closure activities that occur.

Consultation with the relevant Native Title Groups is ongoing to ensure that mining operations do not disturb any significant sites. The most recent Heritage Surveys undertaken in the Cutters Ridge project area include the ‘Cutters Ridge Mine Open Pit, Haul Road, TSF Borrow Pit and TSF Cell 3’ survey in 2018 and ‘Cutters to Rayjax and Haul Road Extension and Area B Tailing Storage Facility’ survey in 2019, both undertaken by Wayne Glendenning.

5.8 European Heritage

There are no sites of European Heritage within the Cutters Ridge dewatering project area.

5.9 Sensitive Receptors

The nearest residential community is the Coolgardie town site, located approximately 20 km to the south of the project area. The township of Kalgoorlie-Boulder is located approximately 25 km to the East of the Project area. Dewatering activities are not expected to have an effect on these receptors.

6.0 Assessment of Environmental Risks from Emissions

6.1 Risk Identification

From the risk identification process, four potential emissions were identified associated with the dewatering into any of the open pits. The likelihood of an event happening where the emissions affect the environment is detailed in Section 6.4.

6.2 Potential Emissions

- Hyper-saline (spill into dewatering system, breach of pipeline);
- Hydrocarbon spill (spill from water pump);
- Noise (from water pump and pipeline inspection vehicles; and
- Dust (from discharge points and pipeline inspection vehicles.

6.3 Risk Assessment

To identify the risks associated with discharging, each component of the process was assessed to identify any risk that may occur within each component. Risks that were identified are summarised below and in Table 6-2. Table 6-1 shows Evolution's risk rating matrix that is used when evaluating risks.

Hypersaline spill occurring is possible and is considered a moderate (13) risk without management measures and a moderate (9) risk after management measures are put in place. The consequences would be a loss of vegetation and/or habitat from contaminating the soil and water.

Hydrocarbon contamination is possible and considered a moderate (8) risk after controls. The consequences would be water and soil contamination which would lead to vegetation deaths and habitat decline. Only a small amount of fuel will be stored within the day tanks of the dewatering pump, therefore a hydrocarbon contamination will not be sizeable.

Noise impacts are highly improbable and considered a low (3) risk. The consequence of residential disturbance would not occur as there are no residents within the immediate vicinity. There is also risk of impact on local fauna populations. It is highlighted that neither of these are likely to be greater than noise impacts from mining operations (excavators, dump trucks, dozers, graders, service trucks, drill rigs and rock breakers).

Dust accumulation is possible but considered a low (4) risk. Again, the impact from discharge points and vehicle movements is not likely to be greater than the mining operations.

Table 6-1: Evolution Mining Risk Rating Matrix

		Likelihood				
		Highly Improbable	Improbable	Possible	Probable	Highly Probable
Consequence Level	Extreme	15 Moderate	20 High	22 Extreme	24 Extreme	25 Extreme
	Major	10 Moderate	14 Moderate	19 High	21 Extreme	23 Extreme
	Moderate	6 Low	9 Moderate	13 Moderate	17 High	18 High
	Minor	3 Low	5 Low	8 Moderate	12 Moderate	16 Moderate
	Very Minor	1 Low	2 Low	4 Low	7 Low	11 Moderate

6.4 Risk Management

Table 6-2: Risk Identification, Analysis and Management of Cutters Ridge Dewatering

ACTIVITY	RISK PATHWAY	IMPACT	INHERENT RISK			TREATMENT	RESIDUAL RISK		
			LIKELIHOOD	CONSEQUENCE	RAW RISK		LIKELIHOOD	CONSEQUENCE	TREATED RISK
Hypersaline Water	Hypersaline water spill from pipeline failure or leak. Similarly, hypersaline water spills from failure of water storage infrastructure (i.e. turkey's nest, mobile tanks).	A hypersaline spill may adversely affect the condition of vegetation adjacent to spill. Groundwater and process water is the primary source for a hypersaline water spill. The majority of the Goldfields region has hypersaline groundwater in excess of (>36,000mg/L TDS). Pipelines remain a critical way of moving water to sites with not enough water, or away from sites site too much water.	Possible	Moderate	Moderate (13)	Mine Dewatering follows the requirements for government approvals, the relevant engineering standards, bunding requirements, inspection regimes (12 hourly, monthly and annual inspections) and contingency plans should a spill occur. A saline water management plan exists on site. Significant hypersaline spills leading to environmental harm are reported to relevant authorities within one business day. If a spill occurs, contaminated material is removed and buried to reduce impact on vegetation. If required, the affected area may be ripped and re-seeded.	Improbable	Moderate	Moderate (9)
Hydrocarbons	Release of hydrocarbons into the environment or into the dewatering network from water pump.	Spilled hydrocarbons or chemicals contaminate soils which has an adverse effect on vegetation and biodiversity. Impacts include surface water contamination, ground water contamination, soil contamination, non- compliance with WA contaminated sites legislation, flora, vegetation and fauna impacts, fire, fauna ingestion, unauthorised discharge, potential contaminated site liability and increased remediation costs.	Probable	Minor	Moderate (12)	Minor hydrocarbons shall be stored in bunded areas with a capacity of holding 110% tank capacity, self-bunded or double wall bunded tanks. All workshops are required to have spill kits and all chemicals are to be correctly labelled. Inductions, training and awareness is conducted on site and monitoring/housekeeping is carried out regularly. A Spill Management Procedure exists on site along with a fully trained Emergency Response Team.	Possible	Minor	Moderate (8)
Noise	Noise (from the water pump) can impact local fauna.	Noise can disrupt fauna behaviour and disturb habitats.	Highly Improbable	Minor	Low (3)	Fauna surveys can identify the species and population in the area to determine the impact. A Fauna Management Procedure exists on site. If required, a pump noise barrier can be placed around the pump.	Highly Improbable	Minor	Low (3)
Dust	Dust accumulation on native vegetation.	Heavy use of vehicles on track carrying out pipeline checks can increase dust emissions, causing vegetation smothering, fauna ingestion, dust migration and nuisance.	Possible	Minor	Moderate (8)	Use appropriate dust suppression techniques on the track. Daily observations on dust within work area and additional measures implemented if required. Revegetation can also help prevent dust emissions.	Possible	Very Minor	Low (4)

7.0 Environmental Performance Objectives, Standards and Measurement Criteria

7.1 Objectives and Standards

Table 7-1: Environmental Performance Objectives and Standards

Environmental Performance Objectives	Standards	Measurement Criteria
Dewatering: ensure groundwater abstraction is not exceeded	<ul style="list-style-type: none"> Groundwater Abstraction Licence 178353(4) Groundwater Operating Strategy Water and Irrigation Regulations 1914 Environmental Protection Act Regulations 1986 Saline Water Management Procedure 	<ul style="list-style-type: none"> Flow meters installed and read daily Annual Groundwater Monitoring Summary
Hypersaline water emissions: ensure all hypersaline water is contained within the pipeline bund, open pits and scour pits	<ul style="list-style-type: none"> Environmental Protection Act Regulations 1986 Saline Water Management Procedure 	<ul style="list-style-type: none"> Pipeline inspection carried out on 12 hourly basis Saline Water Management Procedure Pipeline inspection sheets Isolation and breather valves
Hydrocarbon emissions: ensure hydrocarbons do not leak into the environment	<ul style="list-style-type: none"> Spill management Procedure Groundwater Operating Strategy 	<ul style="list-style-type: none"> Small quantities stored on active machinery System in place to immediately deal with a hydrocarbon spill Hydrocarbon spill kit located nearby Annual water quality monitoring Hydrocarbons not stored in fuel tanks to be banded
Noise emissions: ensure noise is kept at a suitable level to avoid fauna disturbance and residential communities.	<ul style="list-style-type: none"> Environmental Protection (Noise) Regulations 1997 Wildlife Protection Act 1950 	<ul style="list-style-type: none"> Fauna observations in the area to ensure that travel patterns are not changing
Dust accumulation: ensure dust is managed so it does not affect vegetation and the public.	<ul style="list-style-type: none"> Environmental Protection Act Regulations 1986 	<ul style="list-style-type: none"> Implementation of a Dust Suppression Procedure Monitor dust in the area

8.0 Implementation Strategy

8.1 Commissioning

The pipeline will be constructed by Evolution staff once approvals are in place. The v-drain and scour pits will be constructed by use of a grader and/or excavator. Maintenance staff will install flow metres, breather and carry out welding of the pipeline. Estimated costs are shown in Table 8-1. Evolution proposes to undertake a commissioning phase once pipelines are constructed.

Table 8-1: Estimated Costs

Activity	Estimated Cost
6000m HDPE Polypipe (\$15.29/m)	\$92,000
2 years Hire pump (\$275/day)	\$198,000
Flow meter, breather, valve etc.	\$97,800
Machinery	\$8,000
Freight	\$6,300
Pipeline installation labour	\$18,000
TOTAL	\$420,100

8.2 Clearing

No additional clearing is required to construct the dewatering pipeline from Cutters Ridge to Mungari as the v-drain will follow within the Cutters Ridge haul road disturbance footprint and remain within the approved disturbance footprint of CPS 8549/2. The current clearing permit allows clearing of up to 116.2 ha of native vegetation on tenements M15/829, M15/1827 and L15/837. This clearing permit is currently pending amendment to include additional disturbance outline in the Cutters Ridge Mining Proposal.

Any clearing required on tenement M15/829 and M15/830, between Cutters Ridge and White Foil that is not covered under the above clearing Permit will be managed in accordance with Schedule 1, Item 2, Subclause 2 of the Environmental Protection (Clearing of the Native Vegetation) Regulations 2004. Existing pipework will be utilised to transfer water from White Foil to the Pope John pit.

8.3 Monitoring

The dewatering works and infrastructure will be monitored to ensure compliance with the management objectives and to maintain continuation of monitoring from previous operating strategies. The following dot points summarise the key monitoring methods and schedules:

- Daily visual pipeline checks;
- Record the daily flow meter readings;
- Annual water quality monitoring that includes pH, EC, TDS and heavy metals analysis;

- Noise will be monitored on as required basis – given it is a work area triggered by OHS standards; and
- Dust observations will be carried out regularly.

8.4 Rehabilitation

The pipeline will be rehabilitated and revegetated with local species once the pipeline is no longer required in accordance with Department of Mines, Industry Regulation and Safety (DMIRS) requirements.

Rehabilitation is guided by the following principles:

- Ensure that vegetation clearing is kept to a minimum;
- Collect and correctly stockpile vegetative material and available topsoil for later use at selected sites;
- Strip topsoil for immediate re-use on prepared surfaces where possible;
- Progressively rehabilitate completed areas as soon as practicable;
- Only use local native plant species for seeding; and
- Undertake decommissioning and closure of the site to industry leading practice principles and to statutory requirements.

To assist with ongoing review of the rehabilitation and environmental management at the Cutters Ridge project, Evolution submit an Annual Environmental Report (AER) to DMIRS each year.

8.5 Contingencies

8.5.1 Hypersaline Spill

In an event of a hypersaline spill:

- Bunding will assist to contain the spill and the isolation valves will be turned on by the person inspecting the pipeline;
- Repairs will be carried out on the pipeline and any bunding that may have been damaged will be reconstructed to standard by the service crew;
- Earthmoving equipment will be used by the service crew to remove contaminated soil. Soil sampling will be carried out by the Environment Department to assess the extent of the contamination;
- Reports will be provided in accordance with Section 72 of the *Environmental Protection Act 1986* should any environmental harm occur; and
- Rehabilitation of the affected area will be carried out by Environmental Department if required.

8.5.2 Hydrocarbon Spill

In an event of a hydrocarbon spill:

- The source will be stopped immediately, and the spill will be contained with additional bunding from the spill kit that will be in the vicinity;
- Any contaminated soil will be removed and disposed of appropriately by the service crew;

- Soil and water sampling will be carried out by the Environment Department to assess the extent of the contamination. Reports provided in accordance with Section 72 of the *Environmental Protection Act 1986*; and
- Rehabilitation of the affected area will be carried out by the Environmental Department if required.

8.5.3 Dewatering

If dewatering volumes exceed the allowed amount, relevant authorities will be notified by the Environmental Department and pumping volumes will be reduced or ceased to prevent exceedance of the allowed limit.

8.6 Records

The records that are maintained at Evolution to ensure systems, practices and procedures are in place are listed below:

- Groundwater Operating Procedure;
- Pipeline inspection logs including details of any identified issues;
- Record of monthly flow meter readings;
- Annual Groundwater Monitoring Summary;
- Groundwater Monitoring Review every three years;
- Environmental Incident report form; and
- Shift logs.

8.7 Management Responsibilities

Management responsibilities are detailed below to ensure the Environmental Management System (EMS) is established, implemented and maintained throughout the operation.

8.7.1 General Manager & HSE Manager

- Provides resources to implement, maintain and improve the EMS; and
- Appoints and supports the Environment Superintendent who is responsible for implementation of the EMS.

8.7.2 Open Pit Manager and Superintendent

- Ensures that sufficient personnel and resources have been engaged to implement the plans and procedures within the EMS as applicable to the Cutters Ridge project.

8.7.3 Environment Superintendent

- Ensures that the EMS is established, implemented, reviewed and maintained throughout the year in accordance with progress and changes that occur; and
- Reports to the General Manager on the performance of the system.

8.7.4 Operator

- Carries out relevant requirements of the EMS such as the plans and procedures to aim for a minimal incident operation;
- Reports all environmental incidents and opportunities for improvement on the current practices; and
- Report and record all carried out inspections.

8.8 Competence, Training and Awareness

To ensure competence and understanding of operational and license requirements:

- All of the workforce, both Evolution staff and contractors, are given a wide-ranging safety, occupational health and environmental management induction on arrival at the site;
- Pipeline inspectors are trained on the Saline Water Management Procedure to ensure inspectors have a full understanding of their responsibilities;
- Water cart operators are trained to ensure minimum impact on the vegetation; and
- Continuous staff training will involve environmental input at “tool-box” meetings and specific environmental courses as required.

8.9 Communication

Meetings with Department Managers are held to ensure communications are effectively passed through the system. In addition, all EMS policies and procedures are available to all personnel online through SharePoint. Regular meetings are conducted with the Technical Services Departments to discuss any matter that may need addressing.

9.0 Consultation

Table 9-1: Stakeholder Engagement Register

Stakeholder	Date	Description of Engagement	Stakeholder Comments/Issues	Proponent Response and/or Resolution	Stakeholder Response
DMIRS	14/08/2020	Email	Request for Further Information received by DMIRS	Pending response.	
	23/07/2020	Online submission	Cutters Ridge Mining Proposal amendment submitted under new 2020 Guideline.		
	14/5/2020	Email	Clearing Permit 8549/2 granted. Permission to clear up to 116ha of vegetation on tenements – M15/829, M15/1827 and L15/387		
	28/11/2019	Email	Clearing Permit 8549/1 granted. Permission to clear up to 86.5ha of vegetation on tenements – M15/829, M15/1827 and L15/387		
	22/11/2019	Online submission	Cutters Ridge Mining Proposal submitted. Reg ID 83639	Further information requested 04/02/2020 and provided 14/02/2020. MP updated with new information and resubmitted 25/02/2020.	MP approved 28/02/2020
	07/08/2019	Email	Request for further information regarding risk to conservation significant <i>Calandrinina</i> species for CP8549/1.	Targeted flora surveys conducted by Spectrum Ecology.	DMIRS satisfied with the information provided.
	14/06/2019	Online submission	Cutters Ridge Mine Stage 1 Haul Road Mining Proposal submitted. Reg ID 80639.	MP put on hold until further survey information was provided.	MP approved 16/12/2020
DWER	17/08/2020	Email	Contacted Lauren Fox to seek Works Approval checklist to ensure supporting documentation for Cutters Ridge application sufficient.		Provided with relevant links to website and application form location.

Stakeholder	Date	Description of Engagement	Stakeholder Comments/Issues	Proponent Response and/or Resolution	Stakeholder Response
	10/08/2020	Email	Email to Fiona Sharpe re: upcoming submission of Cutters Ridge Works Approval.		Advised to contact Lauren Fox and provided contact details.
	10/03/2020	Email	GWL amended to include Cutters Ridge and Rayjax mining tenements (GWL178553(4))		
DBCA	03/10/2019	Email	DBCA and DMIRS discussions request a targeted flora survey for the conservation significant <i>Calandrinia</i> species prior to the approval of CPS 8549/1.	Targeted <i>Calandrinia</i> survey carried out.	DBCA satisfied with the information provided.
	03/10/2019	Email	DBCA and DMIRS note that the August <i>Calandrinia</i> survey identified a potential new species of <i>Calandrinia</i> which may need to be further surveyed.	Targeted <i>Calandrinia</i> survey carried out. Previous records of Priority 1 <i>Calandrinia</i> species not found again at original locations. These were outside the development envelope.	DBCA satisfied with the information provided.

10.0 Commitments

Evolution Mining has made a number of specific commitments within this works approval. These are summarised in Table 10-1.

Table 10-1: Summary of Commitments

Issue	Commitment
Water Monitoring	<ul style="list-style-type: none"> Monthly water volumes will be undertaken during dewatering Annual water quality sampling will be undertaken whilst dewatering activities are operational
Hypersaline Spill Control	<ul style="list-style-type: none"> Daily pipeline monitoring will occur while actively dewatering V-drain and pipeline bunding is maintained Report all incidents internally and externally as required by Section 72 of EP Act
Rehabilitation	<ul style="list-style-type: none"> The pipeline will be rehabilitated and revegetated with local species once the pipeline is no longer required in accordance with DMIRS requirements
Hydrocarbons	<ul style="list-style-type: none"> Hydrocarbons not within fuel tanks for engines will be stored in bunded areas Hydrocarbons and hydrocarbon contaminated material will be collected and sent offsite for treatment and disposal Spill kits will be available near generators
Dust	<ul style="list-style-type: none"> Dust generating activities will be monitored to ensure that vegetation and workers are not impacted Dust generating equipment will be assessed and a range of measures implemented including water carts, restricting access, increased wind breaks, and change to nozzle parameters Any action being implemented will be reviewed to ensure that it is (a) effective and (b) not having other adverse impacts
Noise	<ul style="list-style-type: none"> Operations will adhere to <i>Environmental Protection (Noise) Regulations 1997</i>

11.0 References

- AQ2 Consultancy (AQ2) (2019). Hydro-Investigations – Cutter’s Ridge, Rayjax and Ridgeback Deposits Technical Memo. 20 March 2019.
- Cowan, M. (2001) Coolgardie 3 (COO3—Eastern Goldfields subregion). *In*: May, J. E. & McKenzie, N. L. (eds) *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002*. Department of Conservation and Land Management, Perth, W.A., pp. 156–169.
- Keighery, B. J. (1994) Bushland Plant Survey. A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc), Nedlands, Western Australia
- Phoenix Environmental Services (Phoenix) (2019a). Flora and vegetation survey for Mungari Operations Cutters Ridge Project. Prepared for Evolution Mining Ltd February 2019
- Phoenix Environmental Services (Phoenix) (2019b). Fauna survey for Mungari Gold Operations Cutters Ridge Project. Prepared for Evolution Mining Ltd February 2019
- Soilwater Consultants (Soilwater) (2019a). Cutters Ridge Geochemical Characterisation. Prepared for Evolution Mining Ltd 14 March 2019.
- Spectrum Ecology (Spectrum) (2019). Targeted Flora Search *Calandrinia lefroyensis/quartzitica*. 15 November 2019.

Appendix A:

Groundwater Licence 178353(4)



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Evolution Mining (Phoenix) Pty Limited		
Description of Water Resource	Goldfields Combined - Fractured Rock West - Fractured Rock	Annual Water Entitlement	1,100,000kL
Location of Water Source	M15/1827 M15/1831 M16/139 M16/140 M16/141 M16/15 M16/152 M16/16 M16/178 M16/179 M16/183 M16/187 M16/189 M16/19 M16/195 M16/198 M16/199 M16/215 M16/22 M16/24 M16/248 M16/33 M16/36 M16/40 M16/444 M16/47 M16/526 M16/527 M16/532 M16/533		

Authorised Activities	Taking of water for	Location of Activity
	Dewatering for mining purposes	M15/1827 M15/1831 M16/139 M16/140 M16/141 M16/15 M16/152 M16/16 M16/178 M16/179

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.

**LICENCE TO TAKE WATER**

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

		M16/183
		M16/187
		M16/189
		M16/19
		M16/195
		M16/198
		M16/199
		M16/215
		M16/22
		M16/24
		M16/248
		M16/33
		M16/344
		M16/36
		M16/40
		M16/444
		M16/47
		M16/526
		M16/527
		M16/532
		M16/533
	Dust Suppression for mining purposes	M15/1827
		M15/1831
		M16/139
		M16/140
		M16/141
		M16/15
		M16/152
		M16/16



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

		M16/178
		M16/179
		M16/183
		M16/187
		M16/189
		M16/19
		M16/195
		M16/198
		M16/199
		M16/215
		M16/22
		M16/24
		M16/248
		M16/33
		M16/344
		M16/36
		M16/40
		M16/444
		M16/47
		M16/526
		M16/527
		M16/532
		M16/533
	Mineral ore processing and other mining purposes	M15/1827
		M15/1831
		M16/139
		M16/140
		M16/141
		M16/15

**LICENCE TO TAKE WATER**

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

		M16/152
		M16/16
		M16/178
		M16/179
		M16/183
		M16/187
		M16/189
		M16/19
		M16/195
		M16/198
		M16/199
		M16/215
		M16/22
		M16/24
		M16/248
		M16/33
		M16/344
		M16/36
		M16/40
		M16/444
		M16/47
		M16/526
		M16/527
		M16/532
		M16/533
Duration of Licence	From 10 March 2020 to 30 November 2027	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 April to 31 March.

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

This Licence is subject to the following terms, conditions and restrictions:

2. The licensee shall comply with the commitments of the operating strategy Castle Hill Gold Project Groundwater Licences Operating Strategy, as prepared by Rockwater Pty Ltd and approved by the Department of Water and Environmental Regulation on 04/12/2017 including any modifications to the commitments as approved during the term of the licence.
3. Every 12 Months the licensee shall provide to the Department of Water and Environmental Regulation a Groundwater Monitoring Summary for the preceding water year. The first report is due 15/06/2020.
4. Every 3 Years the licensee shall provide to the Department of Water and Environmental Regulation a Groundwater Monitoring Review. The first report is due 15/06/2021. A Groundwater Monitoring Summary need not be submitted in a year in which a Groundwater Monitoring Review is due.
5. All monitoring and reporting shall be carried out in accordance with Operational Policy 5.12 'Hydrogeological reporting associated with a groundwater well licence'.

End of terms, conditions and restrictions

Appendix B:

Cutters Ridge Geochemical Characterisation

SOILWATER CONSULTANTS

CUTTERS RIDGE GEOCHEMICAL CHARACTERISATION

Prepared for:	EVOLUTION MINING
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Date of Issue:	14 March 2019
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Project No.:	EVN-005-1-08
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Distribution:

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DOCUMENT STATUS RECORD

Project Title:	CUTTERS RIDGE GEOCHEMICAL CHARACTERISATION				
Project No.:	EVN-005-1-08				
Client:	EVOLUTION MINING				
Revision History					
Revision Code*	Date Revised	Revision Comments	Signatures		
			Originator	Reviewer	Approved
A	06/03/18	Internal review	SC	ASP	SC
B	14/03/18	Client review	SC		

Revision Code*

A - Report issued for internal review

B - Draft report issued for client review

C - Final report issued to client

LIMITATIONS

The sole purpose of this report and the associated services performed by Soil Water Consultants (SWC) was to undertake geochemical characterisation for the Cutters Ridge deposit. This work was conducted in accordance with the Scope of Work presented to Evolution Mining ('the Client'). SWC performed the services in a manner consistent with the normal level of care and expertise exercised by members of the earth sciences profession. Subject to the Scope of Work, the geochemical investigation was confined to the immediate areas of the Cutters Ridge deposit. No extrapolation of the results and recommendations reported in this study should be made to areas external to this project area. In preparing this study, SWC has relied on relevant published reports and guidelines, and information provided by the Client. All information is presumed accurate and SWC has not attempted to verify the accuracy or completeness of such information. While normal assessments of data reliability have been made, SWC assumes no responsibility or liability for errors in this information. All conclusions and recommendations are the professional opinions of SWC personnel. SWC is not engaged in reporting for the purpose of advertising, sales, promoting or endorsement of any client interests. No warranties, expressed or implied, are made with respect to the data reported or to the findings, observations and conclusions expressed in this report. All data, findings, observations and conclusions are based solely upon site conditions at the time of the investigation and information provided by the Client. This report has been prepared on behalf of and for the exclusive use of the Client, its representatives and advisors. SWC accepts no liability or responsibility for the use of this report by any third party.

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1 INTRODUCTION

Soil Water Consultants (SWC) was engaged by Evolution Mining (Evolution) to carry out a geochemical characterisation in support of a mining proposal to develop the Cutters Ridge gold deposit. The proposal involves the development of a new open cut pit which will be excavated using conventional blast and quarry techniques. Excavated mine waste rock from the open cut pit will be disposed of within a new Waste Rock Landform (WRL) to the south east of the mine pit. This geochemical characterisation was undertaken to identify the presence or absence of potential acid mine (AMD) or metalliferous (MD) drainage materials, or other problematic material types within the waste rock materials (e.g. highly saline material) which may impact on the surrounding environment if inappropriately managed.

1.1 STUDY OBJECTIVES

The specific objectives of this work were to:

- Assess the current baseline geochemical conditions existing within the proposed development area.
- Identify the risk of AMD and/or MD developing within waste materials following disturbance.
- Undertake an Acid Base Account (ABA) to identify the environmental risks associated with disturbance of any AMD materials.
- Identify other potentially problematic waste characteristics that may impact on the stability and sustainability of the WRL.
- Suggest management strategies for the handling and utilisation of the waste rock materials during mining and rehabilitation.

1.2 SCOPE OF WORK

The scope of work completed by SWC to meet the study objectives of this project included:

- Review of existing geological and assay drill data provided by Evolution.
- Identification and selection of representative drill holes providing sufficient lithological and spatial coverage within the deposit areas in consultation with Evolution Geologists.
- Undertake and coordinate the initial laboratory screen analysis.
- Selection of samples for additional detailed laboratory analysis to confirm their ARD and MD status.
- Review of laboratory results and preparation of this report.

2 STUDY METHODOLOGY

2.1 STUDY LOCATION

The Cutters Ridge gold deposit is located approximately 20 km northwest of Kalgoorlie in the Goldfields region of Western Australia. Ore from the deposit will be treated at the nearby Mungari processing plant facilities.

2.2 DEPOSIT GEOLOGY

The project area is located in the central part of the Archaean Norseman-Wiluna greenstone belt in Western Australia. It is associated with the southern section of the 250 km long, regionally significant Kunanalling Shear Zone which contains a number of significant gold mines along its length. The belt is characterised by thick sequences of ultramafic, mafic, and fine grained volcanics, as well as various intrusives and sedimentary rocks. Generally the mafic and ultramafic units occur at the base of the sequence, with the Fine Grained Volcanic to volcanoclastic rocks overlying these.

The main mineralisation targeted by the proposed development of the deposit occurs within a series of fine grained sediments and volcanics.

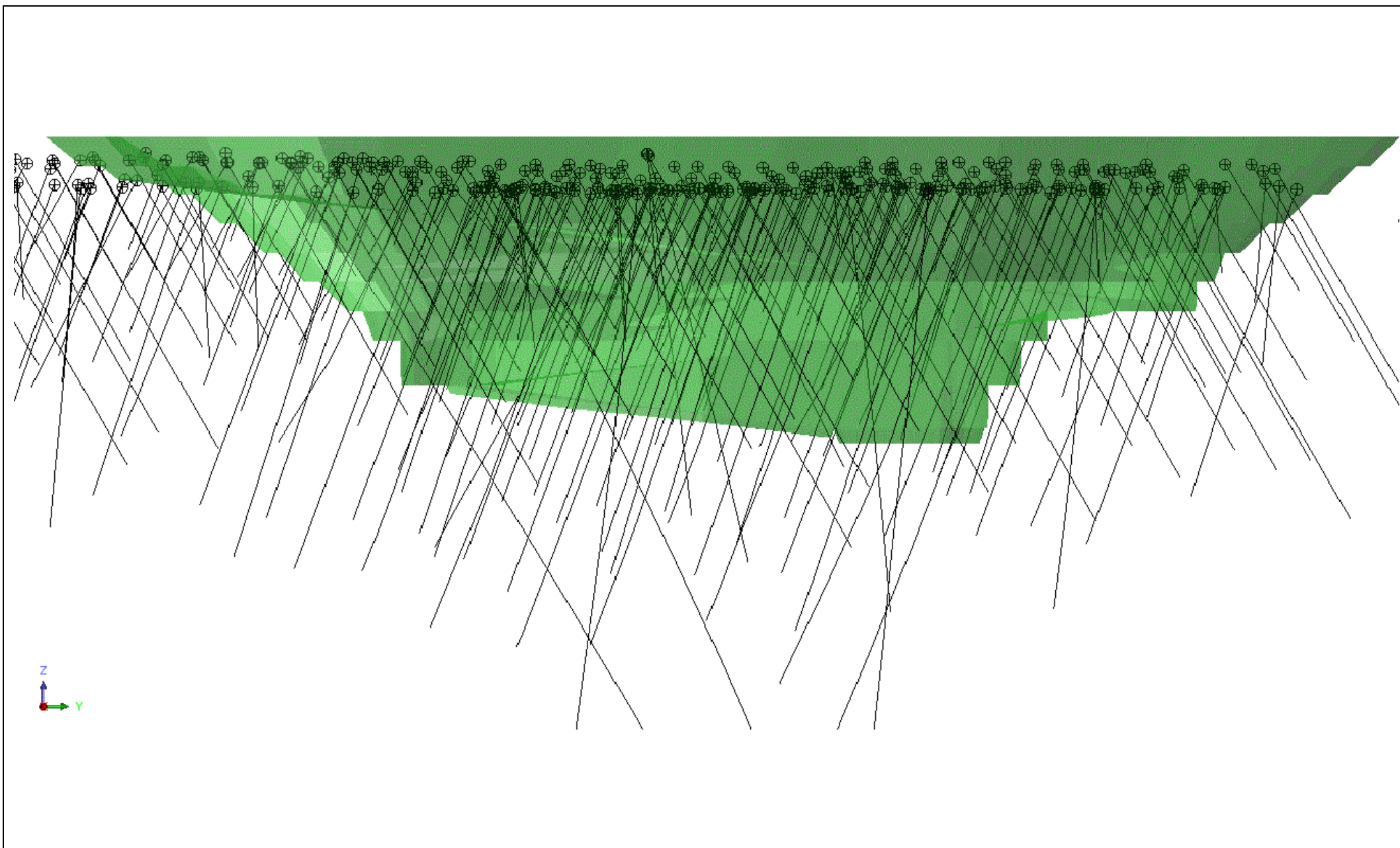
2.3 REVIEW OF EXISTING GEOLOGICAL DRILLING DATA

This section presents a breakdown of the existing geological data which has been gathered across the deposit area. A total of 719 holes have been drilled within the immediate area of the targeted deposit (Figure 2.1). The drilling has been conducted to depths of between 6 and 307 m with samples variously collected as 1, 2 and 3 m vertical composites. This data represents over 20,000 meters of drilling and logging. The number of samples logged for each lithology which comprised greater than 0.1% of samples logged is provided in Table 2.1.

Table 2.1: Summary of lithology data

Lithology	No.	%	Lithology	No.	%
Clay	348	1.6	Sedimentary rock	1,555	7.2
Laterite Mottled Zone	492	2.3	SSHB	92	0.4
Saprolite	7,389	34.2	Shale	334	1.5
Mafic basalt	94	0.4	Siltstone	60	0.3
Dolerite	1,544	7.2	Fine Grained Volcanoclastic	2,587	12.0
Gabbro	5,356	24.8	Intermediate volcanoclastic	286	1.3
Quartz Gabbro	916	4.2	Feldspathic wacke	23	0.1
Transported alluvium	308	1.4	Lithic wacke	120	0.6
Transported alluvium - clay	66	0.3	Vein	23	0.1

The summary data drawn from the drilling database shows the deposit area has a deeply weathered profile, with a thin transported cover of alluvial sediment over a 20 – 30 m thick saprolite / saprock profile with fresh basement rock underneath. The basement rock materials are dominated by gabbro and dolerite intrusives with fine grained Fine Grained Volcanic and sedimentary sequences. Together these unit types represent more than 80% of the logged fresh rock material within the deposit area.



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CUTTERS RIDGE GEOCHEMICAL CHARACTERISATION

Figure 2.1: Drillholes and the Cutters Ridge deposit mine pit design



2.4 SAMPLE SELECTION

Following the review of drilling data, samples from 7 drillholes were identified which together adequately represented the different geological units and weathering characteristics of the major waste lithologies within the deposit area (Figure 2.2). A total of 301 samples were selected from the 7 drillholes in the form of 1 m vertical pulverised composites for screen analysis. Details of the 7 drillholes are provided in Table 2.2, whilst details of the 301 samples are provided in Table 2.3.

Table 2.2: Details of representative drillholes chosen for screen analysis

Drillhole ID	Coordinates (GDA 94, Zone 51)		Drill depth (m)	No. Samples
	Easting	Northing		
CUTC001	326,034	6,594,633	170	16
CUTC002	326,007	6,594,639	102	67
CUTC003	326,001	6,594,564	84	28
CUTC019	326,049	6,594,253	72	15
CUTCD022	326,130	6,594,620	273.65	56
CUTC050	326,038	6,594,580	102	77
CUTC051	326,028	6,594,646	42	42

Table 2.3: Summary of samples chosen for screen analysis

Lithology code	Description	Samples Selected	%	Lithology code	Description	Samples Selected	%
FV	Fine Grained Volcanic / volcaniclastic sediments	86	28.6	RTU	Transported cover	5	1.7
MGQ	Quartz Gabbro	125	41.5	RWR	Saprolite / saprock	85	28.2

2.5 LABORATORY ANALYSIS

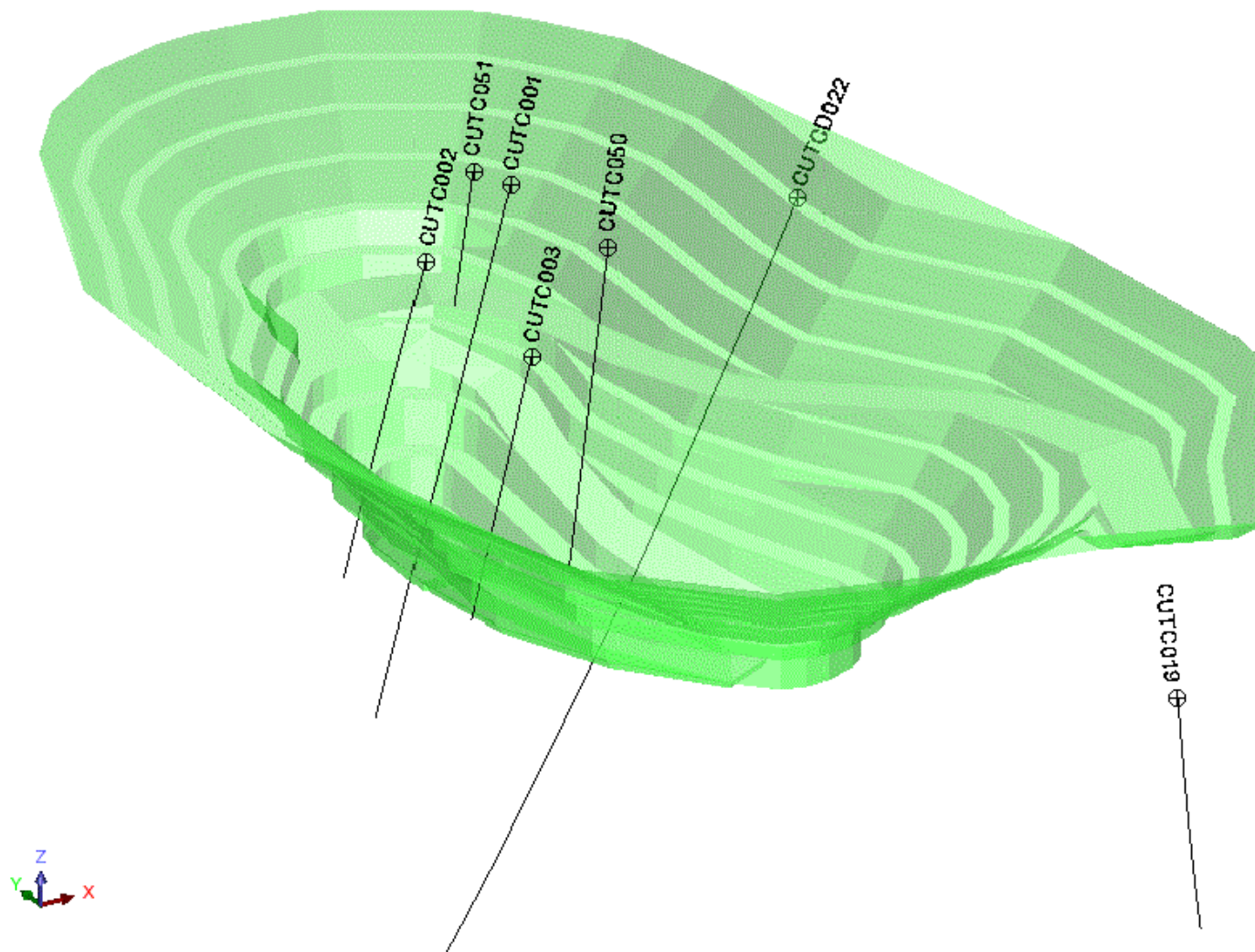
All samples selected during the review process underwent screen laboratory analysis to determine their basic chemical characteristics and provide key information on the likelihood of AMD occurrence. The following analysis was conducted:

- pH - 1:5 soil/water extraction. This parameter measures the existing acidity of the waste materials and determines if previous oxidation of sulphides has occurred and the potential buffering capacity of the materials.
- EC - 1:5 soil/water extraction. This parameter measures the level of salinity in the waste materials, which may reflect previous oxidation of sulphides.
- pH_{fox} - pH of the waste materials following the addition of 30 percent hydrogen peroxide to rapidly oxidise any sulphides present. The method followed is outlined in Stone et al. (1998).

Following the screen analysis and review of these results, 12 samples in total were chosen to undergo different selected detailed testing based on their inherent risk from the screen testing results to confirm their AMD and MD status. The detailed test work carried out on different samples was conducted at Envirolab Services and consisted of:

- Total Sulfur (S)
- Chromium Reducible-S (CRS)
- Sulfate S (SO₄)
- Static Net Acid Generation (NAG)
- Acid Neutralising Capacity (ANC)
- Total Organic and Inorganic Carbon (TOC/TIC)
- Total metals (As, Be, B, Cd, Cr VI, Co, Cu, Hg, Mn, Ni, Pb, Se, Th, U and Zn)
- Neutral and acidic static leach testing and metal mobility determination (As, Be, B, Cd, Cr VI, Co, Cu, Hg, Mn, Ni, Pb, Se and Zn)

All laboratory certificates of analysis and QA/QC data sheets are provided within Appendix A.



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CUTTERS RIDGE GEOCHEMICAL CHARACTERISATION

Figure 2.2: Representative drillholes chosen for screen analysis



3 STUDY RESULTS

3.1 SCREEN TESTING

pH & pH_{FOX}

Depth profiles showing the screen test results for samples within the 7 representative drillholes sampled are provided in Figure 3.1 and Figure 3.2. The pH of all materials tested varied from 9.7 – 4.0, with an average of 7.4 (circum-neutral). The depth profiles show that there are significant changes in the *in situ* pH of the materials with increasing depth in the deposit. The changes observed parallel the logged deep weathering which the profile has undergone. The upper few meters of the profile consists of transported alluvial material and has a neutral to slightly alkaline pH, which quickly drops to an acidic pH between 4 and 5 within the pallid clay zone which exists within the upper regolith. Below this pallid clay zone, which extends from 2-3 m depth to approximately 25 m, the pH gradually increases with profile depth as the material becomes progressively less weathered (saprolite > saprock) until a depth of approximately 30 - 50 m where fresh basement rock is met. The pH of the fresh rock material is generally alkaline to strongly alkaline (pH 8 – 10).

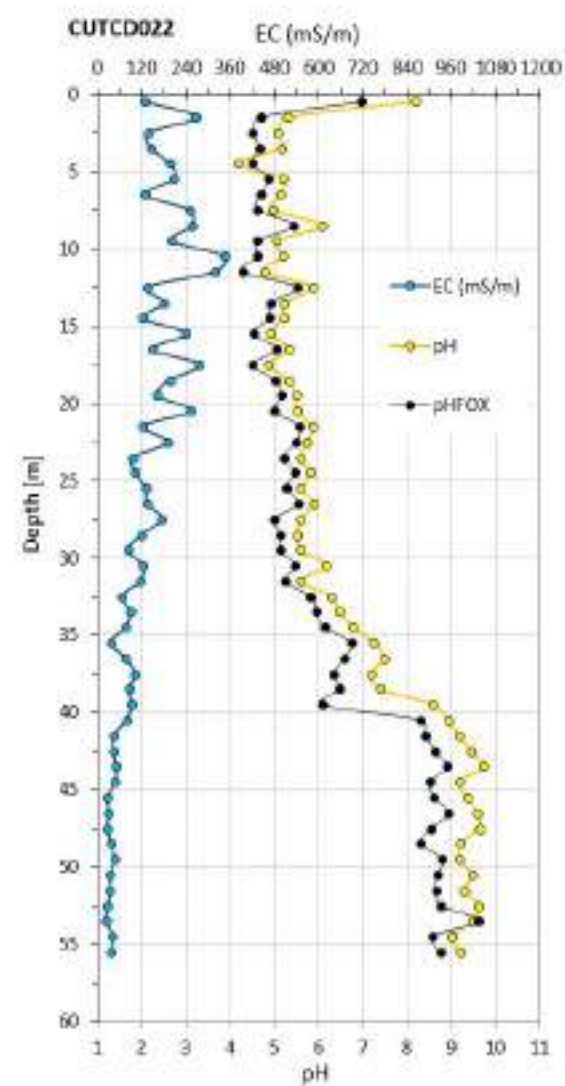
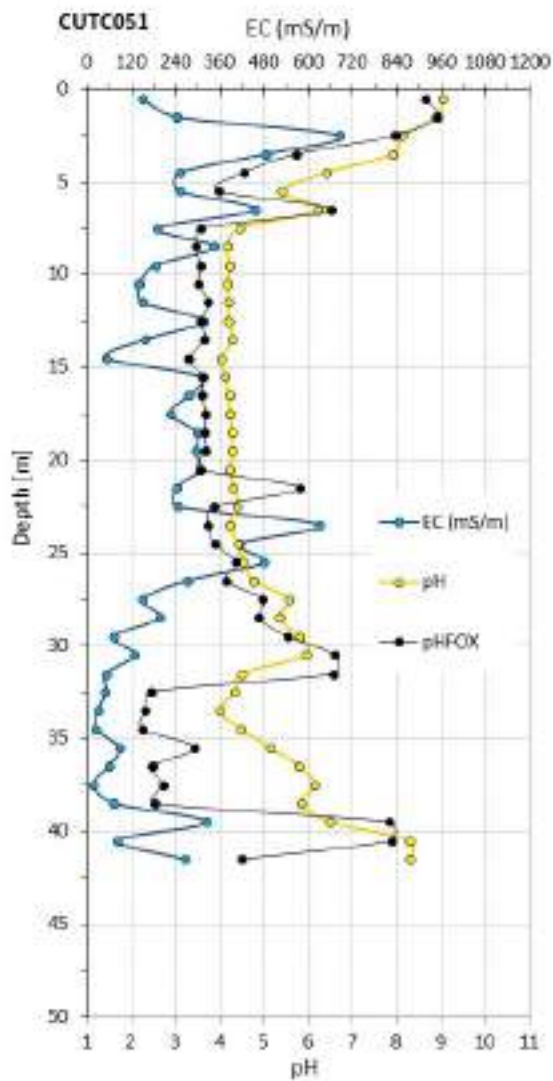
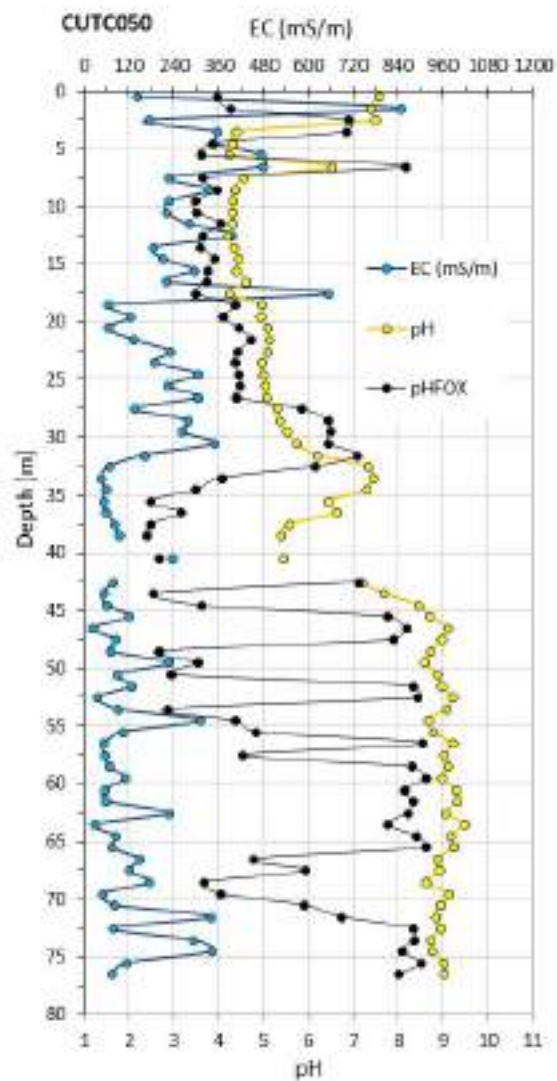
The pH_{FOX} values obtained after decomposition by peroxide of the drilling samples varied from 9.7 – 2.2. For the majority of samples (74%) the pH_{FOX} value dropped less than 1 pH unit from the original pH value, indicating little excess acid was produced after the forced oxidation. However for significant intervals within the fresh rock portion of drillholes CUTC050 and CUTC051, along with isolated samples within drillholes CUTC002 and CUTC019 drill samples reported large drops in pH following oxidation. This indicates a considerable excess production of acidity within these materials which is likely to be the result of oxidation of sulphide minerals.

The widespread testing of pH values across the deposit shows that the majority of the material is likely to be suitable as rehabilitation medium, with the exception of the pallid zone clays in the upper regolith, which display pH values which may be low enough to impact on rehabilitation species growth and germination rates should they be placed close to the surface of the WRL (i.e. top 5 m). This portion of the pit (upper 25 – 30m below the transported cover) should be placed in areas of the WRL which will not be within a 5 m vertical depth of the eventual final surface of the design.

The occurrence of low pH_{FOX} values over a moderate length of several drillholes suggests the interception of zones of sulphide mineralisation. An example of this are logging comments for CUTC050 for interval 41 – 65 'fine grained biotite and albite volcanics, sporadic clay alteration, sporadic trace pyrite' which is associated with a zone of low pH_{FOX} values.

Electrical Conductivity

The salinity measured within the representative materials tested was generally moderate, with measured values ranging from 17 to 846 mS/m and averaging 133 mS/m. These values can be considered moderately saline (median value of 80 mS/m) and therefore are not expected to pose a significant limitation to rehabilitation growth of vegetation species. Sporadic occurrences of significantly higher values above 240 mS/m are generally restricted to the upper regolith materials which will need to be segregated due to low pH in any case. The downhole profiles show a general decrease in salinity from the upper weathered zone to deeper within the regolith profile.

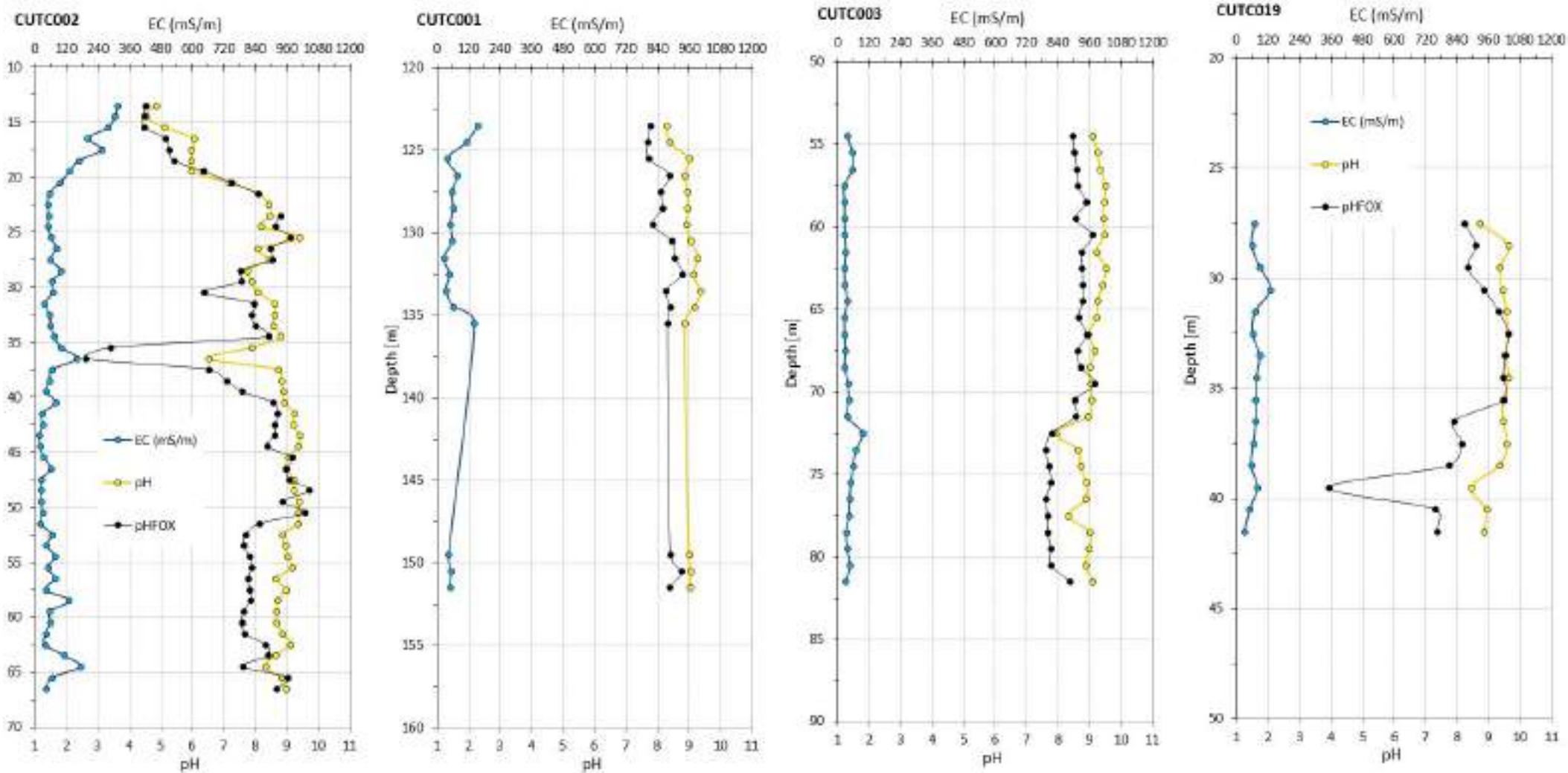


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CUTTERS RIDGE GEOCHEMICAL CHARACTERISATION

Figure 3.1: pH, pH_{fox} & EC depth profiles

soilwater
GROUP



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Figure 3.2: pH, pH_{fox} & EC depth profiles continued...



3.2 DISPERSION RISK

All of the screen samples tested were observed for the degree of dispersion displayed using the modified Emerson test (aggregate method). 15 g of each pulverised sample was placed within approximately 100 ml of DI water and physically mixed for approximately 45 minutes. Following this the samples were allowed to settle and observed for the degree of dispersion 6 hours and 24 hours after the mixing. Each sample received a qualitative score based on the degree of settling that had taken place during the time interval as below;

- Completely settled – 0
- Slight dispersion – 1
- Moderate dispersion – 2
- Complete dispersion - 3

The results of this testing are summarised below by logged lithology and depth (Table 3.1). The breakdown based on depth is provided as an approximation of the assumed degree of weathering. The results show that the finer fraction of the Fine Grained Volcanic samples remains in suspension for significantly shorter periods than the other major lithological types tested, with the average 24 hr observation of all FV samples being no to slight dispersion and the median completely settled. This may be a reflection of a smaller proportion of clay particles with the felsic material which will aid settling rates. The Quartz Gabbro samples typically displayed moderate dispersion at both the 6 and 24 hour observations, whilst the saprolite samples typically displayed quicker settling rates over this period. The overall low dispersion seen across the FV, RWR and RTU samples in comparison to the MGQ samples is likely to be a function of different mineralogy types, with the MGQ likely to have high proportions of plagioclase feldspar, a calcium rich mineral and clinopyroxene.

The breakdown of the observed settling rates into samples obtained from different depths is intended to illustrate the effect the degree of weathering may have on the sample. The results show there is little difference in the observed settling characteristics, possibly owing to the nature of the samples, which have been pulverised and stored for a period of time prior to the testing, which would act to negate possible differences caused by weathering.

Table 3.1: Modified Emerson dispersion testing results

Lithology	No. Samples	Average Emerson Score		Median Emerson Score	
		6 hr	24 hr	6 hr	24 hr
FV	86	1.3	0.2	1	0
MGQ	125	2	1.9	2	2
RWR	85	1.4	0.0	1	0
RTU	5	1.6	0.0	2	0
Depth					
0 – 30	110	1.6	0.5	2	0
30 - 60	107	1.5	0.8	1	0
60 – 90	46	1.5	1.1	1	1
>90	16	1.9	2.2	2	2.5

3.3 SULPHUR SPECIATION

The 12 representative samples selected for detailed testing based on their screen testing results were analysed for Total Sulphur (S) and Chromium reducible (S_{CR}) content. This testing provides accurate data on the different portion of the Total S content which is present within each sample in the form of sulphate minerals (gypsum, jarosite etc.) and sulphide minerals (pyrite, chalcopyrite etc). Determination of the sulphur type is important as it is only the sulphide minerals which can release considerable amounts of acidity when oxidised and are the main drivers of AMD. The results of the sulphur speciation testing on the 12 representative samples tested are presented below in Table 3.2.

The Total S percentage from testing varied from 0.04 to 3.8%, with the majority of samples reporting that greater than three quarters of the Total Sulfur content was present in the form of chromium reducible sulphur. Again the differences in the data set can largely be explained by weathering factors, such that the sample from higher in the profile (MRD061205) had oxidised sulphate whilst the sulfur content within samples from deeper in the profile were largely in the form of sulphides.

Three of the samples tested exceeded the 0.3 % Total Sulfur guideline value which has been settled on by various sources (AMIRA, 2000) as a value to guide the potential use of further investigation resources. These three samples were logged as fresh Fine Grained Volcaniclastic material (MRD061227) and fresh quartz gabbro (MRD001088 and MRD001278). Waste rock units with sulfur concentrations below this guideline value are perceived to be incapable of sustaining sulphate and acid formation through standard weathering processes (Soregaroli and Lawrence, 1997). This viewpoint generally assumes that the remainder of the minerals within the bulk rock are not purely felsic in composition (i.e. quartz / clays; Price, 2009), with the implication that the surrounding bulk rock has some entrained buffering capacity.

Table 3.2: Summary of sulphur speciation data for representative samples

Sample ID	Depth (m)	Lithology	Total Sulphur (%)	S_{CR} (%)	S_{CR} % of Total S
MRD061205	32.5	FV	0.04	0.014	35.0
MRD061070	37.5	FV	0.21	0.16	76.2
MRD061216	43.5	FV	0.18	0.13	72.2
MRD021067	48.5	FV	0.24	0.19	79.2
MRD061227	53.5	FV	0.32	0.26	81.3
MRD061237	62.5	FV	0.17	0.13	76.5
MRD061243	68.5	FV	0.18	0.14	77.8
MRD020694	37.5	MGQ	0.07	0.058	82.9
MRD001088	54.5	MGQ	0.55	0.41	74.5
MRD001393	57.5	MGQ	0.11	0.082	74.5
MRD001278	124.5	MGQ	3.80	2.8	73.7
MRD001287	131.5	MGQ	0.07	0.054	77.1

3.4 ACID NEUTRALISING CAPACITY

The contained buffering or acid neutralising capacity (ANC) of the 12 representative samples was analysed by back titration (HCl addition to sample, followed by back titration utilising NaOH to determine the amount of un-buffered acid) and determination of the inorganic carbon percentage within each sample.

The addition of HCl determines the ANC of the material, but can sometimes overestimate the normally available buffering potential as it includes neutralising effects of primary silicate minerals. These types of minerals are known to have slow rates of dissolution resulting in slow achievable kinetic reaction rates under circum-neutral conditions (White and Brantley, 1995) and can therefore be ineffective at neutralising high acid generation in some circumstances. For this reason the total inorganic carbon (TIC) is also used to calculate a Carbonate Neutralising Potential (CarbNP) which can be a more accurate measure of a materials ability to readily buffer acid generation under normal weathering conditions.

The measured ANC and TIC, along with the calculated CarbNP, of each sample is shown in Table 3.3.

Table 3.3: Measured buffering capacity of representative samples

Sample ID	Depth (m)	Lithology	ANC (kg H ₂ SO ₄ /t)	TIC (%)	CarbNP (kg H ₂ SO ₄ /t)
MRD061205	32.5	FV	12.9	<0.01	<0.8
MRD061070	37.5	FV	13.9	0.02	1.6
MRD061216	43.5	FV	16.9	0.03	2.5
MRD021067	48.5	FV	33.7	0.21	17.2
MRD061227	53.5	FV	15.8	0.02	1.6
MRD061237	62.5	FV	26.8	0.19	15.5
MRD061243	68.5	FV	10.4	0.02	1.6
MRD020694	37.5	MGQ	24.9	0.20	16.3
MRD001088	54.5	MGQ	29.3	0.22	18.0
MRD001393	57.5	MGQ	29.9	0.33	27.0
MRD001278	124.5	MGQ	42.2	0.53	43.3
MRD001287	131.5	MGQ	29.3	0.36	29.4

The results show that a majority of the sample tested reported both low total ANC and CarbNP values (< 30 kg H₂SO₄/t). Two samples reported slightly higher ANC values than this, at 34 and 42 kg H₂SO₄/t.

In two cases the reported ANC was actually slightly lower than the calculated carbonate neutralising value (MRD001278 and MRD001287). This indicates that a proportion of the TIC within these two samples is present in the form of unreactive buffering species composed of Fe (siderite) and/or Mn (rhodochrosite), which are carbonates that generally do not contribute to acid neutralisation (Price, 2009). Overall the results indicate that both major waste materials types can be expected to contain low inherent buffering capacities, with the quartz gabbro indicated as having a higher CarbNP on average than the Fine Grained Volcanics, at 27 and 6 kg H₂SO₄/t respectively.

3.5 ACID BASE ACCOUNT

An Acid Base Account (ABA) is the process of comparing the Maximum Potential Acidity (MPA) and ANC/CarbNP results for different samples and materials to determine the theoretical outcome of oxidation reactions in relation to potential acid production. The result of this comparison for the 12 representative samples is shown in Table 3.4. The MPA value has been calculated from both the measured Total S content and the chromium reducible S content and assumes that all of the reported S within each sample occurs in the form of iron pyrite (FeS₂) and oxidises according to the equation shown below. This oxidation reaction produces the maximum amount of acidity per molar weight of S of any sulphide species and therefore provides a 'worst case' scenario for predicting acid production. The net acid producing potential (NAPP) has been calculated using the measured chromium reducible sulphur content versus the CarbNP, as the CarbNP results

are considered a better representative data set of the materials buffering potential. Where values are below detection limits the calculation has assumed half the detection limit.

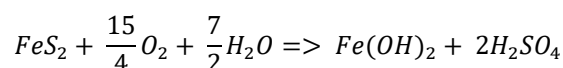


Table 3.4: Acid base account for representative samples

Sample ID	Depth (m)	Lithology	MPA (Total S)*	MPA (S _{CR})*	CarbNP*	ANC*	NAPP* S _{CR}
MRD061205	32.5	FV	1.2	0.4	<0.8	12.9	0
MRD061070	37.5	FV	6.4	4.9	1.6	13.9	3.3
MRD061216	43.5	FV	5.5	4.0	2.5	16.9	1.5
MRD021067	48.5	FV	7.3	5.8	17.2	33.7	-11.3
MRD061227	53.5	FV	9.8	8.0	1.6	15.8	6.3
MRD061237	62.5	FV	5.2	4.0	15.5	26.8	-11.5
MRD061243	68.5	FV	5.5	4.3	1.6	10.4	2.7
MRD020694	37.5	MGQ	2.1	1.8	16.3	24.9	-14.6
MRD001088	54.5	MGQ	16.8	12.5	18.0	29.3	-5.4
MRD001393	57.5	MGQ	3.4	2.5	27.0	29.9	-24.5
MRD001278	124.5	MGQ	116.3	85.7	43.3	42.2	42.4
MRD001287	131.5	MGQ	2.1	1.7	29.4	29.3	-27.8

All values provided in kg H₂SO₄/t

The ABA results underline both the low buffering capacities and the generally small concentrations of sulphide minerals within the samples set, with 5 of the 12 samples tested reporting a slightly negative Net Acid Production Potential (NAPP) value. The remaining 7 samples reported neutral to slightly positive NAPP values, reflective of negligible buffering capacity set against a small MPA. With the exception of sample MRD001278, none of the samples reported an appreciable MPA.

In normal conditions expected within the WRL the acid produced will not have perfect accessibility to the surfaces of mineral grains which can act to neutralise the acid at different scales, with acid sometimes by-passing these minerals at the whole rock scale or potentially cut off from these grains by a barrier of precipitates (e.g. iron-oxyhydroxides). To allow for these effects, scientific investigation and field experience has shown materials which display an ANC/MPA ratio greater than two have a very low potential for sustained AMD generation.

The ABA has been plotted in Figure 3.3. It can be seen that the Fine Grained Volcanic samples tested generally have a lower CarbNP/MPA ratio than the Quartz Gabbro rock samples with the exception of the one high sulfur content sample. Four of the Fine Grained Volcanic samples plot below this line and the line indicating a NAPP of 0. This shows these samples do not contain sufficient acid neutralising potential to adequately buffer themselves should oxidation cause acid generation to occur.

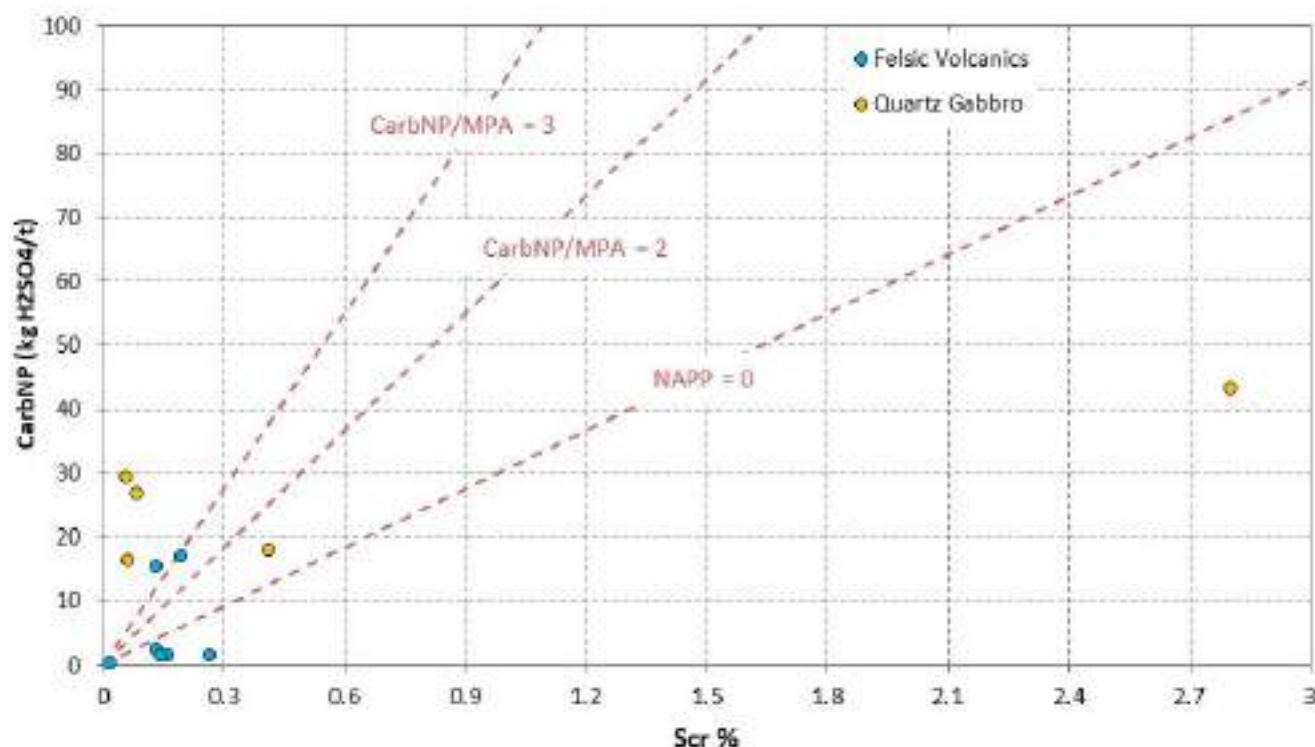


Figure 3.3: ABA plot for representative samples

3.6 GEOCHEMICAL CLASSIFICATION

The results of static NAG testing via back titration of the nine samples tested in this investigation are presented in Table 3.5. These results show the results of static net acid generation testing, with the final pH and acidity of the resultant liquor after forced oxidation and heating of the sample. An indication of the form of the acidity can be determined initially through titration of the NAG liquor to a pH of 4.5, then continuing the titration up to a pH of 7. The value below a pH of 4.5 is given by free acid (i.e. H₂SO₄/t or equivalent) along with soluble iron and aluminium, whilst the value at a pH of 7 also includes metallic ions that precipitate between pH 4.5 and 7.

Due to the uncertainties inherent in both the single addition NAG test, and the calculated ABA when applied individually, these two measurements are compared to provide a more accurate classification tool for use in managing potential AMD issues. The results from the static NAG testing are used in conjunction with the NAPP results (ABA) to allow a geochemical classification of the acid generating potential of a material. Samples are placed into one of three categories based on the following criteria:

- Non-acid forming (NAF) – Samples classified as NAF may have significant acid generating potential but contain sufficient readily available ANC to adequately buffer any acidity formed. A sample is classified as NAF when it has a negative NAPP and a final NAGpH \geq 4.5.
- Potentially-acid forming (PAF) – Samples with a PAF classification present the risk of generating acidic drainage if oxidation (i.e. exposure to atmospheric conditions) occurs. A sample is classified as PAF when it has a positive NAPP and a final NAGpH $<$ 4.5.

- Uncertain (UC) – An uncertain classification is used where there is a conflict between the NAPP and NAG test results (i.e. where the NAPP is positive and the NAGpH ≥ 4.5 or vice versa). Uncertain sample classification may require further investigation to determine the likely acid generation potential.

The geochemical classification of the 12 representative samples tested is presented in Figure 3.4 and summarised in Table 3.5. The majority of the samples plot near the vertical border line which indicates a 0 net acid production capacity. This illustrates the general lack of both acid forming and acid neutralising minerals within most of the samples tested. Five of the samples tested reported both a positive NAPP and had net acid generation pH values below 4.5. These samples are classified as PAF. Four of these samples are Fine Grained Volcanics and have the capacity to generate low volumes of acid after oxidation. The fifth of these samples is Quartz Gabbro and has the potential to generate moderate volumes of acid after oxidation. Additionally one of the samples tested had a net acid generation pH value above 4.5 but reported a neutral NAPP value. This sample is classified as uncertain and may generate small quantities of acidity after oxidation. The uncertainty is caused by lack of knowledge of the mineralogy within the samples and how the different minerals will perform kinetically during the various oxidation reactions. The remaining samples are classified as NAF and include 4 of the 5 MGQ samples tested, and 2 of the 7 FV samples tested.

Table 3.5: Results of static NAG testing

Sample ID	Depth (m)	Lithology	NAG 4.5 (kg H ₂ SO ₄ /t)	NAG 7.0 (kg H ₂ SO ₄ /t)	NAGpH	NAPP* S _{CR}	Classification
MRD061205	32.5	FV	<0.5	4.6	5.4	0	UC
MRD061070	37.5	FV	1.3	2.9	3.6	3.3	PAF
MRD061216	43.5	FV	<0.5	1.2	4.3	1.5	PAF
MRD021067	48.5	FV	<0.5	<0.5	10.6	-11.3	NAF
MRD061227	53.5	FV	1.9	3.6	3.4	6.3	PAF
MRD061237	62.5	FV	<0.5	<0.5	10.4	-11.5	NAF
MRD061243	68.5	FV	<0.5	1.8	4.3	2.7	PAF
MRD020694	37.5	MGQ	<0.5	<0.5	9.1	-14.6	NAF
MRD001088	54.5	MGQ	<0.5	<0.5	6.8	-5.4	NAF
MRD001393	57.5	MGQ	<0.5	<0.5	11.1	-24.5	NAF
MRD001278	124.5	MGQ	42	56	2.3	42.4	PAF
MRD001287	131.5	MGQ	<0.5	<0.5	11.1	-27.8	NAF

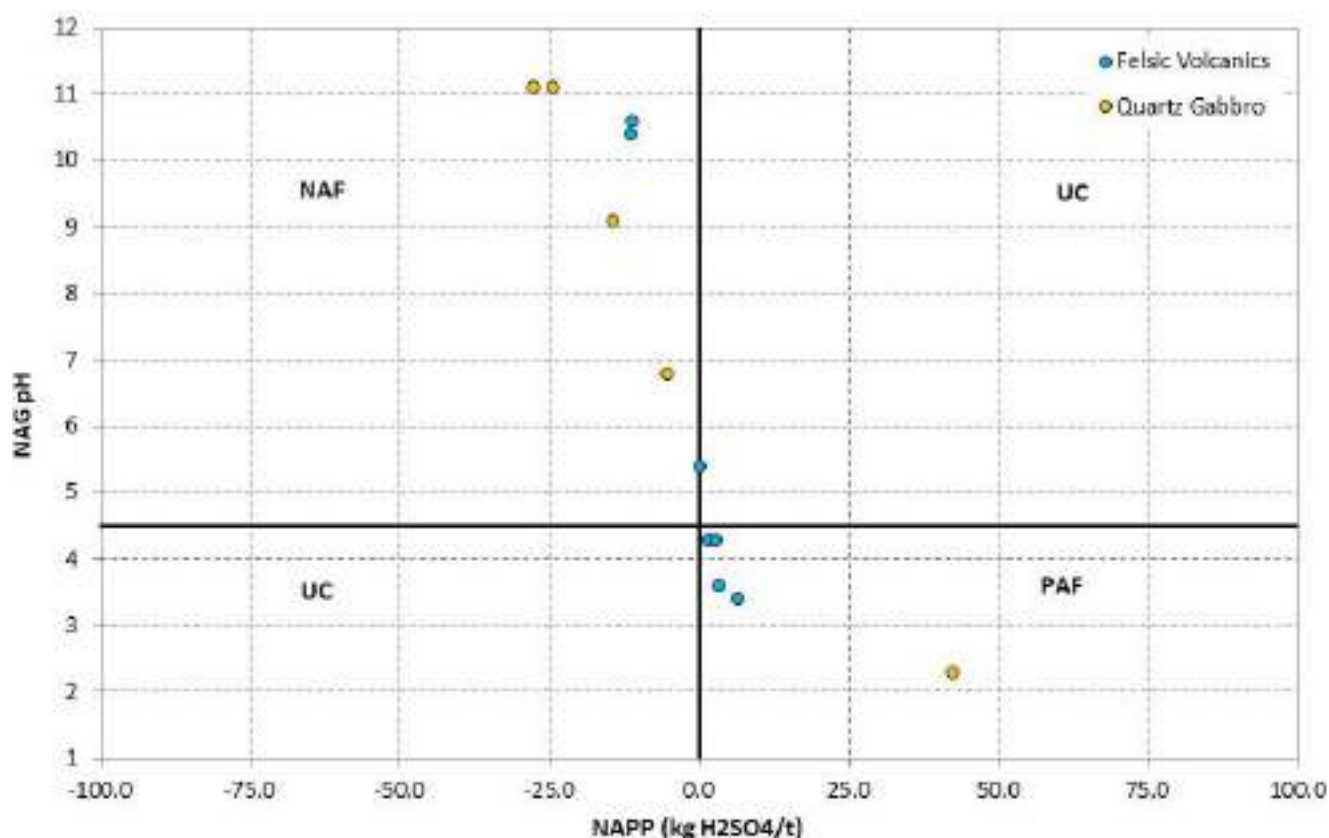


Figure 3.4: Geochemical classification of representative samples

3.7 METAL CONTENT

Element enrichment was determined using the Geochemical Abundance Index (GAI), through the equation below;

$$GAI = \log_2 \left(\frac{C}{1.5 \cdot ACA} \right),$$

with C= element content in sample (mg/kg) and ACA= average crustal abundance (Bowen, 1979). A GAI of 0 indicates that the content of the element is less than, or similar to, the average crustal abundance, a GAI of 3 corresponds to a 12-fold enrichment above the average crustal abundance, and a GAI of 6 indicates a 96-fold or greater enrichment above average crustal abundances. In general, a GAI >3 indicates significant enrichment.

Elemental compositions were compared against the Department of Environment and Conservation (DEC) Ecological Investigation Levels (EIL; DEC, 2010) to identify metals and metalloids that may, if present and mobile, pose a risk to the surrounding environment or to environmental values as a result of non-acid metaliferous drainage. The EIL used by the DEC are based primarily on the Environmental Investigation Levels listed in the Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC/NHMRC, 1992). They represent screening levels in which to provide a first-pass assessment for a site. It is important to note that these levels do not specifically apply to mineralised zones where soils may contain elevated metal and metalloid contents which exceed the EIL criteria in a naturally functioning ecosystem. Site specific information should therefore be used in conjunction with the EIL to assess

the appropriateness of these criteria values. Therefore the values of the EIL are compared to the ACA values to provide a context within which to interpret them.

The multi-element composition of a sub-set of the selected samples is provided in Table 3.7, whilst their corresponding enrichment, compared to average global crustal abundances, is provided in Table 3.8. Values which are above a GAI of 3 have been highlighted in bold. The GAI values show that none of the samples tested were considered to be significantly enriched with respect to average global concentrations.

3.8 NORM

The potential for waste rock to be designated as naturally occurring radioactive material (NORM) and managed accordingly was measured within the material through the determination of Uranium and Thorium contents within the representative samples. The determined Uranium and Thorium contents were assumed to be present in the form of U238 and Th232 in each case. The number of moles of each element present within a gram of material was determined, and then multiplied by the effective half-life and a conversion factor for each sample to determine the amount of Becquerel's per gram (Bq/g).

The calculated concentrations of radionuclides in each sample are shown in Table 3.6. The maximum acceptable concentrations that radionuclides could be diluted to and then dispersed in the ground without extra management control needing to be instituted is provided within the NORM Management Guidelines¹ and is given as 1 Bq/g of thorium and/or uranium. The total activity within the samples tested was a maximum of 1/10th of the guideline for classification of NORM.

Table 3.6: Calculated radionuclide activity within representative samples

Sample ID	Depth (m)	Lithology	Uranium (mg/kg)	Uranium 238 (Bq/g)	Thorium (mg/kg)	Thorium 232 (Bq/g)	Total Activity (Bq/g)
MRD061227	53.5	FV	4	0.050	13	0.053	0.103
MRD061237	62.5	FV	3	0.037	13	0.053	0.090
MRD061070	37.5	FV	3	0.037	14	0.057	0.094
MRD061216	43.5	FV	4	0.050	14	0.057	0.107
MRD061205	32.5	FV	2	0.025	9	0.037	0.062
MRD001278	124.5	MGQ	1	0.012	8	0.033	0.045

3.9 METAL MOBILITY

In order to investigate metal mobility under the likely conditions which may occur within the proposed waste landform after waste excavation, determination of the mobility of various elements was carried out by static extraction, using the Australian Standard Leaching Procedure (ASLP; AS4439). This bottle leach method used a mild acetic acid solution with a high solid to solution ratio (1:20) which results in a shift in equilibrium encouraging maximum desorption of the elements from the solid phase into solution. The results of the static leach testing on the six samples chosen are shown in Table 3.9.

¹ DMP, 2010. Managing naturally occurring radioactive material (NORM) in mining and mineral processing: Resources Safety Department of Mines and Petroleum, Western Australia, 21pp.

The results show the majority of metals tested were immobile under the mildly acidic leaching conditions, with As, Be, B, Cd, Cu, Hg, Pb and Se concentrations all close to or below the limit of reporting in all samples tested. Reported concentrations of the remaining metals showed low to moderate contents within the leachate.

The results of leach testing have been compared with both the domestic non-potable use water guidelines published by the Department of Health, and the long term irrigation water use guidelines published by ANZECC & ARMCANZ (2000). Whilst water which interacts with the waste landform is unlikely to see the use which is stipulated in either of these guidelines they are included for completeness. The long term irrigation water guidelines are considered indirectly relevant to the surrounding flora and fauna which may be impacted upon through runoff from the post-mine landform.

The comparison of the leaching analysis to the guidelines shows that for most of the samples and metals tested the reported results are below the respective guidelines. The exceptions to this are Mn, where all samples exceed the long term irrigation guideline and one sample exceeded the domestic potable use guideline and Co, where one sample exceeded the long term irrigation guideline.

When interpreting the results of the bottle leach tests it is important to note that the testing procedure produces an aggressive leaching environments which is unlikely to be reproduced in the field. Whilst the testing environment is likely to exceed even a worst case scenario in real terms and the testing has shown the materials can be considered low risk, the results indicate that runoff from the waste landform should be controlled to prevent the potential transport of dissolved metals and the potential for build-up of concentrations of these metals within surrounding receptors.

Table 3.7: Multi-element composition of representative samples

Depth (m)	Lithology	As	Be	B	Cd	Cr VI	Co	Cu	Pb	Mn	Hg	Ni	Se	Zn	U	Th
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
53.5	FV	3	<1	<3	0.5	<1	12	64	8	180	<0.1	30	<2	150	4	13
62.5	FV	4	<1	<3	<0.4	<1	7	16	7	330	<0.1	17	<2	59	3	13
37.5	FV	5	<1	<3	<0.4	<1	10	28	8	210	<0.1	21	<2	96	3	14
43.5	FV	<2	<1	<3	<0.4	<1	10	26	13	210	<0.1	20	<2	110	4	14
32.5	FV	<2	<1	<3	<0.4	<1	5	18	7	150	<0.1	19	<2	58	2	9
124.5	MGQ	2	<1	<3	0.6	<1	7	19	8	590	<0.1	4	<2	41	1	8
Ecological Investigation Limits*		20	-	-	3	400	50	100	600	500	1	60	-	200	-	-

*DEC, 2010

Table 3.8: Global abundance index data

Depth (m)	Lithology	As	Be	B	Cd	Cr	Co	Cu	Pb	Mn	Hg	Ni	Se	Zn	U	Th
	ACA*	1.5	1.9	10	0.11	100	20	50	14	950	0.05	80	0.05	75	2.4	12
53.5	FV	0	-	-	2	-	0	0	0	0	-	0	-	0	0	0
62.5	FV	1	-	-	-	-	0	0	0	0	-	0	-	0	0	0
37.5	FV	1	-	-	-	-	0	0	0	0	-	0	-	0	0	0
43.5	FV	-	-	-	-	-	0	0	0	0	-	0	-	0	0	0
32.5	FV	-	-	-	-	-	0	0	0	0	-	0	-	0	0	0
124.5	MGQ	0	-	-	2	-	0	0	0	0	-	0	-	0	0	0

*Bowen, 1979

Table 3.9: Results of static leach testing (mild acetic acid)

Depth (m)	Lithology	As	Be	B	Cd	Cr VI	Co	Cu	Pb	Mn	Hg	Ni	Se	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
53.5	FV	<0.05	<0.01	<0.2	<0.01	0.02	<0.01	<0.005	<0.03	0.69	<0.00005	0.04	<0.12	0.44
62.5	FV	<0.05	<0.01	<0.2	<0.01	0.01	<0.01	<0.005	<0.03	3.00	<0.00005	<0.02	<0.12	0.13
37.5	FV	<0.05	<0.01	<0.2	<0.01	0.05	0.06	<0.005	<0.03	0.69	<0.00005	0.08	<0.12	0.37
43.5	FV	<0.05	<0.01	<0.2	<0.01	0.04	0.03	<0.005	<0.03	0.81	<0.00005	0.06	<0.12	0.36
32.5	FV	<0.05	<0.01	<0.2	<0.01	0.02	0.05	<0.005	<0.03	0.49	<0.00005	<0.02	<0.12	0.20
124.5	MGQ	<0.05	<0.01	<0.2	<0.01	<0.01	<0.01	<0.005	<0.03	14.0	<0.00005	<0.02	<0.12	0.05
Domestic non-potable use*		0.07	-	40	0.02	0.5	-	20	0.1	5	0.01	0.2	0.1	30
Long term irrigation water*		0.1	0.1	0.5	0.01	-	0.05	0.2	2	0.2	0.002	0.2	0.02	2

*ANZECC & ARMCANZ (2000)

4 CONCLUSIONS

A geochemical characterisation was undertaken for the Cutters Ridge gold deposit to assess the potential for acid rock and metalliferous drainage to occur following disturbance of waste rock within the mine design, and to identify the distribution of other potential problematic waste rock materials that may impact on the success of rehabilitation. The major findings from this investigation are:

- Screen testing conducted on representative drillholes has shown the weathered regolith material (saprolitic clay) displays acidic to strongly acidic pH levels which may impact on rehabilitation growth. This material is located underneath an approximately 2 m thick cover of transported alluvium to approximately 30 m below ground level.
- The fresh rock material underlying the saprolitic clays displays an alkaline to strongly alkaline pH level.
- The entire profile displays generally moderate to low salinity, with isolated instances of higher salinity within the saprolitic clay.
- The waste materials can therefore be used without restriction to construct the WRL, with the exception of the acidic upper saprolitic clay zone, which should be placed greater than 2 m depth from the outer surface of the WRL. All materials display low salt content which should not restrict root exploration, and therefore the waste materials are likely to represent favourable growth medium materials.
- Screen testing and sulphur speciation determination has shown that the occurrences of sulphides are likely to be associated with sporadic pyrite mineralisation which has been noted principally within the fine grained volcanic and sedimentary units.
- All lithology types tested were reported to contain generally low average buffering capacities. The measured ANC was found to be largely unavailable within the fine grained volcanics; therefore the CarbNP values should be used to estimate buffering capacity.
- The results of ABA comparison and geochemical classification have shown that a majority of the fine grained volcanic samples tested can be considered to be PAF. However the volume of acid these samples are cumulatively capable of generating is small, with the average NAPP of all samples classified as PAF or UC only 2.8 kg H₂SO₄/t. When considering all of the FV samples tested, the average NAPP is negative (-1.3 kg H₂SO₄/t).
- Based on the average NAPP values and the moderate average buffering capacity displayed by the Quartz Gabbro samples, these materials should be able to be co-disposed, with no need for specific AMD management.
- Multi-element composition and leaching trials have reported generally low concentrations both within the solid materials phase and the bottle test leachate. Concentrations of Manganese and Cobalt were slightly above the guidelines for long term irrigation water use. Consequently the risk of MD following disturbance of waste materials is considered to be low.

Based on the screen testing and AMD testing conducted, the occurrence of PAF materials within the waste material is expected to be confined to isolated examples within the Fine Grained Volcanics and Sedimentary units where sporadic pyrite mineralisation has occurred. Cumulatively these materials have been calculated to have a slightly negative NAPP, which when coupled with the moderate buffering capacity displayed by the Quartz Gabbro material, should allow co-disposal.

In order to confirm this management option, a waste volume calculation should be carried out to determine the proportion of each of these lithological types present within the expected waste volume.

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APPENDIX A
LABORATORY COA & QA/QC

CERTIFICATE OF ANALYSIS 222750

Client Details

Client	Soilwater Group
Attention	Sam Collins
Address	45 Gladstone Street, EAST PERTH, WA, 6005

Sample Details

Your Reference	<u>Cutters Ridge</u>
Number of Samples	12 Waste Rock Pulp
Date samples received	22/02/2019
Date completed instructions received	26/02/2019

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/03/2019
Date of Issue	11/03/2019
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Michael Mowle, Metals/Inorganics Supervisor
 Stacey Hawkins, Acid Soils Supervisor

Authorised By



Todd Lee, Laboratory Manager

Client Reference: Cutters Ridge

Chromium Reducible Sulphur						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Chromium Reducible Sulfur	%w/w	0.26	0.13	0.16	0.13	0.014

Chromium Reducible Sulphur						
Our Reference		222750-6	222750-7	222750-8	222750-9	222750-10
Your Reference	UNITS	MRD001278	MRD001088	MRD001393	MRD001287	MRD614243
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Chromium Reducible Sulfur	%w/w	2.8	0.41	0.082	0.054	0.14

Chromium Reducible Sulphur			
Our Reference		222750-11	222750-12
Your Reference	UNITS	MRD021067	MRD020694
Type of sample		Waste Rock	Waste Rock
Chromium Reducible Sulfur	%w/w	0.19	0.058

Client Reference: Cutters Ridge

Net Acid Generation						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019	22/02/2019	22/02/2019	22/02/2019
Date Analysed		27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019
NAG pH	pH units	3.4	10.4	3.6	4.3	5.4
NAG pH 4.5	kg H2SO4/tonne	1.9	<0.5	1.3	<0.5	<0.5
NAG pH 7.0	kg/H2SO4/tonne	3.6	<0.5	2.9	1.2	4.6

Net Acid Generation						
Our Reference		222750-6	222750-7	222750-8	222750-9	222750-10
Your Reference	UNITS	MRD001278	MRD001088	MRD001393	MRD001287	MRD614243
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019	22/02/2019	22/02/2019	22/02/2019
Date Analysed		27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019
NAG pH	pH units	2.3	6.8	11.1	11.1	4.3
NAG pH 4.5	kg H2SO4/tonne	42	<0.5	<0.5	<0.5	<0.5
NAG pH 7.0	kg/H2SO4/tonne	56	<0.5	<0.5	<0.5	1.8

Net Acid Generation			
Our Reference		222750-11	222750-12
Your Reference	UNITS	MRD021067	MRD020694
Type of sample		Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019
Date Analysed		27/02/2019	27/02/2019
NAG pH	pH units	10.6	9.1
NAG pH 4.5	kg H2SO4/tonne	<0.5	<0.5
NAG pH 7.0	kg/H2SO4/tonne	<0.5	<0.5

Client Reference: Cutters Ridge

Acid Neutralisation Capacity*						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019	22/02/2019	22/02/2019	22/02/2019
Date Analysed		01/03/2019	01/03/2019	01/03/2019	01/03/2019	01/03/2019
Fizz Rating		0	2	0	0	0
ANC	kg H2SO4/tonne	15.8	26.8	13.9	16.9	12.9
ANC	% CaCO3	1.6	2.7	1.4	1.7	1.3

Acid Neutralisation Capacity*						
Our Reference		222750-6	222750-7	222750-8	222750-9	222750-10
Your Reference	UNITS	MRD001278	MRD001088	MRD001393	MRD001287	MRD614243
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019	22/02/2019	22/02/2019	22/02/2019
Date Analysed		01/03/2019	01/03/2019	01/03/2019	01/03/2019	01/03/2019
Fizz Rating		2	2	2	2	0
ANC	kg H2SO4/tonne	42.2	29.3	29.9	29.3	10.4
ANC	% CaCO3	4.3	3.0	3.0	3.0	1.1

Acid Neutralisation Capacity*			
Our Reference		222750-11	222750-12
Your Reference	UNITS	MRD021067	MRD020694
Type of sample		Waste Rock	Waste Rock
Date Prepared		22/02/2019	22/02/2019
Date Analysed		01/03/2019	01/03/2019
Fizz Rating		2	2
ANC	kg H2SO4/tonne	33.7	24.9
ANC	% CaCO3	3.4	2.5

Client Reference: Cutters Ridge

External Testing						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Total Inorganic Carbon in soil	%	0.02	0.19	0.02	0.03	<0.01
Sulphur - Total*	%	0.32	0.17	0.21	0.18	0.040

External Testing						
Our Reference		222750-6	222750-7	222750-8	222750-9	222750-10
Your Reference	UNITS	MRD001278	MRD001088	MRD001393	MRD001287	MRD614243
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Total Inorganic Carbon in soil	%	0.53	0.22	0.33	0.36	0.02
Sulphur - Total*	%	3.8	0.55	0.11	0.070	0.18

External Testing			
Our Reference		222750-11	222750-12
Your Reference	UNITS	MRD021067	MRD020694
Type of sample		Waste Rock	Waste Rock
Total Inorganic Carbon in soil	%	0.21	0.20
Sulphur - Total*	%	0.24	0.070

Client Reference: Cutters Ridge

Metals - soil						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date digested	-	28/02/2019	28/02/2019	28/02/2019	28/02/2019	28/02/2019
Date analysed	-	28/02/2019	28/02/2019	28/02/2019	28/02/2019	28/02/2019
Arsenic	mg/kg	3	4	5	<2	<2
Beryllium	mg/kg	<1	<1	<1	<1	<1
Boron	mg/kg	<3	<3	<3	<3	<3
Cadmium	mg/kg	0.5	<0.4	<0.4	<0.4	<0.4
Chromium (VI)	mg/kg	<1	<1	<1	<1	<1
Cobalt	mg/kg	12	7	10	10	5
Copper	mg/kg	64	16	28	26	18
Lead	mg/kg	8	7	8	13	7
Manganese	mg/kg	180	330	210	210	150
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	30	17	21	20	19
Selenium	mg/kg	<2	<2	<2	<2	<2
Zinc	mg/kg	150	59	96	110	58
Uranium	mg/kg	4	3	3	4	2
Thorium	mg/kg	13	13	14	14	9

Metals - soil		
Our Reference		222750-6
Your Reference	UNITS	MRD001278
Type of sample		Waste Rock
Date digested	-	28/02/2019
Date analysed	-	28/02/2019
Arsenic	mg/kg	2
Beryllium	mg/kg	<1
Boron	mg/kg	<3
Cadmium	mg/kg	0.6
Chromium (VI)	mg/kg	<1
Cobalt	mg/kg	7
Copper	mg/kg	19
Lead	mg/kg	8
Manganese	mg/kg	590
Mercury	mg/kg	<0.1
Nickel	mg/kg	4
Selenium	mg/kg	<2
Zinc	mg/kg	41
Uranium	mg/kg	1
Thorium	mg/kg	8

Client Reference: Cutters Ridge

Metals in ASLP (pH 5.0)						
Our Reference		222750-1	222750-2	222750-3	222750-4	222750-5
Your Reference	UNITS	MRD61227	MRD61237	MRD61070	MRD61216	MRD61205
Type of sample		Waste Rock	Waste Rock	Waste Rock	Waste Rock	Waste Rock
Date extracted	-	27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019
Date analysed	-	27/02/2019	27/02/2019	27/02/2019	27/02/2019	27/02/2019
pH of final Leachate	pH units	5.2	5.6	5.2	5.2	5.2
Arsenic in ASLP pH 5.0	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Beryllium in ASLP pH 5.0	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Boron in ASLP pH 5.0	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium in ASLP pH 5.0	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt in ASLP pH 5.0	mg/L	0.02	0.01	0.05	0.04	0.02
Copper in ASLP pH 5.0	mg/L	<0.01	<0.01	0.06	0.03	0.05
Chromium (VI) in ASLP pH 5.0	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Lead in ASLP pH 5.0	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03
Manganese in ASLP pH 5.0	mg/L	0.69	3.0	0.69	0.81	0.49
Mercury in ASLP pH 5.0	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel in ASLP pH 5.0	mg/L	0.04	<0.02	0.08	0.06	<0.02
Selenium in ASLP pH 5.0	mg/L	<0.12	<0.12	<0.12	<0.12	<0.12
Zinc in ASLP pH 5.0	mg/L	0.44	0.13	0.37	0.36	0.20

Metals in ASLP (pH 5.0)		
Our Reference		222750-6
Your Reference	UNITS	MRD001278
Type of sample		Waste Rock
Date extracted	-	27/02/2019
Date analysed	-	27/02/2019
pH of final Leachate	pH units	6.5
Arsenic in ASLP pH 5.0	mg/L	<0.05
Beryllium in ASLP pH 5.0	mg/L	<0.01
Boron in ASLP pH 5.0	mg/L	<0.2
Cadmium in ASLP pH 5.0	mg/L	<0.01
Cobalt in ASLP pH 5.0	mg/L	<0.01
Copper in ASLP pH 5.0	mg/L	<0.01
Chromium (VI) in ASLP pH 5.0	mg/L	<0.005
Lead in ASLP pH 5.0	mg/L	<0.03
Manganese in ASLP pH 5.0	mg/L	14
Mercury in ASLP pH 5.0	mg/L	<0.00005
Nickel in ASLP pH 5.0	mg/L	<0.02
Selenium in ASLP pH 5.0	mg/L	<0.12
Zinc in ASLP pH 5.0	mg/L	0.05

Client Reference: Cutters Ridge

Method ID	Methodology Summary
AMD-001	Acid Mine Drainage determined by AMIRA International - Acid Rock Drainage Test Handbook.
Ext-053	Analysed by Genalysis, accreditation number 3244
INORG-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
INORG-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
INORG-118	Hexavalent Chromium by Ion Chromatographic separation and colourimetric determination.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS. For urine samples total Mercury is determined, however, mercury in urine is almost entirely in the inorganic form (CDC).
METALS-022	Determination of various metals by ICP-MS.

Client Reference: Cutters Ridge

QUALITY CONTROL: Chromium Reducible Sulphur						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Chromium Reducible Sulfur	%w/w	0.005	INORG-068	[NT]	1	0.26	0.26	0	101	[NT]

QUALITY CONTROL: Chromium Reducible Sulphur						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Chromium Reducible Sulfur	%w/w	0.005	INORG-068	[NT]	11	0.19	0.19	0	[NT]	[NT]

Client Reference: Cutters Ridge

QUALITY CONTROL: Net Acid Generation					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				22/02/2019	1	22/02/2019	22/02/2019		22/02/2019	[NT]
Date Analysed				05/03/2019	1	27/02/2019	27/02/2019		05/03/2019	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	1	3.4	3.4	0	97	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	1.9	1.8	5	90	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	1	3.6	3.6	0	102	[NT]

QUALITY CONTROL: Net Acid Generation					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date Prepared				[NT]	11	22/02/2019	22/02/2019		[NT]	[NT]
Date Analysed				[NT]	11	27/02/2019	27/02/2019		[NT]	[NT]
NAG pH	pH units	0.1	AMD-001	[NT]	11	10.6	10.6	0	[NT]	[NT]
NAG pH 4.5	kg H2SO4/tonne	0.5	AMD-001	[NT]	11	<0.5	<0.5	0	[NT]	[NT]
NAG pH 7.0	kg/H2SO4/tonne	0.5	AMD-001	[NT]	11	<0.5	<0.5	0	[NT]	[NT]

Client Reference: Cutters Ridge

QUALITY CONTROL: Acid Neutralisation Capacity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date Prepared				22/02/2019	1	22/02/2019	22/02/2019		22/02/2019	[NT]
Date Analysed				01/03/2019	1	01/03/2019	01/03/2019		01/03/2019	[NT]
Fizz Rating			AMD-001	[NT]	1	0	0		[NT]	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	1	15.8	16.0	1	94	[NT]
ANC	% CaCO3	0.01	AMD-001	[NT]	1	1.6	1.6	0	94	[NT]

QUALITY CONTROL: Acid Neutralisation Capacity*					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date Prepared				[NT]	11	22/02/2019	22/02/2019		[NT]	[NT]
Date Analysed				[NT]	11	01/03/2019	01/03/2019		[NT]	[NT]
Fizz Rating			AMD-001	[NT]	11	2	2	0	[NT]	[NT]
ANC	kg H2SO4/tonne	0.5	AMD-001	[NT]	11	33.7	32.4	4	[NT]	[NT]
ANC	% CaCO3	0.01	AMD-001	[NT]	11	3.4	3.3	3	[NT]	[NT]

Client Reference: Cutters Ridge

QUALITY CONTROL: External Testing						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	222750-2
Total Inorganic Carbon in soil	%	0.01	Ext-053	<0.03	1	0.02	NT		[NT]	[NT]
Sulphur - Total*	%	0.01	Ext-053	<0.01	1	0.32	NT		104	[NT]

QUALITY CONTROL: External Testing						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Total Inorganic Carbon in soil	%	0.01	Ext-053	[NT]	11	0.21	0.23	9	[NT]	[NT]
Sulphur - Total*	%	0.01	Ext-053	[NT]	11	0.24	0.24	0	[NT]	[NT]

Client Reference: Cutters Ridge

QUALITY CONTROL: Metals - soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	222750-2
Date digested	-			28/02/2019	1	28/02/2019	28/02/2019		28/02/2019	28/02/2019
Date analysed	-			28/02/2019	1	28/02/2019	28/02/2019		28/02/2019	28/02/2019
Arsenic	mg/kg	2	METALS-020	<2	1	3	3	0	95	102
Beryllium	mg/kg	1	METALS-020	<1	1	<1	<1	0	99	97
Boron	mg/kg	3	METALS-020	<3	1	<3	<3	0	105	109
Cadmium	mg/kg	0.4	METALS-020	<0.4	1	0.5	0.4	22	98	93
Chromium (VI)	mg/kg	1	INORG-118	<1	1	<1	<1	0	98	#
Cobalt	mg/kg	1	METALS-020	<1	1	12	11	9	101	98
Copper	mg/kg	1	METALS-020	<1	1	64	60	6	103	115
Lead	mg/kg	1	METALS-020	<1	1	8	7	13	101	98
Manganese	mg/kg	1	METALS-020	<1	1	180	170	6	102	[NT]
Mercury	mg/kg	0.1	METALS-021	<0.1	1	<0.1	<0.1	0	88	110
Nickel	mg/kg	1	METALS-020	<1	1	30	29	3	100	96
Selenium	mg/kg	2	METALS-020	<2	1	<2	<2	0	97	104
Zinc	mg/kg	1	METALS-020	<1	1	150	140	7	105	98
Uranium	mg/kg	1	METALS-022	<1	1	4	3	29	89	[NT]
Thorium	mg/kg	1	METALS-022	<1	1	13	13	0	79	[NT]

Client Reference: Cutters Ridge

QUALITY CONTROL: Metals in ASLP (pH 5.0)						Duplicate		Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	222750-2
Date extracted	-			27/02/2019	1	27/02/2019	27/02/2019		27/02/2019	27/02/2019
Date analysed	-			27/02/2019	1	27/02/2019	27/02/2019		27/02/2019	27/02/2019
Arsenic in ASLP pH 5.0	mg/L	0.05	METALS-020	<0.05	1	<0.05	<0.05	0	95	[NT]
Beryllium in ASLP pH 5.0	mg/L	0.01	METALS-020	<0.01	1	<0.01	<0.01	0	96	[NT]
Boron in ASLP pH 5.0	mg/L	0.2	METALS-020	<0.2	1	<0.2	<0.2	0	97	[NT]
Cadmium in ASLP pH 5.0	mg/L	0.01	METALS-020	<0.01	1	<0.01	<0.01	0	91	[NT]
Cobalt in ASLP pH 5.0	mg/L	0.01	METALS-020	<0.01	1	0.02	0.02	0	91	[NT]
Copper in ASLP pH 5.0	mg/L	0.01	METALS-020	<0.01	1	<0.01	<0.01	0	103	[NT]
Chromium (VI) in ASLP pH 5.0	mg/L	0.005	INORG-118	<0.005	1	<0.005	<0.005	0	94	93
Lead in ASLP pH 5.0	mg/L	0.03	METALS-020	<0.03	1	<0.03	<0.03	0	94	[NT]
Manganese in ASLP pH 5.0	mg/L	0.01	METALS-020	<0.01	1	0.69	0.68	1	94	[NT]
Mercury in ASLP pH 5.0	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	<0.00005	0	110	[NT]
Nickel in ASLP pH 5.0	mg/L	0.02	METALS-020	<0.02	1	0.04	0.04	0	93	[NT]
Selenium in ASLP pH 5.0	mg/L	0.12	METALS-020	<0.12	1	<0.12	<0.12	0	100	[NT]
Zinc in ASLP pH 5.0	mg/L	0.02	METALS-020	<0.02	1	0.44	0.44	0	97	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available).	

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) a

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Percent recovery not available due to matrix interference or sample inhomogeneity.
An acceptable recovery was achieved for the LCS.

Total Sulfur and TIC analysis performed by Intertek Genalysis, report number 438.0/1902616.

Appendix C:

Cutters Ridge Groundwater Analysis



Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EP1902602	Page	: 1 of 4
Client	: Evolution Mining Mungari	Laboratory	: Environmental Division Perth
Contact	: Abbey Majimbi	Contact	: Customer Services EP
Address	: Kundana Road Kalgoorlie 6433	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: ----	Telephone	: +61-8-9406 1301
Project	: Cutters_Ridge_GW	Date Samples Received	: 21-Mar-2019 09:20
Order number	: 182182	Date Analysis Commenced	: 21-Mar-2019
C-O-C number	: ----	Issue Date	: 28-Mar-2019 16:50
Sampler	: Eren Reid		
Site	: Mungari Gold Operation		
Quote number	: EP/402/18 V4		
No. of samples received	: 3		
No. of samples analysed	: 3		



This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Arenie Vijayaratham	Non-metals prep supervisor	Melbourne Inorganics, Springvale, VIC
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Indra Astuty	Instrument Chemist	Perth Inorganics, Wangara, WA



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- EK026SF and EK028SF conducted by ALS Melbourne, NATA accreditation no. 825, site no 13778
- EG020F : LOR has been raised for various elements due to possible matrix interference.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LVT_MB01 Cutters Ridge	RB_MB01 Cutters Ridge	RJ_MB01 Cutters Ridge	----	----
Client sampling date / time				19-Mar-2019 12:14	19-Mar-2019 11:08	19-Mar-2019 07:35	----	----	
Compound	CAS Number	LOR	Unit	EP1902602-001	EP1902602-002	EP1902602-003	-----	-----	
				Result	Result	Result	----	----	
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit	4.80	5.50	7.10	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	70100	62400	105000	----	----	
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L	53700	46900	89800	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	22	249	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	<1	22	249	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	5160	4310	7740	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	25200	22400	40800	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	853	746	908	----	----	
Magnesium	7439-95-4	1	mg/L	2480	2000	5410	----	----	
Sodium	7440-23-5	1	mg/L	14400	12900	22000	----	----	
Potassium	7440-09-7	1	mg/L	118	73	319	----	----	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	1.08	1.39	<0.50	----	----	
Arsenic	7440-38-2	0.001	mg/L	<0.050	<0.050	<0.050	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0050	0.0427	<0.0050	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.050	<0.050	<0.050	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.510	0.244	0.077	----	----	
Copper	7440-50-8	0.001	mg/L	<0.050	0.165	<0.050	----	----	
Lead	7439-92-1	0.001	mg/L	<0.050	<0.050	<0.050	----	----	
Manganese	7439-96-5	0.001	mg/L	25.1	2.77	10.5	----	----	
Nickel	7440-02-0	0.001	mg/L	0.278	0.440	0.102	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.50	<0.50	<0.50	----	----	
Zinc	7440-66-6	0.005	mg/L	2.50	0.375	0.490	----	----	
Iron	7439-89-6	0.05	mg/L	<2.50	<2.50	<2.50	----	----	
EK026SF: Total CN by Segmented Flow Analyser									



Analytical Results

Sub-Matrix: **WATER**
 (Matrix: **WATER**)

Client sample ID

				LVT_MB01 Cutters Ridge	RB_MB01 Cutters Ridge	RJ_MB01 Cutters Ridge	----	----
Client sampling date / time				19-Mar-2019 12:14	19-Mar-2019 11:08	19-Mar-2019 07:35	----	----
Compound	CAS Number	LOR	Unit	EP1902602-001	EP1902602-002	EP1902602-003	-----	-----
				Result	Result	Result	----	----
EK026SF: Total CN by Segmented Flow Analyser - Continued								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser								
Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	818	722	1320	----	----
Total Cations	----	0.01	meq/L	876	765	1460	----	----
Ionic Balance	----	0.01	%	3.41	2.88	5.00	----	----

Appendix D:

AQ2 Hydrogeological Investigations



Technical Memo

To	Matt Varvari	Company	Evolution – Mungari Operations
cc	Marcelle Watson, Kara Postle		
From	Jon Hall and Liam Coffey	Job No.	202-C1
Date	20/03/2019	Doc No.	008a
Subject	Hydro-Investigations - Cutter's Ridge, Rayjax and Ridgeback Deposits		

Matt/Marcelle/Kara,

We have now completed our assessment of likely pit inflows to the proposed Cutter's Ridge, Rayjax and Ridgeback pits based on the results of the recent hydro drilling/testing programme, and we are pleased to present the following report.

This report presents details on the drilling, bore construction and testing, a confirmation of the conceptual hydrogeological model, predicted groundwater inflows (and total inflows) to each pit and the recommended dewatering strategy.

1. SUMMARY OF KEY FINDINGS

Key conclusions and recommendations from the hydro-investigations are as follows:

- While there are local aquifers at each deposit (associated with the transition zone and fractured basement), the indicated bulk permeability is very low and predicted base case groundwater inflows are consequently low (less than 5L/s at each pit).
- However, aquifer conditions in such hydrogeological environments can be highly variable. Uncertainty assessment indicates that groundwater inflows could be around 10 to 13L/s (at Cutter's Ridge and Ridgeback) and around 4L/s (Rayjax) if bulk permeability is one order of magnitude higher than adopted. These are still only low to moderate inflow rates.
- Total inflows will be dominated by rainfall runoff (during wet months and storms). Rough estimates of runoff for a 1 in 10-year storm are some five to ten times higher than the high uncertainty case predicted groundwater inflows.
- Pit dewatering will most practically be achieved by pit sump pumping, with sumps/pumps primarily sized to accommodate storm runoff. More rigorous hydrological assessment is required to confirm likely/possible rainfall runoff to the pits and to confirm the optimum design pumping rates.

2. BACKGROUND

Evolution Mining Ltd (Mungari Operations) are currently planning for the development of the Cutter's Ridge, Rayjax and Ridgeback deposits to maintain mill feed to the Mungari process plant (located at White Foil). Figure 1 shows a regional location plan. AQ2 were commissioned by Evolution to assess hydrogeological conditions at each site and to undertake limited investigations to confirm these conditions and then predict groundwater inflows to each pit. It is noted that no previous investigations had been completed at any of the three deposits.

A preliminary desk-top assessment was completed in December 2018 (AQ2, 2018)¹, and a conceptual hydrogeological model was developed, based on review of the local geology/hydrogeology and drilling results (DDH core photos and some reported RC drilling water intersections), our experience with pit dewatering in the region. Key features of the conceptual hydrogeological models were as follows:

- Minor aquifers associated with the transition from weathered to fresh rock and particularly over the ore zones and hanging wall contacts.
- Possible minor aquifers in “fresh rock” associated with:
 - the hanging wall contacts of the ore host units at Cutter’s Ridge and Ridgeback,
 - fractured rocks associated with some of the shallow dipping ore lode structures at Rayjax,
 - within zones of quartz dissolution within the ore hosts at all deposits.
- Overall, low to moderate bulk permeability at all deposits.
- Minor to moderate groundwater inflows.

An investigation drilling/testing and monitor bore programme was recommended to confirm the conceptual hydrogeological model, provide quantitative data on groundwater levels and bulk aquifer permeability and install monitor bores for ongoing operational and environmental monitoring. The programme results were then to be used to establish simple groundwater flow models to predict the likely ranges of groundwater inflows to each pit to help determine overall pit dewatering requirements.

This report presents the results of this follow-up investigation.

3. DRILLING AND BORE INSTALLATION

3.1 Overview

The drilling and testing programme at each deposit comprised the following:

- Monitoring bores outside the pit but targeted on the expected main aquifer (extension of the ore host structure and deep weathering above these) to provide groundwater levels, aquifer conditions in ex-pit aquifers and long-term monitoring.
- Test bores within each pit located on the expected main aquifer zones (ore zones and hanging wall contacts and deep weathering above these) to provide aquifer conditions in in-pit aquifers.
- Hydraulic testing during drilling (airlift flow and recovery tests – where possible) and following completing of the monitoring bores (falling head and airlift recovery tests).

Bore locations were determined from Leapfrog geological models developed as part of the preliminary assessments. These are shown on Figures 2 to 4.

Drilling, bore construction and testing was undertaken by Topdrill Pty Ltd (under direct contract to Evolution) under the direction of an AQ2 hydrogeologist. Lithological descriptions were confirmed by Evolution geologists, to ensure consistency with the drilling database.

3.2 Drilling

The bores were drilled using conventional RC drilling techniques. The top 6m of each hole was reamed (to 178mm diameter) and 150mm ND PVC collar casing installed and sealed in place with an A&B Foam compound. The holes were then drilled to total depth using a 151mm diameter percussion hammer assembly.

¹ AQ2 Pty Ltd, 2018: *Mungari Satellite Pits – Proposed Hydro Investigation Programme*. Memo report to Evolution, 14 Dcember 2018.

When water returns were observed (usually at rod change), the hole was airlifted at the end of the next rod and the airlift flow measured. In most cases, flows were very minor (<0.1Ls) and dried up quickly. The holes were again airlifted at total depth and as the rods were being pulled at the end of hole.

Graphical bore logs for all boreholes are presented in Appendix A, with key bore details also listed in Table A1. Key observations during the drilling were as follows:

3.2.1 Cutter's Ridge

- **Borehole CUT MB01:**

- Drilled to 60m and intersected highly weathered (saprolitic) hanging wall volcanics overlying variably weathered volcanics and then quartz gabbro (or host unit) at 44m. The base of the transition zone was at 40m depth.
- The hole made very little water during drilling and collapsed at the completing of drilling, preventing any end of hole airlifting.

- **Borehole CUT TB01:**

- Drilled to 80m depth and intersected variably weathered volcanics to 34m depth and then fresh quartz gabbro.
- The hole made water returns from 51m and initial airlift yields of around 0.2 to 0.3L/s were measured at the end of each rod. These dried up within 10 to 15 minutes.

- **Borehole CUT TB02:**

- Drilled to 80m depth and intersected variably weathered volcanics to 47m depth and then alternating fresh quartz gabbro and volcanics, suggesting the hole was drilled along a vertical contact zone.
- The hole made minor amounts of water during drilling at 65m depth but these flows dried up at 72m.

3.2.2 Rayjax

- **Borehole RJ MB01:**

- Drilled to 60m depth and intersected quartz gabbro beneath a thin (11m) veneer of transported material and saprolite. The base of the transition zone was at 34m depth.
- The hole made little to no water during drilling.

- **Borehole RJ TB01:**

- Drilled to 80m depth and intersected variably weathered dolerite, gabbro and porphyry. The hole did not intersect fresh rock.
- The hole made little to no water during drilling.

- **Borehole RJ TB02:**

- Drilled to 80m depth and intersected variably weathered gabbro and ultra-mafics to 64m, then fresh ultra-mafics.
- The hole made little to no water during drilling.

3.2.3 Ridgeback

- **Borehole RB MB01:**

- Drilled to 60m depth and intersected variably weathered porphyry and ultra-mafics to 50m, then fresh ultra-mafics and minor porphyry.
- The hole made little to no water during drilling.

- **Borehole RB TB01:**

- Drilled to 60m depth and intersected variably weathered ultra-mafics to 40m depth, basalt to 61m and then alternating basalt and porphyry. The base of the transition zone was at 56m depth.
- Airlift yields during drilling increased from around 0.1L/s in the basalt to around 2L/s in the alternating basalt and porphyry. However, the flow declined back to around 0.2L/s when the rods were pulled back at the end of the rod. Airlift yields of around 0/6L/s were recorded at the base of the hole, but flows ceased once the rods were pulled back to above 48m depth.

- **Borehole RB TB02:**

- Drilled to 80m depth and intersected weathered ultra-mafics to 28m, basalt to 39m and then porphyry. The base of the transition zone was at 46m.
- The hole made very little water during drilling. It airlifted 0.4L/s at the end of the hole but this dried up after 12 minutes.

3.3 Monitor Bore Construction

The monitor bore design included lining the holes with thread coupled 50mm ID PVC casing, slotted against interpreted aquifer horizons, with the annulus gravel packed to above the casing slots, a bentonite seal above the gravel pack and backfill to the surface. The bores were completed with 150mm steel protective collars (with lockable lids) and a concrete plinth around the base of the steel collar.

The bores were developed during airlift recovery testing (refer Section 4).

However, there were some issues during bore construction and two of the bores could not be completed as per the design. Key features of the bore completion are listed below:

Monitoring Bore CUT MB01:

- The hole collapsed at the end of drilling and continued to collapse after several attempts to clear the hole.
- The RC rod inners were removed and the "open rods" drilled to total depth. The 50mm PVC bore casing was installed inside the RC rods and then the RC rods pulled back over the PVC.
- The hole collapsed around the 50mm PVC and bridged at around 15m (interpreted from tagging the gravel at 17m depth after three buckets of gravel were poured into the annulus).
- The annulus was grouted with bentonite slurry (mixed on site) to 3m below surface.
- The bore was developed (during airlift recovery testing) for two hours at just less than 0.1L/s.

Monitoring Bore RJ MB01:

- The 50mm PVC casing and gravel pack were installed to target depths/intervals.
- A 2m bentonite grout seal was placed (using bentonite pellets) and the annulus then backfilled to surface with surface soils.
- The bore was developed (during airlift recovery testing) for two hours at less than 0.1L/s.

Monitoring Bore RB MB01:

- The hole initially collapsed at the end of drilling.
- The RC rod inners were removed and the "open rods" drilled to total depth. The 50mm PVC bore casing was installed to target depth inside the RC rods and then the RC rods pulled back over the PVC.
- The hole collapsed around the casing to a depth of around 15m (confirmed by tagging the top of gravel pack after two buckets of gravel had been poured into the annulus).

- A 2m bentonite grout seal was placed (using bentonite pellets) and the annulus then backfilled to surface with gravel pack material.
- The bore was developed (during airlift recovery testing) for two hours at 0.2L/s.

4. HYDRAULIC TESTING

4.1 Testing Methodology

Each monitoring bore was subjected to falling head tests after the completing of drilling and then airlift recovery testing at the completion of the programme.

The falling head tests were completed by the site hydrogeologist and comprised the following:

- The bore water level was recorded prior to testing.
- The bore casing was filled with water for 10 minutes and the maximum rise in bore water level recorded.
- Falling heads (recovering bore water levels) were measured for around two hours.
- The data were plotted as the ratio of transient excess head to initial excess head vs time (on log-linear scales) and the resulting graphical plots analysed using standard graphical analysis techniques to derive estimates of bulk aquifer permeability.

The airlift recovery tests made use of a portable 100psi/150cfm compressor and 25mm diameter airline operated by Topdrill under the direction of the site hydrogeologist, and comprised the following:

- The bore water level was recorded prior to testing.
- The airline was run to 3m off the base of the 50mm PVC casing and the bore airlift pumped for two hours, with airlift flow rates measured at regular intervals.
- Following cessation of pumping, the airline was removed and rising (recovering) bore water levels measured for two hours.
- The test data were plotted as residual drawdown vs the ratio of time since pumping started to the time since pumping stopped (on linear-log scales) and analysed using standard graphical analysis techniques (Theis Recovery Method) to derive estimates of bulk aquifer permeability.

4.2 Test Results

Graphical plots of hydraulic test data are presented in Appendix B with a summary of key details and hydraulic analysis results listed in Table B1. Analysis results are also summarised in Table 1 below:

Table 1: Summary of Derived Bulk Permeabilities

Bore	Derived Bulk Permeability (m/d)	
	Falling Head Test	Airlift Recovery Test
CUT MB01	0.002 to 0.003	0.003
RJ MB01	0.002 to 0.004	0.001 to 0.002
RB MB01	0.003 to 0.005	0.03

Key observations and outcomes from the testing and data analysis are as follows:

- Early data in the falling head tests on CUT MB01 and RB MB01 showed the influence of flow into the unsaturated zone above the water table but below the bentonite seal in each bore. These early data were not analysed.

- The derived permeabilities from both test types at bores CUT MB01 and RJ MB01 are consistent (in fact, very close).
- The derived permeability from the airlift recovery test at bore RB MB01 is one order of magnitude higher than that derived from the falling head test. The reason for this is not clear but could be one (or both) of the following:
 - The bore may have been in poor hydraulic connection with the aquifer in the falling head test – resulting in an underestimate of permeability.
 - The bore recovered very quickly during the airlift recovery test and early time data (which could not be recorded) may have indicated a lower permeability.

The implications of the range of results at Ridgeback (and other deposits) will be addressed in uncertainty inflow predictions (refer Section 5).

4.3 Confirmation of conceptual hydrogeological models

The results of the drilling and testing programme are largely consistent with the conceptual hydrogeological model developed during the preliminary assessment (AQ2, 2018) and as summarised in Section 1. In fact, if anything, the results suggest that the aquifers are even less permeable (and pit inflows may be even lower) than previously anticipated.

The confirmed conceptual hydrogeological model and implications for pit inflows (and dewatering) are as follows:

- There are minor unconfined to semi-confined aquifer zone associated with the transition zone between weathered and fresh basement rocks, particularly where the transition zone has eroded down into variably fractured basement rock. This aquifer made little to no water during drilling, but this is more likely to be a function of the drilling method, the low permeability and the limited submergence during drilling/airlifting.
- There are minor confined aquifer zones associated with fracture permeability at the contacts with the ore-host units and possibly also within zones of quartz dissolution within the ore host units.
- Permeability is likely to be higher and more variable within the pit shells than in the country rocks. This higher in-pit permeability will influence short-term dewatering (i.e. groundwater storage depletion within the pit shell) but storage will be limited.
- Longer term pit inflows will be controlled by the bulk ex-pit permeability.

5. PREDICTED GROUNDWATER INFLOWS TO THE PITS

5.1 Approach

An analytical modelling approach was adopted to simulate groundwater inflows and provide estimates of pit dewatering requirements. The approach predicts groundwater inflow to the pit from aquifers surrounding the pit over set time periods. As the specific yield (drainable porosity) of the material to be mined from within the pit shell pit will be very low, the contributions to total inflows/dewatering from storage in the mined ore/waste have not been included.

The model is a simple analytical groundwater flow model based on the Dupuit-Forcheimer and Theim Equations for groundwater flow to a large diameter well. Key steps in the model are as follows:

- The pit, or various sections of the pit, are represented by a series of large diameter “equivalent wells” of similar area and depth at various time steps, representing various stages of pit development
- Average aquifer parameters are applied to each equivalent well (representing stages of the pit)

- The model is used to calculate the pumping rate required to maintain pumping water levels in each equivalent well at or below the base of each equivalent well (pit base) at the end of each time step

The analytical model used is a lumped parameter model (the model uses average values for all aquifer parameters) and makes a number of simplifying assumptions. As such, it cannot be considered as an exact model. However, the model does provide for good approximations of pit dewatering requirements based on limited data.

At other nearby mines in the Eastern Goldfields, this modelling approach has provided predicted dewatering rates comparable with those derived from more complex (and more time consuming) numerical modelling.

5.2 Model Set-up

The life of each pit is very short (from 4 months to one year) and the model was run to simulate groundwater inflows to the final pit at the end of mining. In practice, groundwater inflows will start once the pits has progressed to below the water table and then gradually increase as the pit develops towards the final pit depth.

Model inputs were derived as follows:

- The equivalent wells (representing the final pits) and simulation times were derived from current mine plans.
- Bulk aquifer permeability was derived from the results of aquifer testing. Base case predictions adopted the following bulk permeabilities:
 - Cutter's Ridge: 0.005m/d (rounded up to nearest half order of magnitude)
 - Rayjax: 0.005m/d (rounded up to nearest half order of magnitude)
 - Ridgeback: 0.01m/d (mean rounded to nearest order of magnitude)
- A uniform specific yield of 0.5% (typical value for Goldfields type fractured rock aquifers) was adopted.

5.3 Predicted Inflows – Base Case

Predicted inflows for adopted base case conditions are listed in Table 2 below:

Table 2: Predicted Groundwater Inflows – Base Case

Pit	Adopted Bulk Permeability (m/d)	Simulated Final Pit		Predicted Groundwater Inflow (L/s)
		Time Period (months)	Pit Base (mBGL)	
Cutter's Ridge	0.005	12	250	2
Rayjax	0.005	4	310	1
Ridgeback	0.01	12	300	4

Predicted inflows are very low, which is consistent with the drilling and hydraulic testing results.

5.4 Prediction Uncertainty

There is always some inherent uncertainty in any model prediction, particularly in fractured rock aquifers. In particular, there is some uncertainty about the bulk ex-pit permeability at Ridgeback. To provide some possible ranges of groundwater inflows for mine planning and dewatering system design purposes, some predictions have been completed to assess the implications of possible ranges

bulk aquifer permeability. The results are listed in Table 3 below (which includes base case results for easy comparison).

Table 3: Predicted Groundwater Inflows – Uncertainty Runs

Pit	Base Case		Uncertainty Case (High)		Uncertainty Case (Low)	
	Adopted K (m/d)	Predicted Inflow (L/s)	Adopted K (m/d)	Predicted Inflow (L/s)	Adopted K (m/d)	Predicted Inflow (L/s)
Cutter's Ridge	0.005	2	0.05	10	0.001	1
Rayjax	0.005	1	0.05	4	0.001	<1
Ridgeback	0.01	4	0.05	13	0.001	2

The high case results are still only moderate, with predicted high case inflows ranging from 4L/s at the small/shallow Rayjax pit to 10 to 13L/s at the larger Cutter's Ridge and Ridgeback pits.

5.5 Total Pit Inflows

The predicted inflows described in the previous sections relate to groundwater inflows only. Total inflows will also comprise rainfall runoff to the pit catchments (areas inside pit containment bunds). To put the predicted groundwater inflows into context, we have made some "approximate" calculations of rainfall runoff to the pits for a 1 in 10-year storm (10-year ARI, 72 hour storm). The results, in comparison with the high case groundwater inflow predictions, are summarised in Table 4 below.

Table 4: Comparison of Groundwater Inflows with Rainfall Runoff to Pits

Pit	High Case Predicted Groundwater Inflow (L/s average)	Estimated 1 in 10 Storm Runoff* (L/s average)
Cutter's Ridge	10	82
Rayjax	4	20
Ridgeback	13	60

* Assumptions: 10-year ARI 72 hour storm = 100mm
Runoff Coefficient = 0.75

The results above confirm that groundwater inflows (even for the high case uncertainty prediction) are significantly lower than estimated rainfall runoff for 1 in 10 year storm (typical design event for pits with mine life of one year or less).

5.6 Dewatering Strategy

Given that predicted groundwater inflows are low (especially compared with potential rainfall runoff) and there are no obvious aquifer targets for perimeter dewatering bores, the most practical and cost-effective dewatering strategy will be to manage all inflows with pit floor sumps and pumps.

Apart from at Rayjax, which has a short mine life (4 months), the pits will be mined over winter months and will be subjected to some rainfall and rainfall runoff. Given the relative contributions of predicted groundwater and surface water inflows, it is recommended that the sumps and pumps at Cutter's Ridge and Ridgeback be sized primarily based on rainfall runoff (with some allowance for

groundwater). However, pump capacity need not match the predicted total runoff after a storm. If the mine plan can accommodate the bottom bench (for example) being inundated for a period, the total pumping capacity can be reduced.

If Rajax is to be mined over summer, it would be possible to size sumps/pumps based on predicted groundwater inflows. However, given that predicted groundwater and surface water inflows are not that large and that summer rainstorms can occur, it is recommended that provision be made to manage a 1 in 10 year storm.

It is noted that, while it does provide indicative results, the runoff assessment completed is very preliminary (rough) and based on some generic Kalgoorlie area assumptions. A more rigorous hydrological assessment would be required to provide more reliable runoff predictions, using variable runoff coefficients and based on more accurate survey data on the pit catchments. Such an assessment should also include simple water balance modelling to assess pumping capacity requirements versus available buffer storage (i.e. volume and time allowed for inundation of lower bench(es)).

We trust that this report (Technical Memo) is sufficient for your current requirements. If we can provide any further assistance in water management planning for the satellite pits, please do not hesitate to contact us.

In particular, we would be able to complete a more rigorous hydrological assessment of rainfall runoff (and surface water management plans for Rayjax and Ridgeback) relatively quickly and at short notice, if required. As you know, we have already completed a surface water management plan for Cutter's Ridge.

Regards

Jon

Consulting Hydrogeologist

Liam

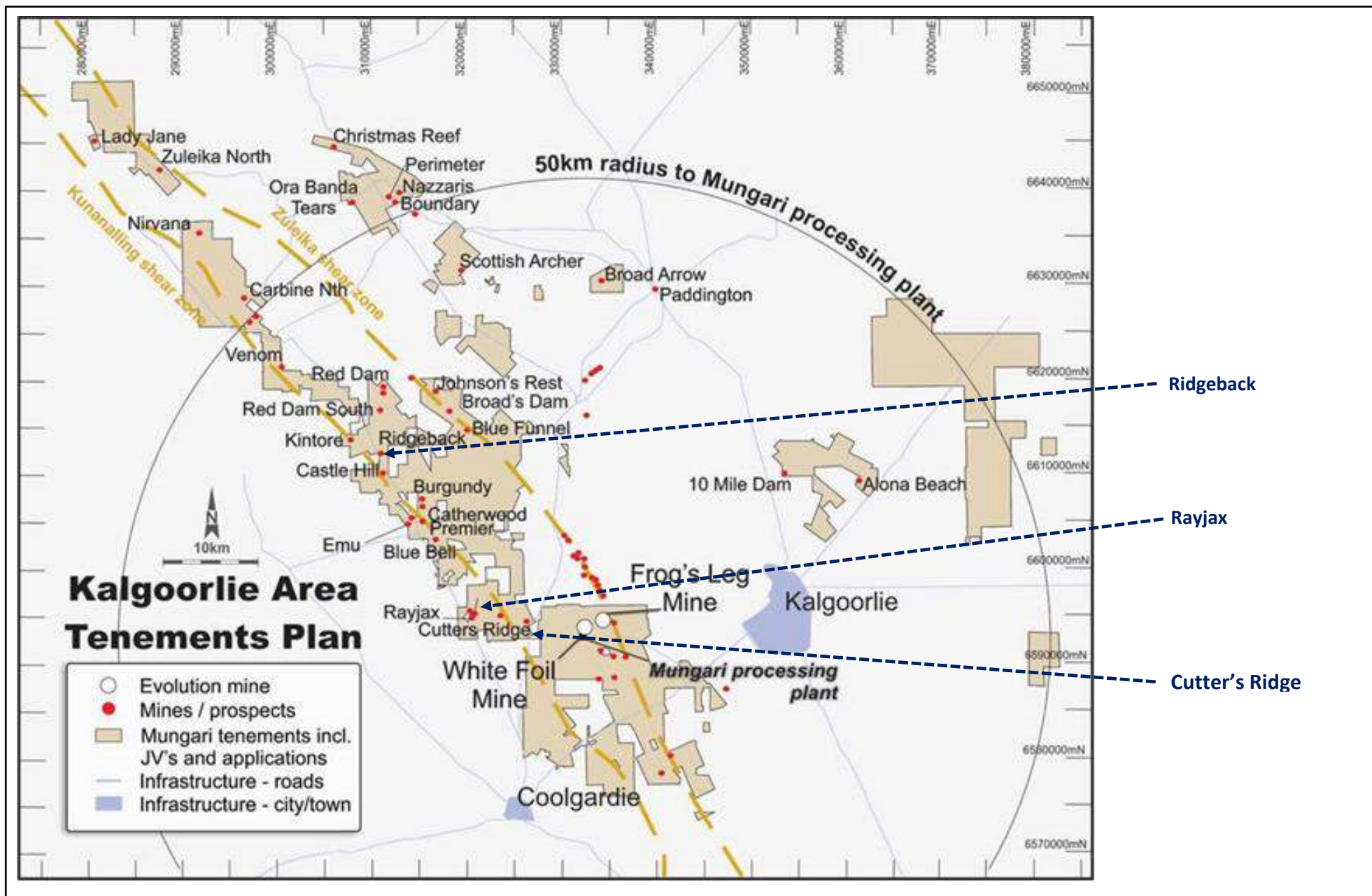
Hydrogeologist

Author: JWH (15/03/19)
Checked: LC (20/03/19)
Reviewed: KLR (20/03/19)

Attached:

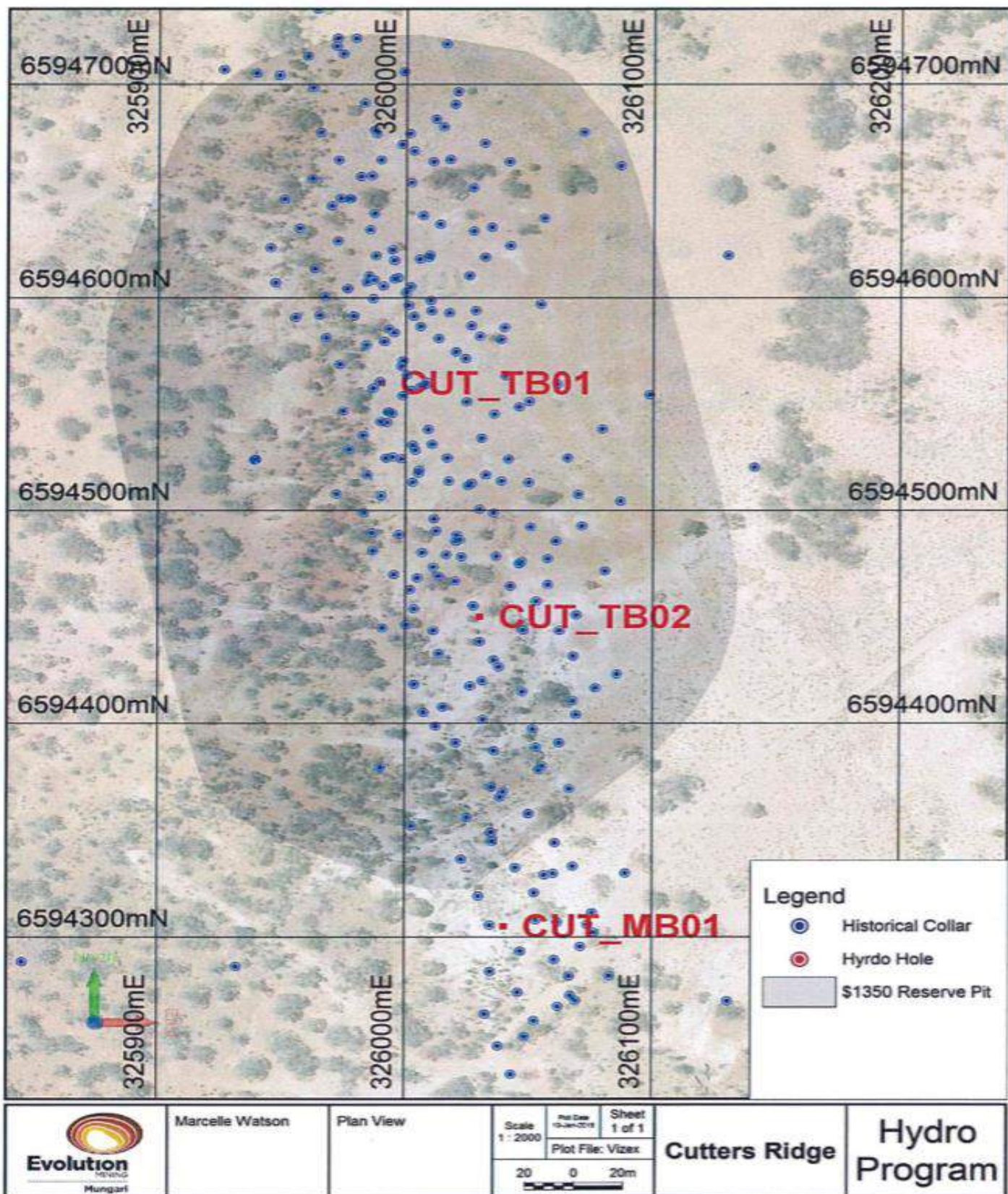
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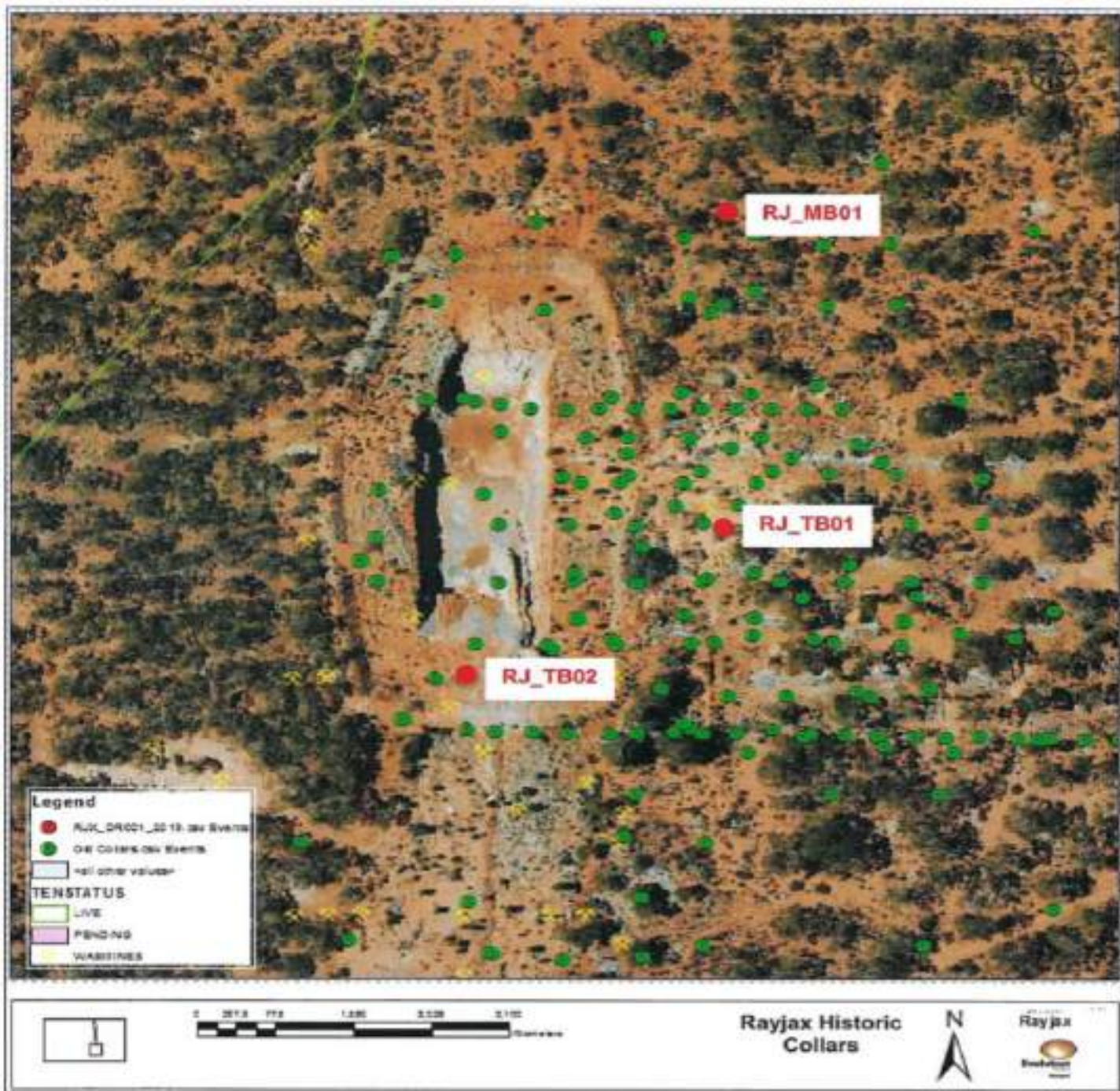
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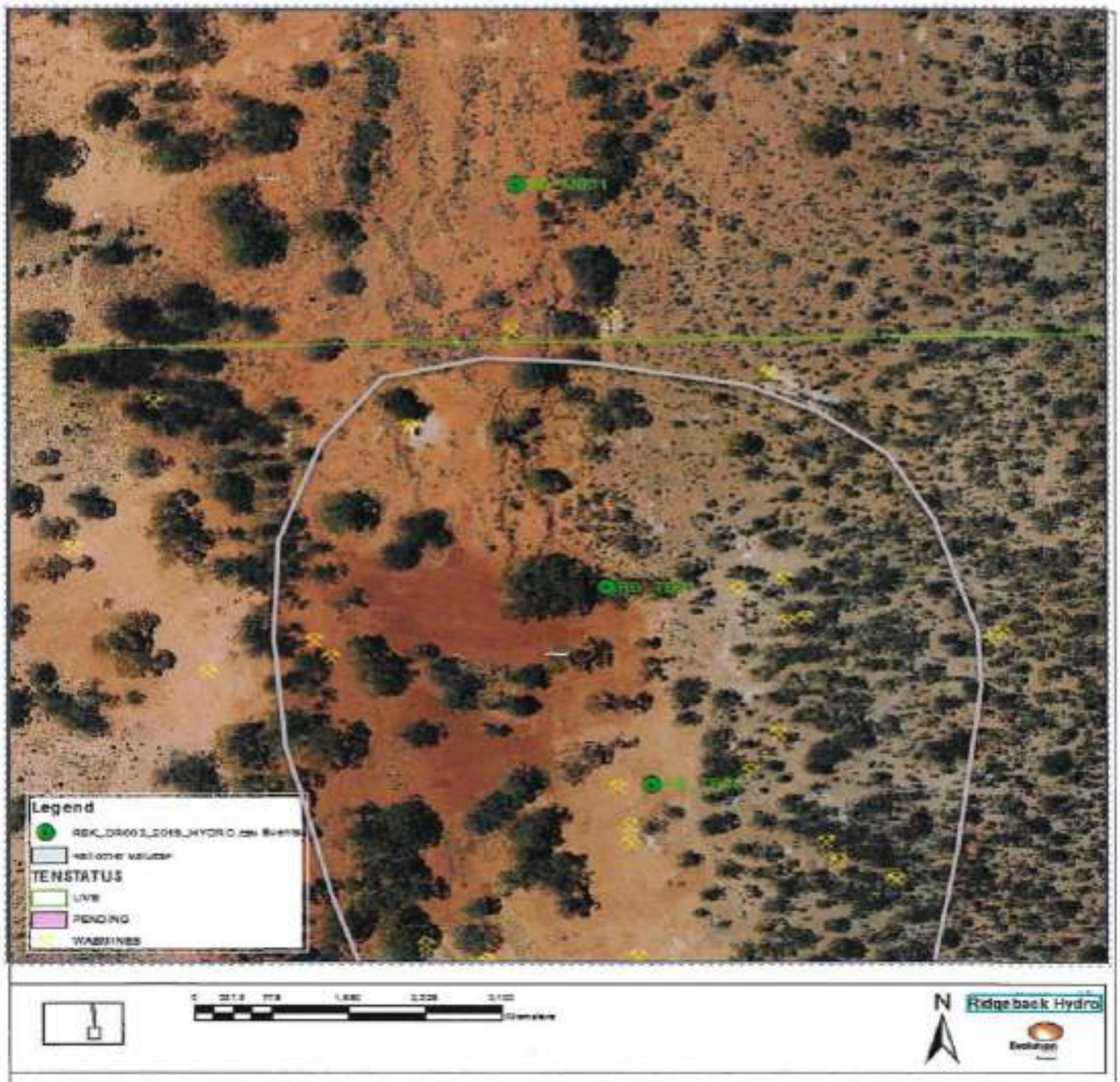


REGIONAL LOCATION PLAN

FIGURE 1







APPENDIX A

DRILLING & BORE DETAILS

Appendix A Table A1: Summary of Bore Details

Bore		Location Data			Drilling						Bore Completion Details								Groundwater Yields/Levels				Comments	
											Standpipe Monitoring Bore						Protective Collar							
Borehole ID	Type	Easting (m)	Northing (m)	Elevation (mRL) ¹	Started	Completed	Dip (°)	Total Depth	Drilling Method	Maximum Airlift Yield During Drilling (L/s)	Bore Casing Type	Total Depth Casing (mBGL)	Screened Interval (mBGL)	Base of Bentonite Seal (mBGL)	PVC Casing Stickup (mAGL)	Top of PVC Casing (mRL)	Collar Type	Collar Stickup (mAGL)	Top of Collar (mRL)	Airlift Yield (L/s)	SWL (mBTC - PVC)	SWL (mRL)	Date Recorded	
CUT MB01	Monitoring Bore	326052	6594303	359.35	18/02/2019	19/02/2019	-90	60	RC	<0.1	50mm PVC	55.7	19.7 - 55.7	13.5	0.71	360.06	150mm steel	0.76	360.11	0.07	15.95	343.40	26/02/2019	Airlifted for 2 hours during testing duration. Muddy, green water returns.
CUT TB01	Test Bore	325985	6594563	357.91	20/02/2019	20/02/2019	-90	80	RC	0.3														No airlift yield when rods pulled back above 48m.
CUT TB02	Test Bore	326019	6594468	357.43	19/02/2019	19/02/2019	-90	80	RC	<0.1														Airlift at 65m produced muddy yellow/brown water returns. Flow stopped at 72m.
RJ MB01	Monitoring Bore	320679	6595341	379.85	21/02/2019	21/02/2019	-90	60	RC	-	50mm PVC	59.7	29.7 - 59.7	26	1	380.85	150mm steel	1.21	381.05	0.04	20.41	359	26/02/2019	Airlifted for 2 hours during testing. Muddy, blue/grey water returns.
RJ TB01	Test Bore	320720	6595231	381.36	20/02/2019	20/02/2019	-90	60	RC	-														No airlift returns
RJ TB02	Test Bore	320611	6595184	380.12	21/02/2019	21/02/2019	-90	80	RC	<0.1														Airlift at end of hole, pumped dry in 3 minutes.
RB MB01	Monitoring Bore	311057	6613319	404.55	22/02/2019	23/02/2019	-90	60	RC	-	50mm PVC	57.7	27.7 - 57.7	14	1	405.55	150mm steel	1.21	405.76	0.2	18.51	386.04	25/02/2019	Airlift for 2 hours during testing. Muddy, yellow water returns.
RB TB01	Test Bore	311095	6613119	405.95	22/02/2019	22/02/2019	-90	80	RC	2														Airlift yields increased at 60m to produce muddy water returns . No airlift yields when rods pulled back above 48m.
RB TB02	Test Bore	311117	6613017	406.87	21/02/2019	21/02/2019	-90	80	RC	0.4														Airlift yields at 72m to produce muddy, brown water retunes, but pumped dry in 12 minutes.



Bore No: CUT_MB01

Project: White Foil Pit Inflow Modelling

Area: Mungari

Elevation: 359.35 mAHD

Easting: 326052

Nothing: 6594303

Remarks: PVC stick up = 0.8m

Geological Log (Left):


- 0 - 15m: Completely weathered saprolite
- 15 - 17m: Quartz Vein
- 17 - 20m: Completely weathered saprolite
- 20 - 22m: Quartz Vein
- 22 - 30m: Completely weathered saprolite
- 30 - 32m: Quartz Vein
- 32 - 38m: Volcaniclastics
- 38 - 40m: Quartz Gabbro
- 40 - 45m: Volcaniclastics
- 45 - 60m: Quartz Gabbro

Well Completion Diagram (Right):



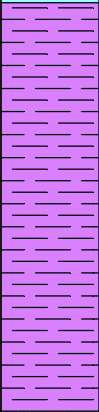
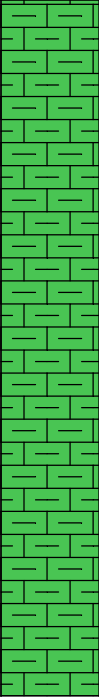
- 0 - 3.1m: Backfill
- 3.1 - 6m: 150mm PVC Pre-collar
- 6 - 13.5m: bentonite seal
- 13.5 - 17.1m: 50mm CL18 PVC (gravel pack 3.2-6.4mm)
- 17.1 - 60m: 50mm CL18 PVC
- 60 - 70m: hole collapsed material


Additional Information:

- Weathered to fresh rock transition @ 40m
- Airlift: 0.07 L/s, Muddy greenish coloured water

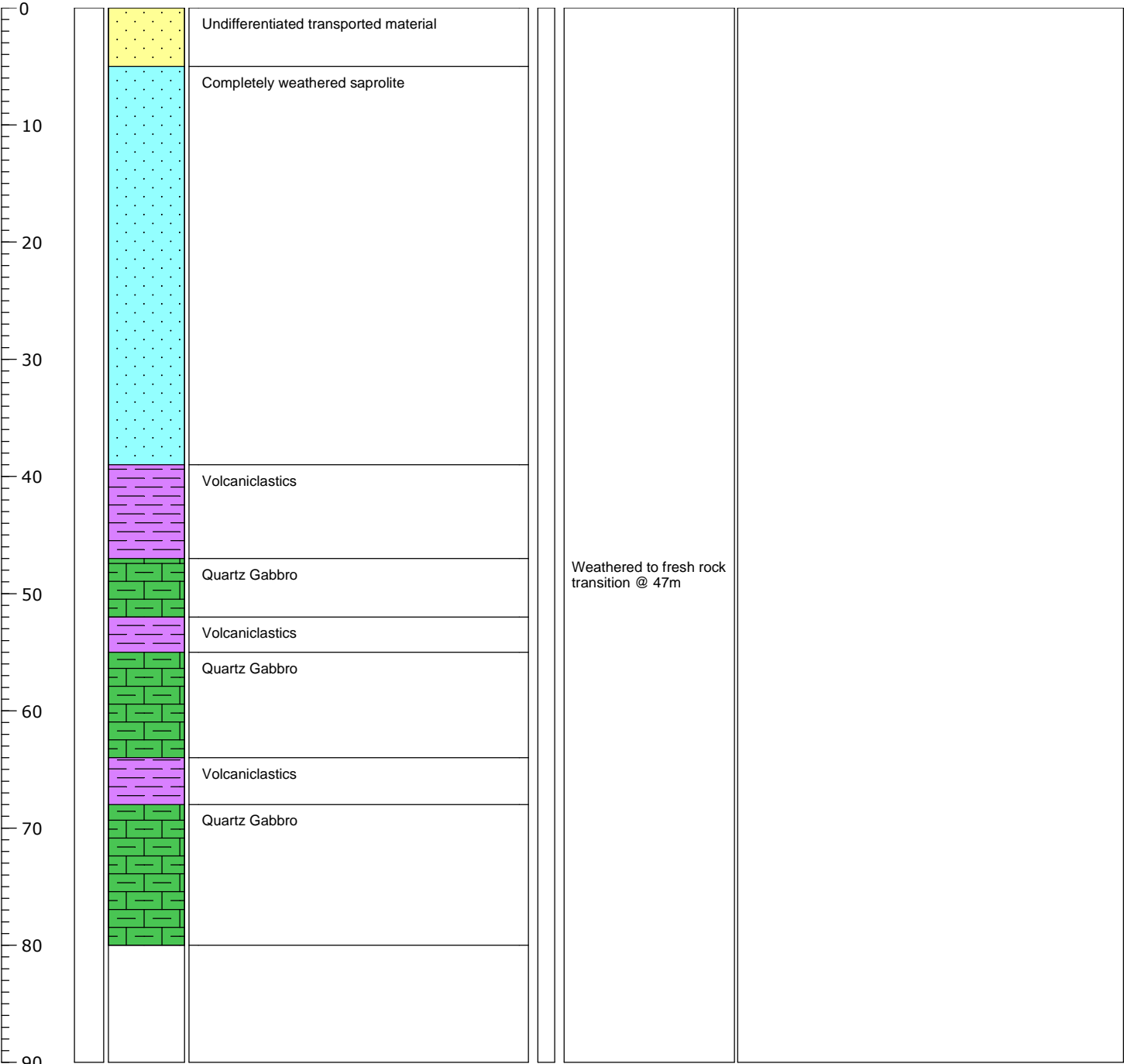
 Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au	COMPOSITE WELL LOG		Bore No: CUT_TB01	
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling	
	Commenced: 20/02/2019 Completed: 20/02/2019 Drilled: Topdrill Logged By: HH		Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-80 = 151mm	
			Area: Mungari Elevation: 357.91 mAHD Easting: 325985 Northing: 6594563 Projection: MGA94 Zone 51	
	Static Water Level:		Date:	
		Remarks:		

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes

0			Undifferentiated transported material				
			Completely weathered saprolite				
10			Volcaniclastics				
20							
30							
40			Quartz Gabbro		Weathered to fresh rock transition @ 34m		
50					Airlift: Very weak flow, pumped dry, Muddy brown coloured water		
60					Airlift: 0.2 L/s, Muddy brown coloured water		
70					Airlift: 0.3 L/s, Muddy brown coloured water		
80					Airlift: 0.3 L/s, Muddy brown coloured water		
90					Airlift: 0.3 L/s, Muddy brown coloured water		

<div></div> <div>Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au</div>	COMPOSITE WELL LOG		Bore No: CUT_TB02	
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling	
	Commenced: 19/02/2019 Completed: 19/02/2019 Drilled: Topdrill Logged By: LU		Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-80 = 151mm Area: Mungari Elevation: 357.43 mAHD Easting: 326019 Northing: 6594468 Projection: MGA94 Zone 51	
	Static Water Level:		Date:	
		Remarks:		

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes





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COMPOSITE WELL LOG

Bore No: RJ_MB01

Client: Evo - Mungari Operations

Project: White Foil Pit Inflow Modelling

Commenced: 21/02/2019

Method: RC

Area: Mungari

Completed: 21/02/2019

Fluid: Air

Elevation: 379.85 mAHD

Drilled: Topdrill

Bit Record: 0-6m = 171mm

Easting: 320679

Logged By: HH

6-60 = 151mm

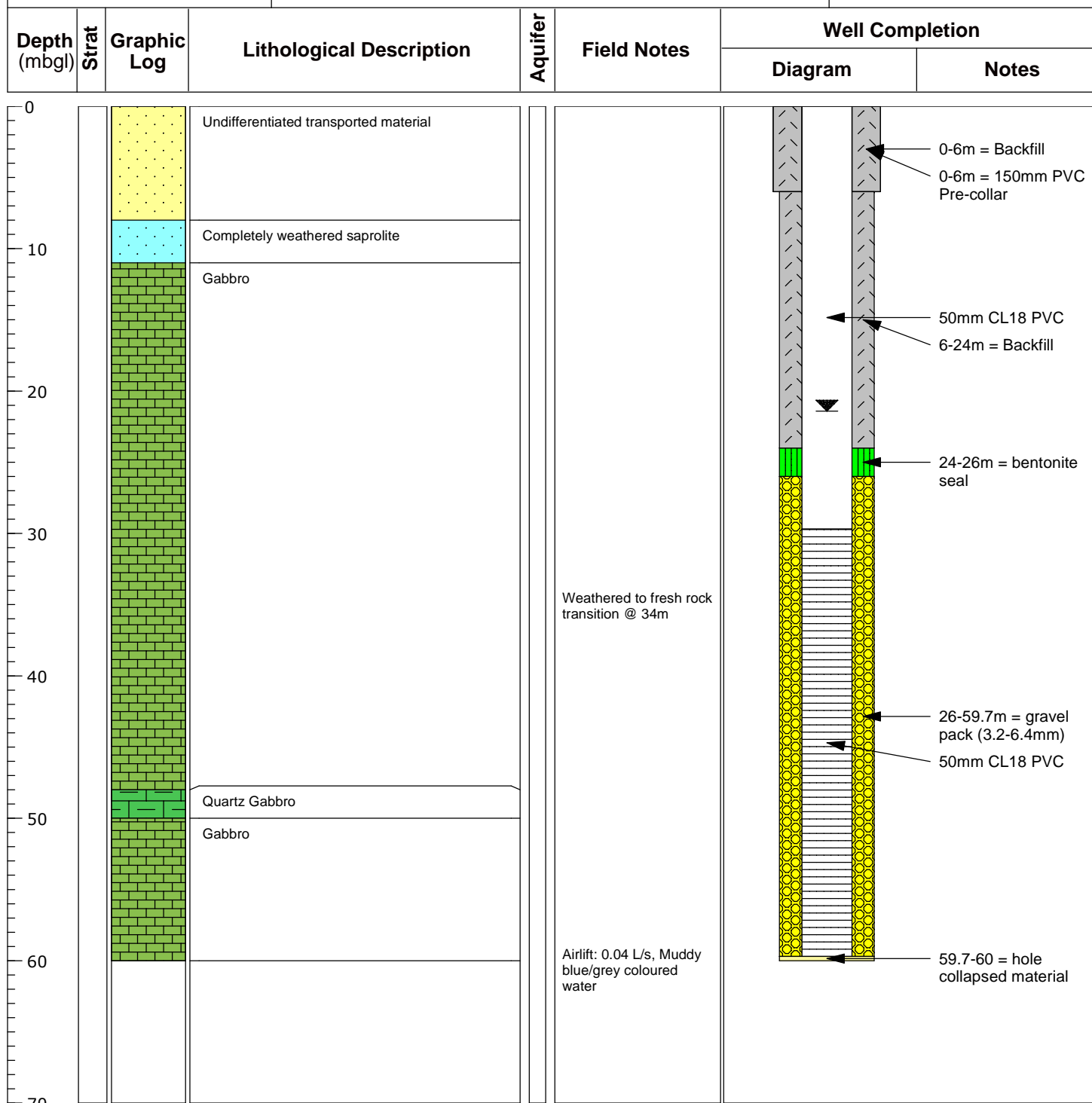
Northing: 6595341


Projection: MGA94 Zone 51




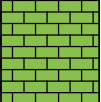

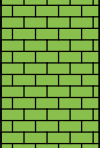

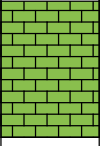
Static Water Level: 21.41 mbtoc


Date: 26/02/2019

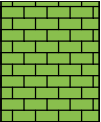
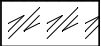
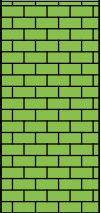

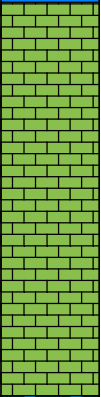
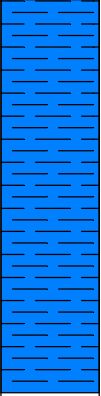

Remarks: PVC stick up = 1m



 <p>Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au</p>	COMPOSITE WELL LOG		Bore No: RJ_TB01
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling
	Commenced: 20/02/2019 Completed: 20/02/2019 Drilled: Topdrill Logged By: HH	Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-60 = 151mm	Area: Mungari Elevation: 381.36 mAHD Easting: 320720 Northing: 6595231 Projection: MGA94 Zone 51
	Static Water Level:		Date:

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Undifferentiated transported material				
10			Dolerite				
20							
30			Porphyry				
30			Gabbro				
40			Dolerite				
40			Gabbro				
50			Quartz Vein				
50			Gabbro				
60					Did not reach fresh rock		
70							

<div></div> <div>Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au</div>	COMPOSITE WELL LOG		Bore No: RJ_TB02	
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling	
	Commenced: 21/02/2019 Completed: 21/02/2019 Drilled: Topdrill Logged By: HH		Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-80 = 151mm	
	Area: Mungari Elevation: 380.12 mAHD Easting: 320611 Northing: 6595184 Projection: MGA94 Zone 51			
Static Water Level:		Date:		Remarks:

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes
0			Gabbro				
10			Quartz Vein				
20			Gabbro				
30			ULTRAMAFIC				
40			Gabbro				
50			ULTRAMAFIC				
60							
70							
80							
90							



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COMPOSITE WELL LOG

Bore No: RB_MB01

Client: Evo - Mungari Operations

Project: White Foil Pit Inflow Modelling

Commenced: 22/02/2019

Method: RC

Area: Mungari

Completed: 23/02/2019

Fluid: Air

Elevation: 404.55 mAHD

Drilled: Topdrill

Bit Record: 0-6m = 171mm

Easting: 311057

Logged By: HH

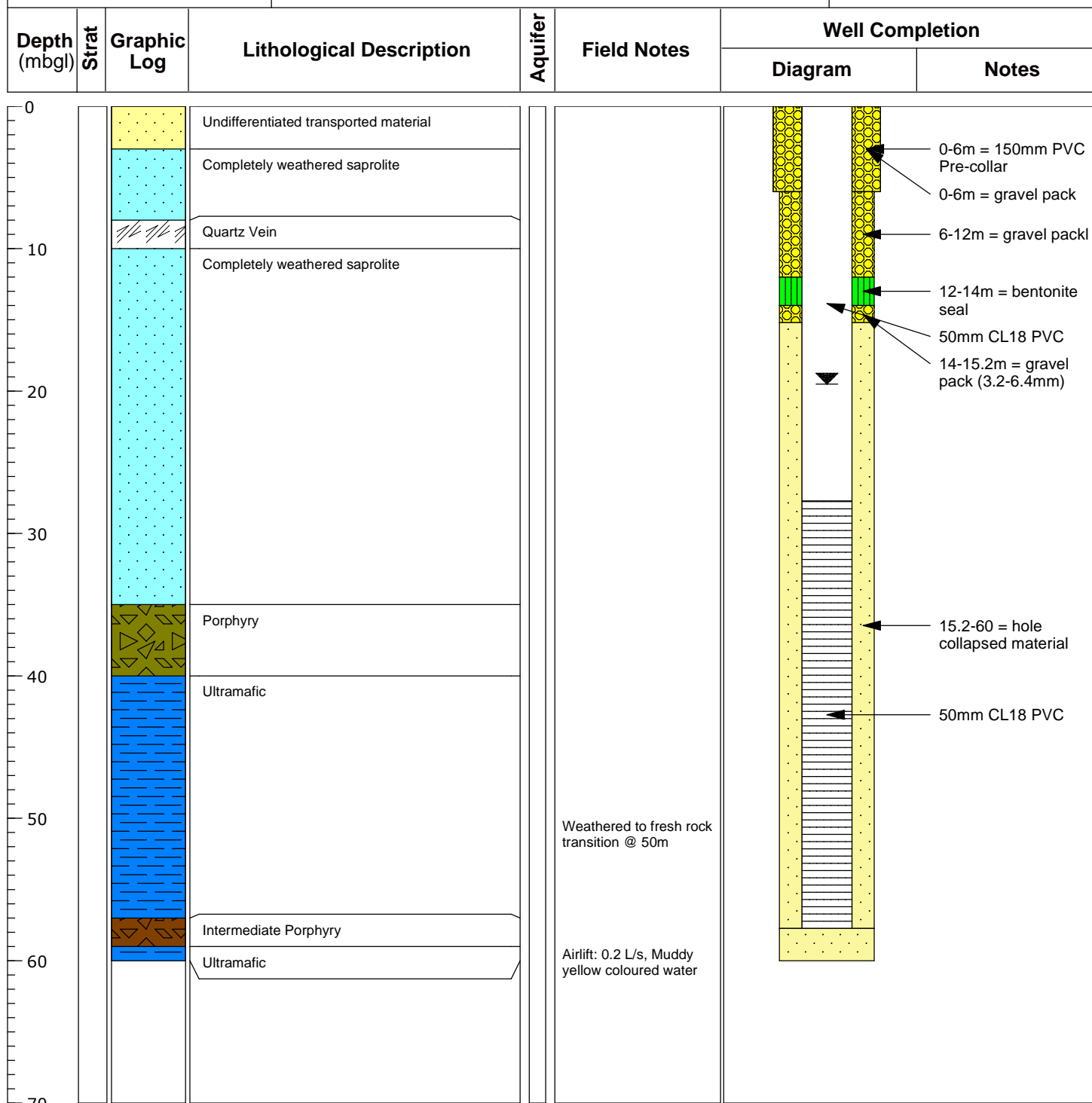
6-60 = 151mm


Northing: 6613319

Static Water Level: 19.51 mbtoc

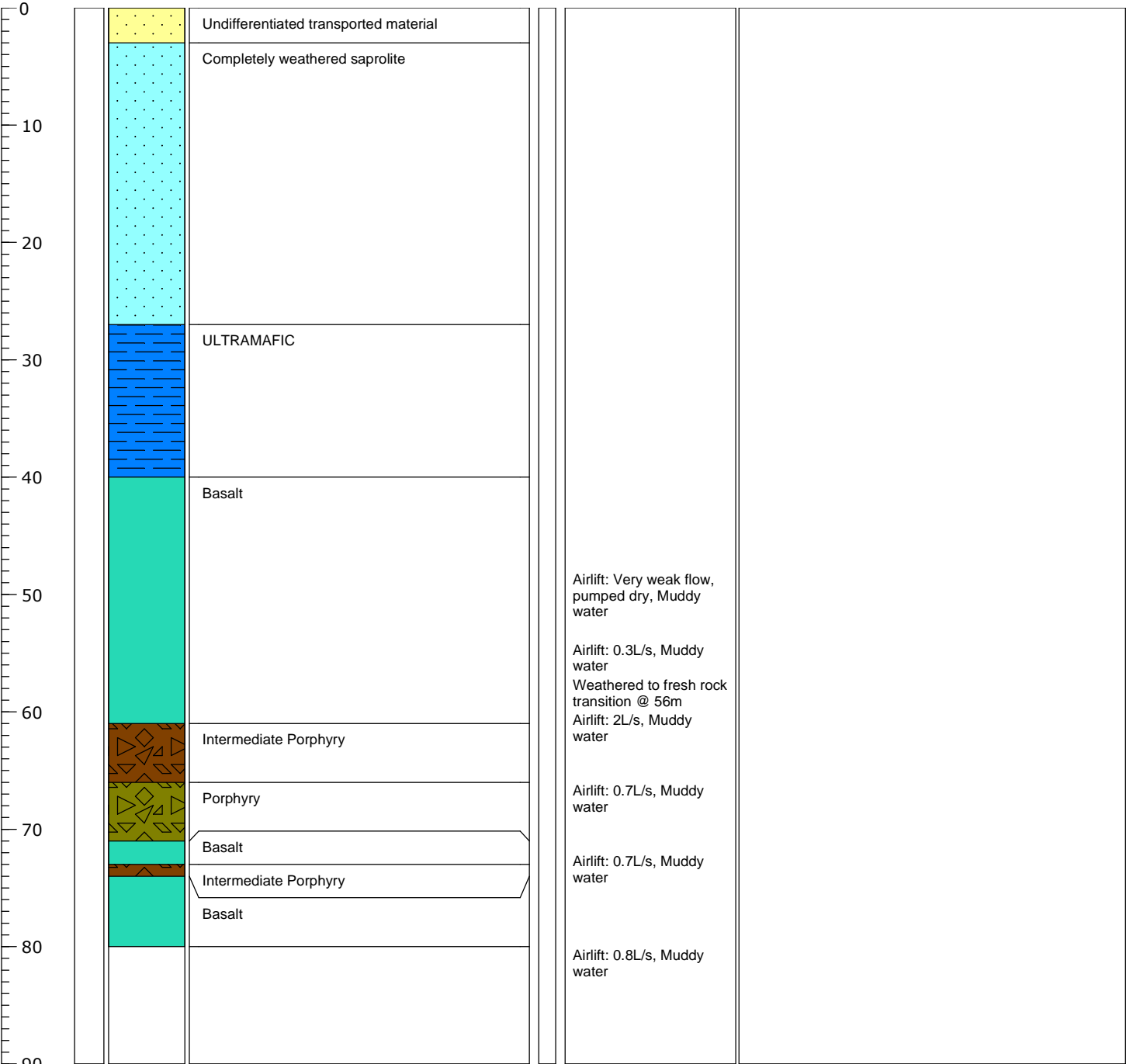
Date: 25/02/2019


Remarks: PVC stick up = 1m



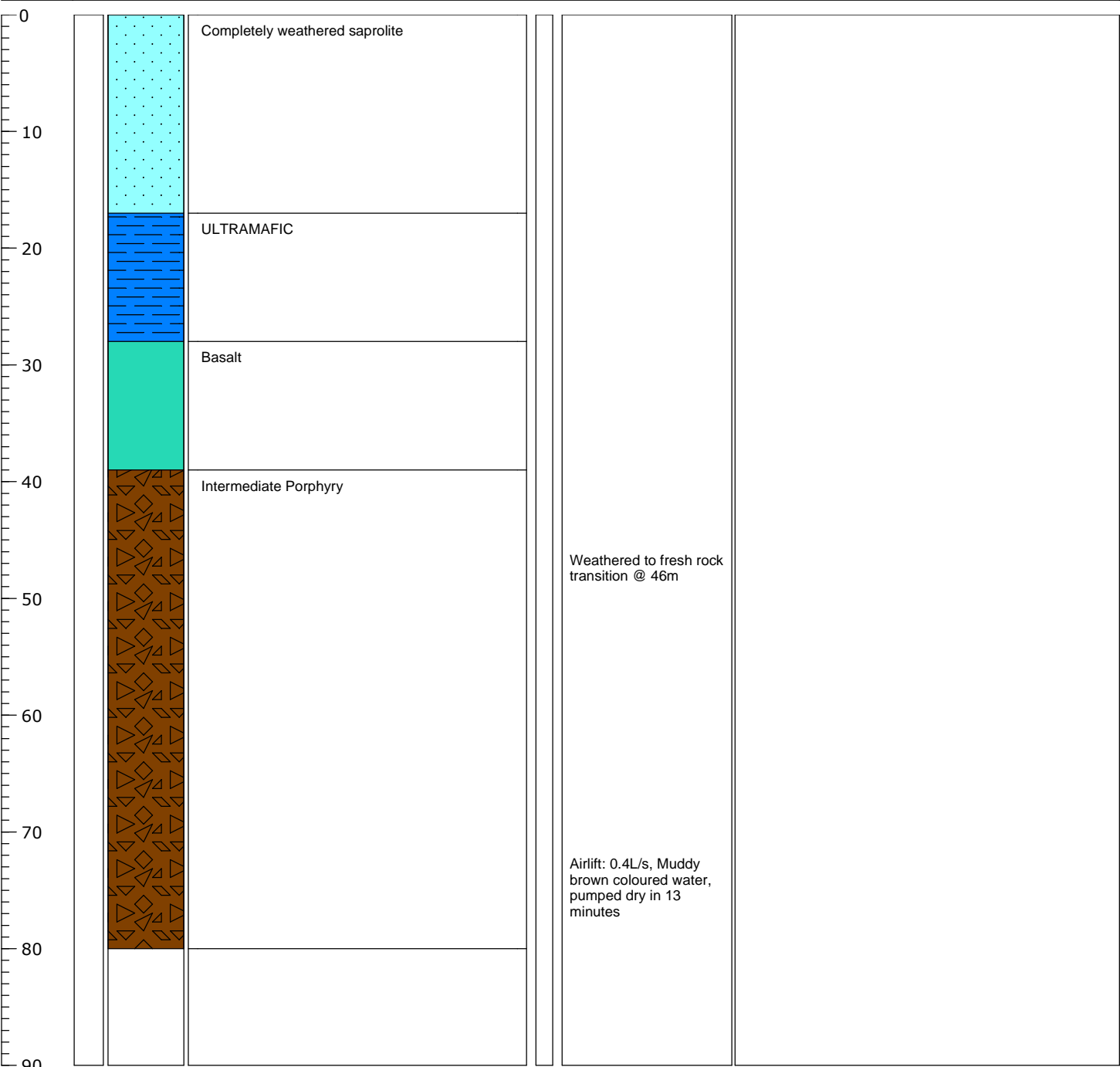
<div></div> <div>Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au</div>	COMPOSITE WELL LOG		Bore No: RB_TB01	
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling	
	Commenced: 22/02/2019 Completed: 22/02/2019 Drilled: Topdrill Logged By: HH		Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-80 = 151mm Area: Mungari Elevation: 405.95 mAHD Easting: 311095 Northing: 6613119 Projection: MGA94 Zone 51	
	Static Water Level:		Date:	
		Remarks:		

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes



<div></div> <div>Level 4, 56 William Street Perth WA 6000 Australia t: +61 (8) 9322 9733 e: aq2general@aq2.com.au</div>	COMPOSITE WELL LOG		Bore No: RB_TB02	
	Client: Evo - Mungari Operations		Project: White Foil Pit Inflow Modelling	
	Commenced: 21/02/2019 Completed: 21/02/2019 Drilled: Topdrill Logged By: HH		Method: RC Fluid: Air Bit Record: 0-6m = 171mm 6-80 = 151mm Area: Mungari Elevation: 406.87 mAHD Easting: 311117 Northing: 6613017 Projection: MGA94 Zone 51	
	Static Water Level:		Date:	
Remarks:				

Depth (mbgl)	Strat	Graphic Log	Lithological Description	Aquifer	Field Notes	Well Completion	
						Diagram	Notes



APPENDIX B

HYDRAULIC TESTING RESULTS

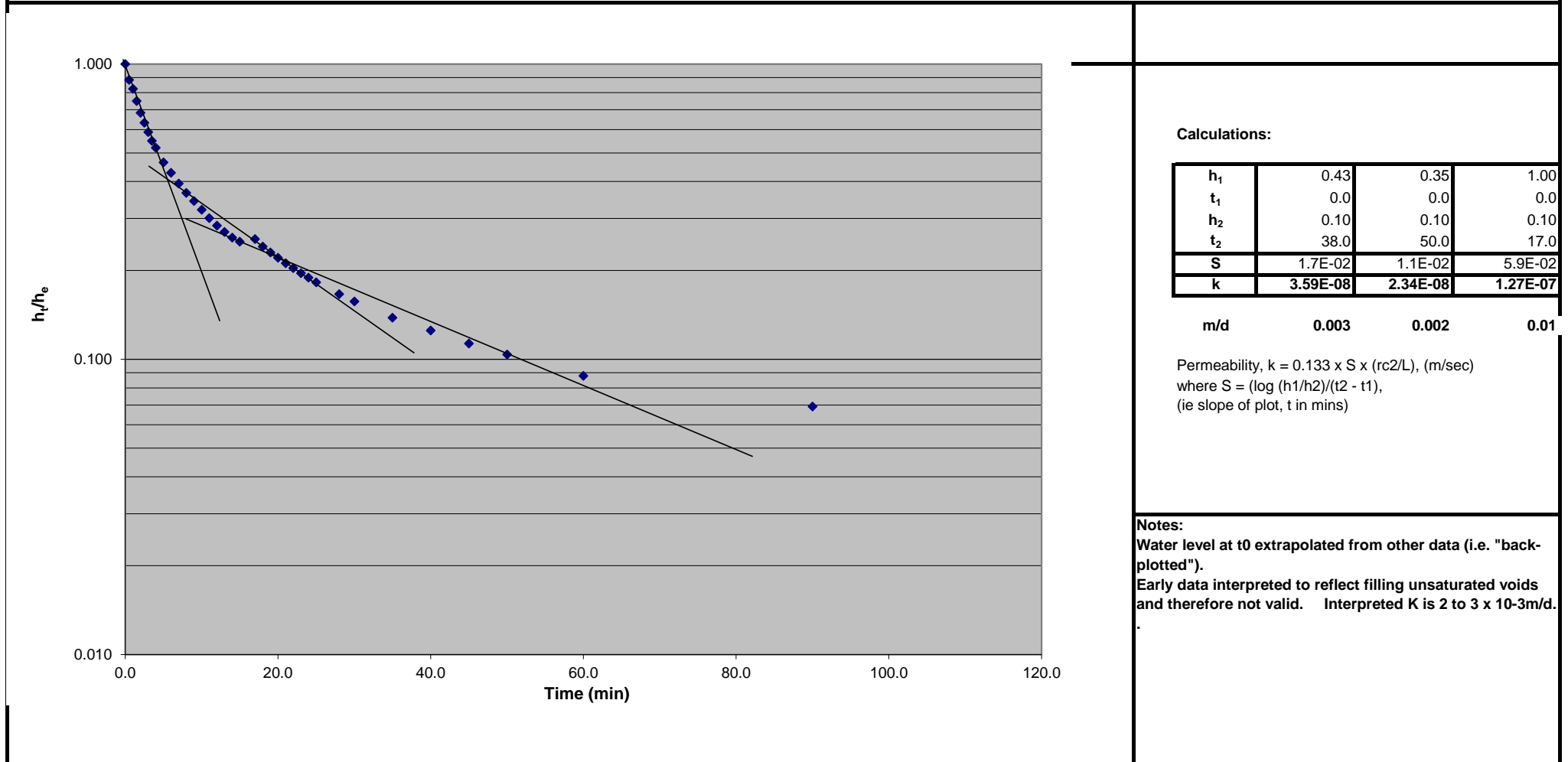
Appendix B Table B1: Summary of Hydraulic Testing

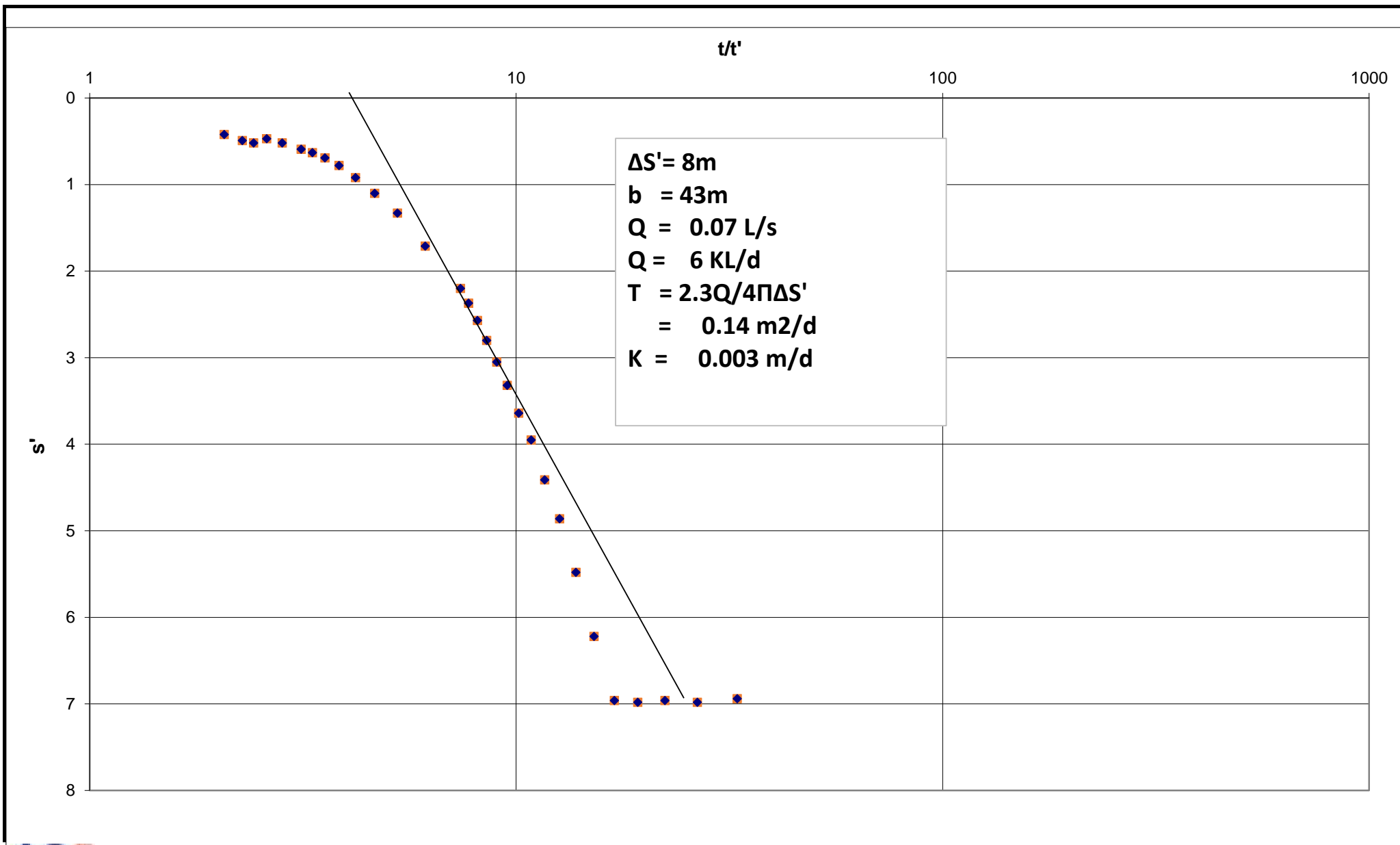
Bore	Test Interval (mBGL)	Test Type	Date	SWL (mBTC)	Excess Head Applied (m)	Airlift Pumping Rate (L/s)	Duration of Pumping (min)	Duration of Recovery Monitoring (min)	% Recovery Achieved	Derived Bulk Permeability (m/d)	Comments
CUT MB01	17.1 to 55.7	Falling Head	20/02/2019	17.01	7.51			120	95	0.002 to 0.003	Early time data affected by unsaturated zone - not used
		Airlift Recovery	26/02/2019	16.75		0.07	120	120		0.003	Mid time data used to derive K
RJ MB01	26 to 59.7	Falling Head	23/02/2019	22.22	17.22			120	94	0.002 to 0.004	Early and mid time data used to derive K
		Airlift Recovery	26/02/2019	21.41		0.04	120	120		0.001 to 0.002	Early and mid time data used to derive K
RB MB01	14 to 57.7	Falling Head	24/02/2019	19.51	11.19			120	92	0.003 to 0.005	Early time data affected by unsaturated zone - not used
		Airlift Recovery	25/02/2019	19.51		0.2	120	120		0.03	Rapid recovery and no recovery data available for first 5 minutes. Late time data used to derive K - considered conservatively high.

FALLING HEAD TEST

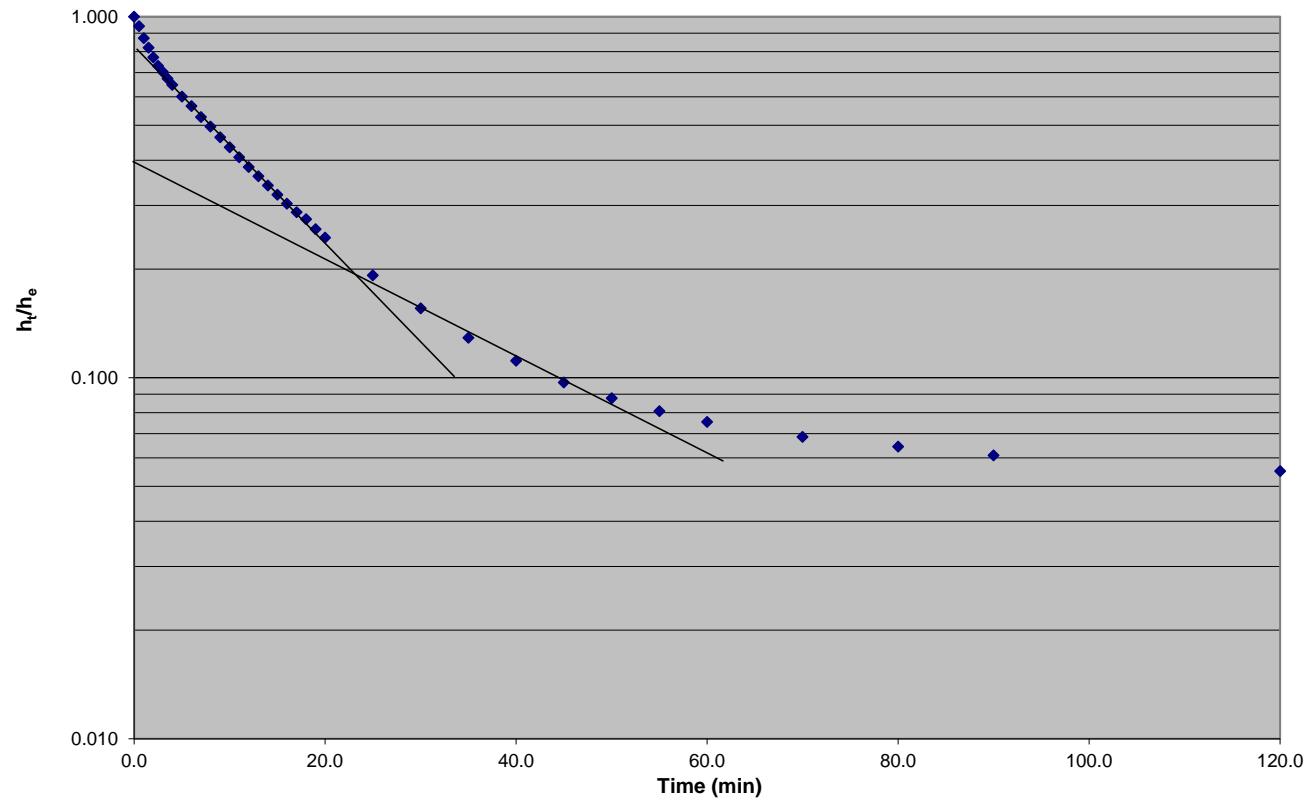


Bore No:	CUTMB01	Test No:	FHT #1	Job No:	202-C1	Date:	20-Feb-19	Logged by:	LC
Borehole co-ordinates: Easting:	326052	Northing:	6594303	Collar elevation (m):	365	Length of test section, L (m):	38.6	Radius of borehole, r (m):	0.075
Depth to top of test section (m):	17.1	Depth of static water level, H_w (m):	17.01	Excess head, h_e (m):	7.51	Radius of standpipe or casing, r_c (m):	0.025		





Bore No:	RJ MB01	Test No: #1	Job No: 202	Date: 23-Feb-19	Logged by: LC
Borehole co-ordinates: Easting:	320679	Northing:	6595341	Collar elevation (m):	380
Depth to top of test section (m):	14			Length of test section, L (m):	43.7
Depth of static water level, H_w (m):	22.22			Radius of borehole, r (m):	0.075
Excess head, h_e (m):	17.22			Radius of standpipe or casing, r_c (m):	0.025



Calculations:

h_1	0.80	0.40
t_1	0.0	0.0
h_2	0.10	0.10
t_2	35.0	45.0
S	2.6E-02	1.3E-02
k	4.91E-08	2.54E-08

m/d 0.004 0.002

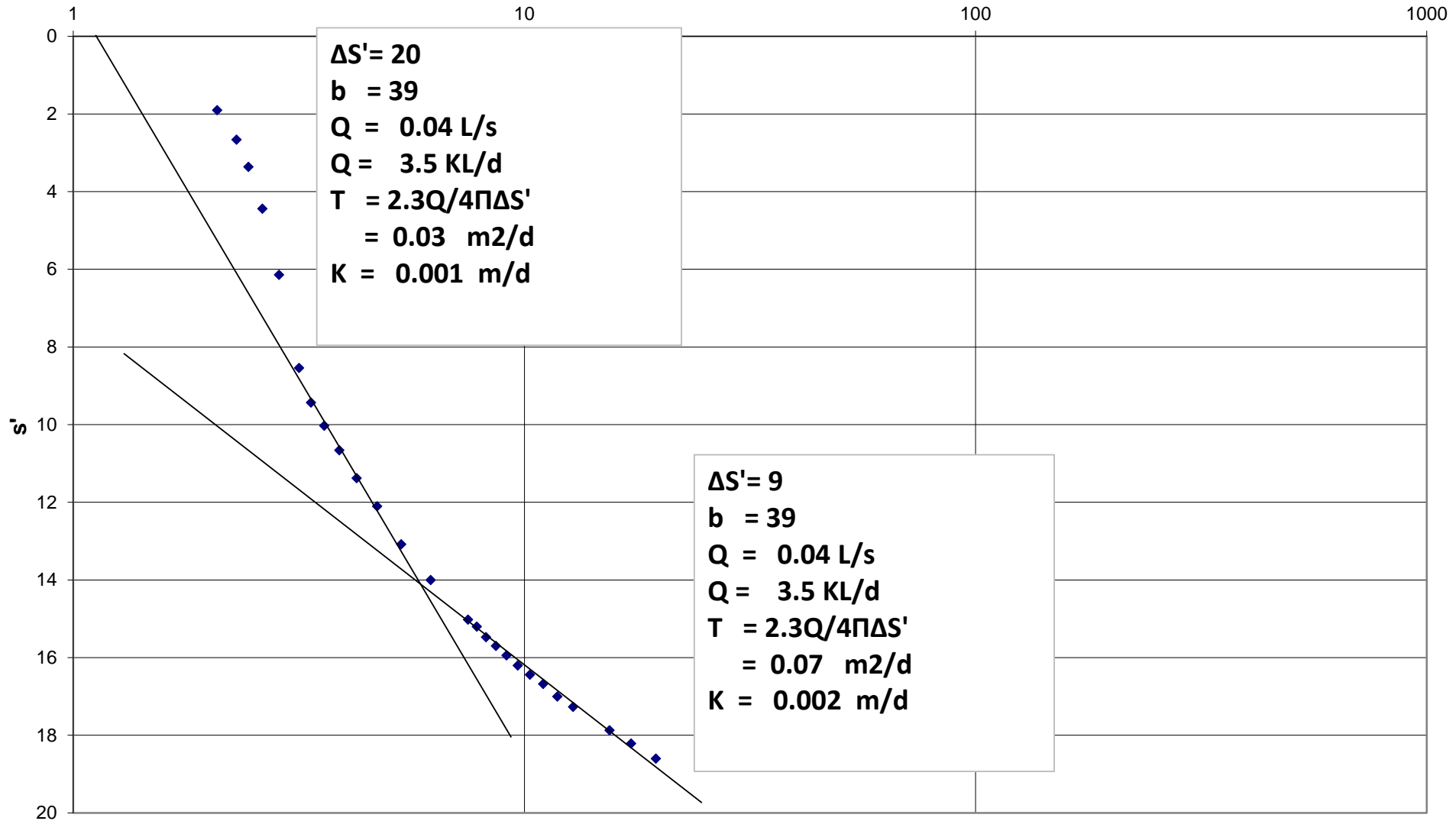
Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log (h_1/h_2))/(t_2 - t_1)$,
 (ie slope of plot, t in mins)

Notes:

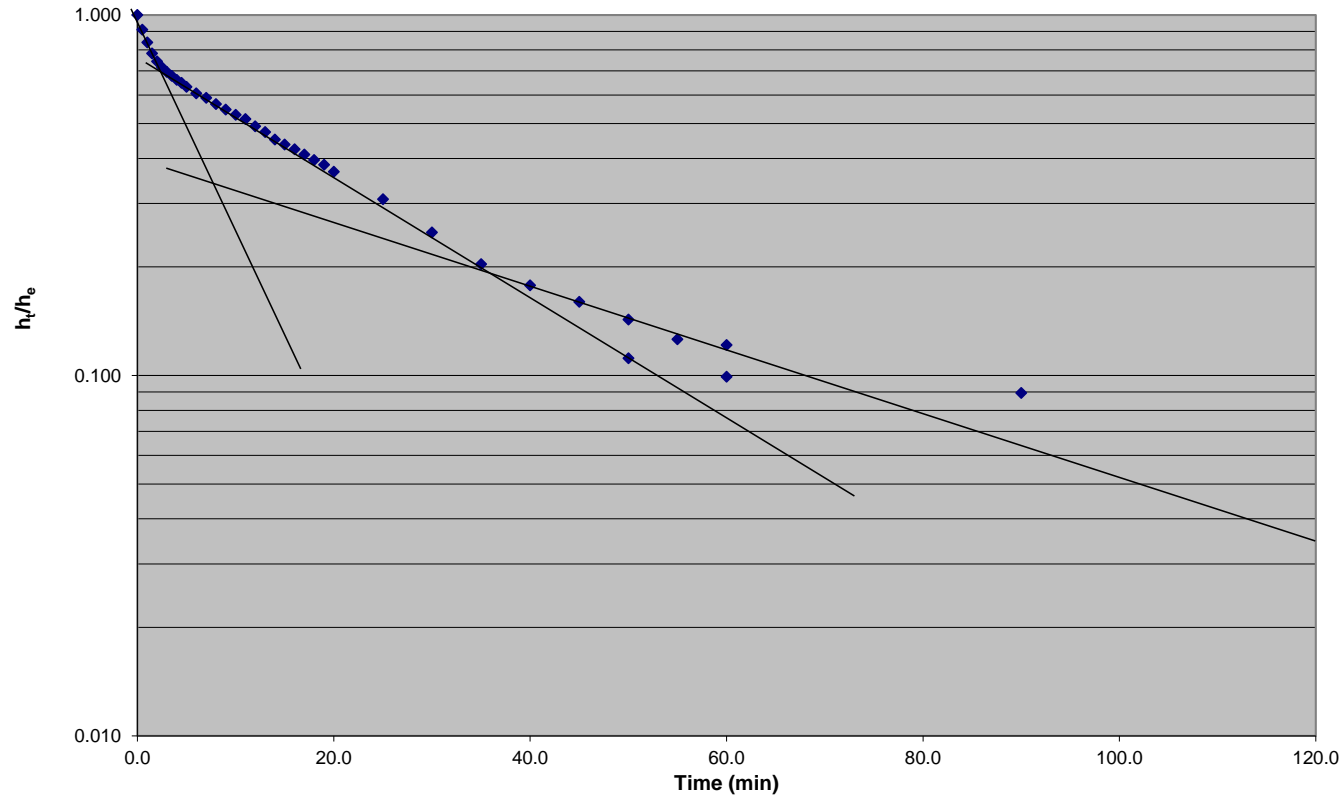
Water level at t_0 extrapolated from other data (i.e. "back-plotted").

Interpreted K is 2 to 4 x 10⁻³m/d. .

t/t'



Bore No:	RB MB01	Test No: ##1	Job No: 202-C1	Date: 24-Feb-19	Logged by: LC
Borehole co-ordinates: Easting:	311057	Northing:	6613319	Collar elevation (m):	405
Depth to top of test section (m):	13.5			Length of test section, L (m):	23.7
Depth of static water level, H_w (m):	19.51			Radius of borehole, r (m):	0.075
Excess head, h_e (m):	11.19			Radius of standpipe or casing, r_c (m):	0.025

**Calculations:**

h₁	0.80	0.40	1.00
t₁	0.0	0.0	0.0
h₂	0.31	0.04	0.01
t₂	25.0	120.0	35.0
S	1.6E-02	8.8E-03	5.7E-02
k	5.78E-08	3.09E-08	2.00E-07

m/d **0.005** **0.003** **0.017**

Permeability, $k = 0.133 \times S \times (rc^2/L)$, (m/sec)
 where $S = (\log (h_1/h_2))/(t_2 - t_1)$,
 (ie slope of plot, t in mins)

Notes:

Water level at t₀ extrapolated from other data (i.e. "back-plotted").

Early data interpreted to reflect filling unsaturated voids and therefore not valid. Interpreted K is 3 to 5 x 10⁻³ m/d.

APPENDIX C

INFLOW MODELLING RESULTS

Appendix C: Inflow Modelling Results

Sheet 1

Client: Evolution - Mungari Gold Operations

Project: 202-C - Hydro-Investigations at Cutter’s Ridge, Rayjax and Ridgeba

ESTIMATION OF GROUNDWATER INFLOWS TO MINE USING DUPUIT-THIEM EQUATION (UNCONFINED AQUIFER CONDITIONS)

$Q=\pi.k.(h_o^2-h_w^2)/ln(r_o/r_w)$

where

Q=inflow or outflow from large diameter well or pit (kL/d)

k=hydraulic conductivity (m/d)

h_o=height of SWL above base of aquifer (m)

h_w=height of depressed water level in bore or pit (m)

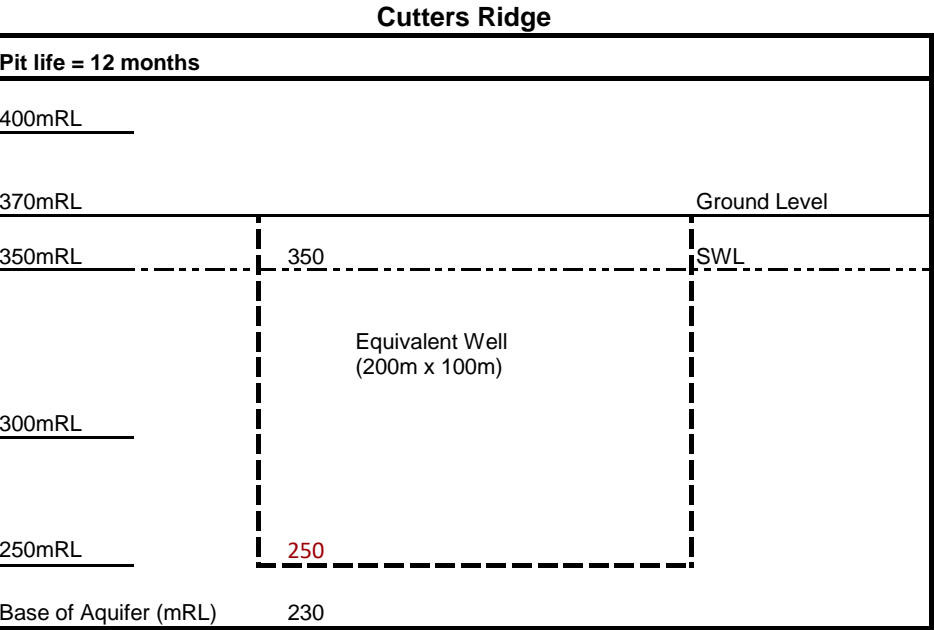
r_w=radius of well or equivalent radius of pit (m)

r_o=radius of max extent of cone of drawdown (m)=SQRT(2.25.k.h_o.t/Sy)

t=time since pumping or inflow started (days)

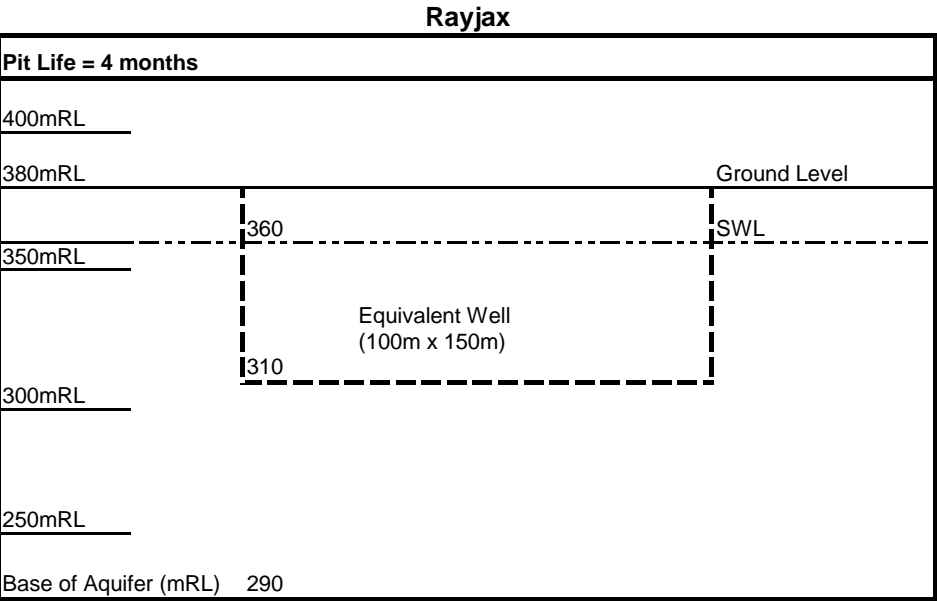
Sy=specific yield

Model developed by	JWH	14/03/2019
Model run by	JWH	14/03/2019
Model checked by	KLR	18/03/2019



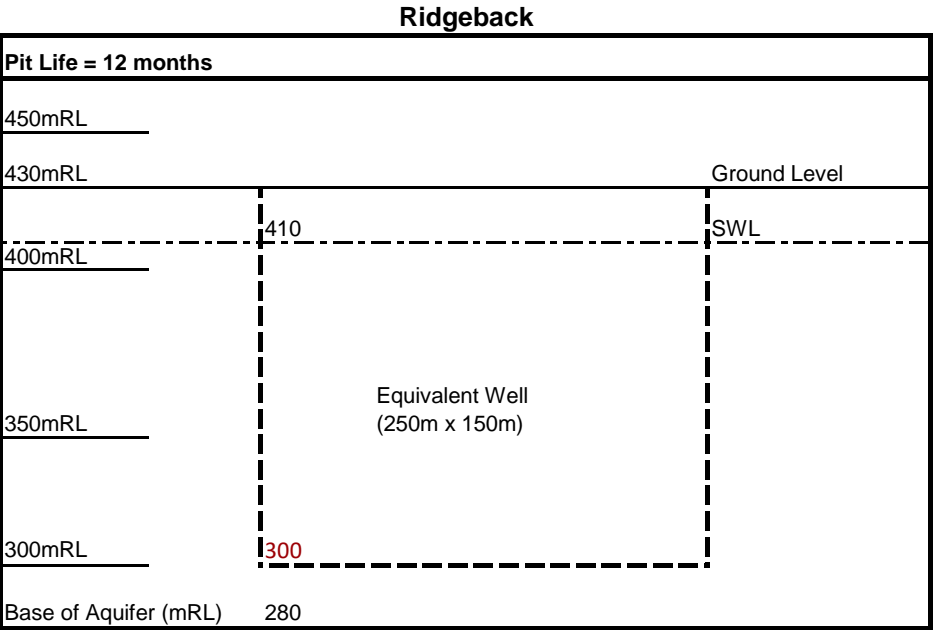
N-S (strike) length effective pit (m)	200
E-W width of effective pit (m)	100
Area of effective pit base (m2)	20000
Radius of equivalent well (m)	80

Basement Inflow Calcs			
k (m/d) =	0.005	0.05	0.001
h _o (m) =	120	120	120
h _w (m) =	20	20	20
r _w (m) =	80	80	80
t (months)	12	12	12
t (days) =	366	366	366
Sy=	0.005	0.005	0.005
r _o (m) =	314	994	141
Q (kL/d) =	160	872	78
Q (L/s) =	2	10	1



N-S (strike) length effective pit (m)	100
E-W width of effective pit (m)	150
Area of effective pit base (m2)	15000
Radius of equivalent well (m)	69

Basement Inflow Calcs			
k (m/d) =	0.005	0.05	0.001
h _o (m) =	70	70	70
h _w (m) =	20	20	20
r _w (m) =	69	69	69
t (months)	4	4	4
t (days) =	122	122	122
Sy=	0.005	0.005	0.005
r _o (m) =	139	438	62
Q (kL/d) =	102	383	NA (r ₀ < r _w)
Q (L/s) =	1	4	NA



N-S (strike) length effective pit (m)	250
E-W width of effective pit (m)	150
Area of effective pit base (m2)	37500
Radius of equivalent well (m)	109

Basement Inflow Calcs			
k (m/d) =	0.010	0.05	0.001
h _o (m) =	130	130	130
h _w (m) =	20	20	20
r _w (m) =	109	109	109
t (months)	12	12	12
t (days) =	366	366	366
Sy=	0.005	0.005	0.005
r _o (m) =	463	1034	146
Q (kL/d) =	359	1153	178
Q (L/s) =	4	13	2

ROUGH ESTIMATION OF SURFACE WATER INFLOWS TO MINE FOR STORM EVENT (10 YEAR ARI 72 HOUR STORM)

Cutters Ridge	
Area inside pit crest (m2) =	283000
10 yr ARI 72 hr storm - Kalgoorlie (mm) =	100
Runoff Coefficient +	0.75
Runoff Volume (ML) =	21
Storm Runoff rate (L/s) =	82

Rayjax	
Area inside pit crest (m2) =	70000
10 yr ARI 72 hr storm - Kalgoorlie (mm) =	100
Runoff Coefficient +	0.75
Runoff Volume (ML) =	5
Storm Runoff rate (L/s) =	20

Ridgeback	
Area inside pit crest (m2) =	206000
10 yr ARI 72 hr storm - Kalgoorlie (mm) =	100
Runoff Coefficient +	0.75
Runoff Volume (ML) =	15
Storm Runoff rate (L/s) =	60

Appendix E:

Flora and Vegetation Survey for the Cutters Ridge Project



PHOENIX

ENVIRONMENTAL SCIENCES

Flora and vegetation survey for Mungari Gold Operations Cutters Ridge Project

Prepared for Evolution Mining Ltd

May 2019

Final Report



Biological survey for Mungari Gold Operations Cutters Ridge Project

Prepared for Evolution Mining Ltd

Final Report

Authors: Grant Wells, Alice Watt

Reviewer: Karen Crews

Date: 15 May 2019

Submitted to: Kara Postle

Version history			
Name	Task	Version	Date
G.B. Wells	Draft for internal review	0.1	1/2/2019
K. Crews	Draft for client comments	0.2	12/2/2019
K. Crews	Final for client submission	1	15/5/2019

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Project code: 1204-MUN-EVO-BOT

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EXECUTIVE SUMMARY

Evolution Mining Ltd (EVO) operates the Mungari Gold Operations (MGO) located in the Goldfields region, approximately 20 km west of Kalgoorlie. Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by EVO to undertake a detailed flora and vegetation survey of the Cutters Ridge area plus a road corridor between Cutters Ridge and the Mungari Mill (collectively the study area).

The scope of works for the flora and vegetation survey was as follows:

- conduct a desktop assessment to define the potential botanical values of the study area
- complete a two season detailed flora and vegetation field survey
- prepare a comprehensive technical report outlining survey outcomes
- prepare and provide all spatial data collected during the survey.

The study area for the survey was 1,176.5 ha in size. The desktop assessment indicated that the study area occurred in a floristically diverse region and identified 48 significant flora that may potentially occur, comprised of two Threatened species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and State *Biodiversity Conservation Act 2016* (BC Act), *Gastrolobium graniticum* and *Thelymitra stellata*, 17 Priority 1 taxa, six Priority 2 taxa, 19 Priority 3 taxa and four Priority 4 taxa. None of the records of significant flora were located within the study area. No TECs listed under the EPBC Act or at the State level, nor any PECs listed by DBCA, were returned in database search results and none of the previous flora and vegetation surveys reviewed identified any vegetation types considered to have conservation significance.

Survey design, methodology and report-writing adhered to relevant principles and guidelines. Field work for flora and vegetation surveys was conducted over two trips, on 13-15 June and 2-9 October and involved a combination of sampling within bounded vegetation quadrats located in representative native vegetation, relevés (unbound areas), searches for significant species and vegetation. A total of 38 quadrats, three transects and six relevés were sampled throughout the study area. Quadrat and transect data were analysed (separately) and sites grouped by hierarchical cluster analyses (UPGMA). Vegetation types were then defined by clusters of quadrats, supplemented by field observations based on species composition, structure and dominance at the stratum level.

A total of 215 flora taxa representing 36 families and 81 genera were recorded in the study area, of which eight could not be definitively identified to species level but did not resemble any of the recorded species. A further ten specimens could not be identified to species level but were considered to represent one of the species recorded elsewhere. The assemblage included 189 perennial species and 26 annual or short-lived species, 208 native species and seven introduced species none of which were a Declared Pest or a weed of national significance. The most prominent families recorded were Chenopodiaceae (56 species), Fabaceae (20 species), Scrophulariaceae (19 species), Myrtaceae (18 species) and Asteraceae (17 species).

No Commonwealth or State listed Threatened flora were recorded in the study area during the survey. Four Priority flora, *Eremophila praecox* (P1), *Allocasuarina eriochlamys* subsp. *grossa* (P3), *Austrostipa blackii* (P3) and *Calandrinia ?quartzitica/C. ?lefyoyensis* (P1) were recorded in the study area. The specimen of the *Calandrinia* taxon could not be definitively identified due to the seeds being too immature but was shown to Frank Obbens, the taxonomic specialist for *Calandrinia*, who identified it as either one of the two Priority species (P1).

Eremophila praecox, *Allocasuarina eriochlamys* subsp. *grossa* were identified in the field and therefore plant counts obtained for these species. The *Austrostipa blackii* and the *Calandrinia* specimens were not recognised as significant species in the field and therefore the size and distribution of the

populations in the study area is unknown. Both the specimens were collected during a quadrat survey with a recorded foliage cover of 0.1% indicating the species was rare in the quadrat.

The study area represented a range extension for *Calandrinia* sp. Gypsum which was subsequently considered a significant flora for the study area.

Assessment of the likelihood of occurrence in the study area for the remaining 45 significant flora identified from the desktop assessment determined six as possible and 39 unlikely. Of those considered to possibly occur, one was Priority 1, one was Priority 2, three were Priority 3 and one was Priority 4.

A total of 19 vegetation types were defined for the study area based on statistical analyses that comprised nine *Tecticornia* spp. shrublands, one chenopod shrubland, two shrublands and seven woodlands. One *Tecticornia* spp. shrubland (MhTiDc) that occurred on undulating sandy plain adjacent a salt lake was clearly distinguishable and was mapped as a distinct vegetation type. All remaining *Tecticornia* shrublands occurred on salt lake playa and it was not possible from aerial imagery or in the field to readily distinguish boundaries between the different vegetation types defined from the statistical analysis and subsequently these vegetation types were mapped as a single mosaic.

The majority of the vegetation in the study area (86.69%) was recorded to be in Excellent to Pristine condition. A small proportion of the study area (0.37%) was recorded to be Completely Degraded, i.e. these areas had been cleared and were virtually devoid of any native vegetation. The remaining 12.94% of the study area was in Good to Very Good condition with disturbance primarily in the form of weed infestations, grazing damage from livestock, vehicle tracks and historic clearing.

None of the vegetation types represented a listed TEC or PEC. Five vegetation types defined for the study area EcDIOM, AbDIPO, CsAvDc, -EtEsOm and MhTiDc, were considered significant vegetation as they represent a refuge for significant flora species. In addition, the shrubland AbDIPO had a limited distribution that was completely encompassed within the study area; however, this vegetation type did align with vegetation recorded outside the current study area in a previous survey for MGO indicating a broader distribution in the surrounding area. All other vegetation types defined for the study area had distributions that extended out of the study area and aligned with vegetation types from other studies indicating a broader distribution in the surrounding area.

1 INTRODUCTION

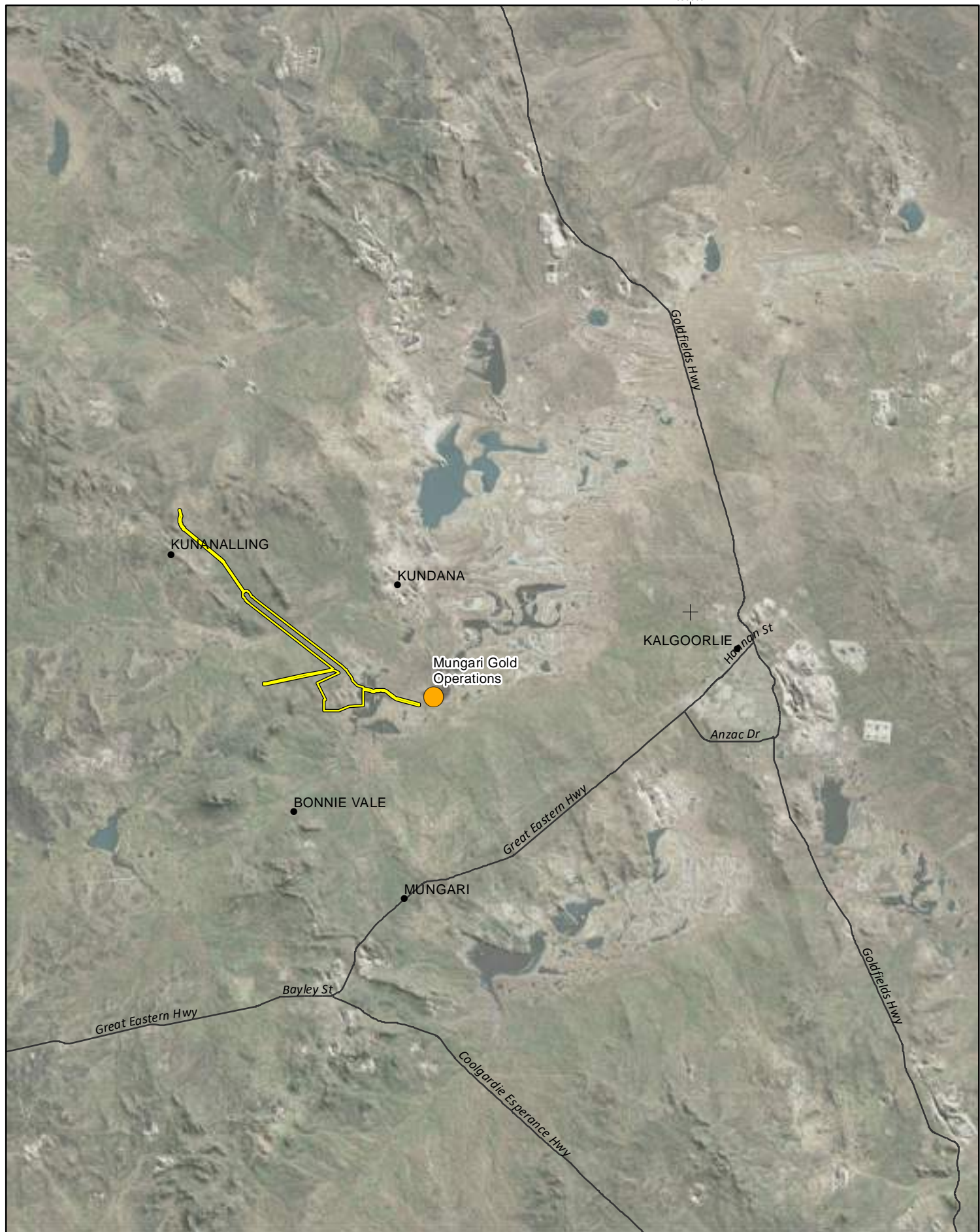
Evolution Mining Ltd (EVO) operates the Mungari Gold Operations (MGO) including the Frog's Leg and White Foil gold projects. MGO is located in the Goldfields region, approximately 20 km west of Kalgoorlie (Figure 1-1).

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by EVO to undertake a flora and vegetation survey for the Cutters Ridge Project (the Project), which included the Cutters Ridge mining area and a road corridor between Cutters Ridge and Mungari Mill (near White Foil) covering a total of 1,176.5 ha (collectively the study area), both located within the current MGO area (Figure 1-1).

1.1 SCOPE OF WORK

The scope of works for the flora and vegetation survey of the study area was as follows:

- conduct a desktop assessment of all existing flora and vegetation information collected within 40 km of the study area in order to define the potential botanical values present
- complete a two season flora and vegetation field survey, using methods applicable to a detailed (including targeted) survey (EPA 2016c)
- prepare a comprehensive technical report outlining survey outcomes of the survey for both seasons (autumn and spring 2018)
- provide commentary against the 10 clearing principles for proposed clearing within an indicative disturbance footprint for the Cutters Ridge Mine and a haul road from Mungari to Cutters Ridge
- prepare and provide all spatial data collected during the survey.



2 LEGISLATIVE CONTEXT

The protection of flora and vegetation in Western Australia (WA) is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

The BC Act came into full effect on 1 January 2019 and replaced the functions of the *Wildlife Conservation Act 1950* (WC Act).

2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of the Environment and Energy (DoEE). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a Matter of National Environmental Significance (NES), require approval from the Australian Government Minister for the Environment through a formal referral process. The EPBC Act provides for the listing of Threatened native flora and threatened ecological communities (TECs) as matters of NES.

Conservation categories applicable to Threatened Flora species under the EPBC Act are as follows:

- Extinct (EX)¹ – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent (CD)¹ – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

Ecological communities are defined as ‘naturally occurring biological assemblages that occur in a particular type of habitat’ (English & Blyth 1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

¹ Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened flora species in the following categories:

- critically endangered – species facing an extremely high risk of extinction in the wild in the immediate future²
- endangered – species facing a very high risk of extinction in the wild in the near future²
- vulnerable – species facing a high risk of extinction in the wild in the medium-term future².

Species may also be listed as specially protected under the BC Act in the one or more of the following categories:

- species of special conservation interest – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- migratory species
- cetaceans
- species subject to international agreement
- the category of species otherwise in need of special protection.

The DBCA administers the BC Act and also maintains a non-statutory list of Priority flora and fauna. Priority species are still considered to be of conservation significance – that is they may be rare or Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority flora and fauna lists are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

2.2.2 Threatened and Priority Ecological Communities

The BC Act provides for the listing of TECs in the following categories:

- critically endangered ecological community – facing an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future²
- endangered ecological community – facing a very high risk of becoming eligible for listing as a collapsed ecological community in the near future²
- vulnerable ecological community – facing a high risk of becoming eligible for listing as a collapsed ecological community in the medium-term future².

An ecological community may be listed as a collapsed ecological community under the BC Act if there is no reasonable doubt that the last occurrence of the ecological community has collapsed or the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure.

The DBCA also maintains a non-statutory list of Priority Ecological Communities (PECs), which may become TECs in the future, however, do not currently meet survey criteria or that are not adequately

² As determined in accordance with criteria set out in the ministerial guidelines.

defined. PECs are assigned to one of five categories depending on their priority for survey or definition, with Priority 1 of highest concern and Priority 5 of lowest concern.

2.2.3 Critical habitat

Under the BC Act, habitat is eligible for listing as critical habitat if it is critical to the survival of a threatened species or a TEC and its listing is otherwise in accordance with the ministerial guidelines.

2.2.4 Other significant flora, vegetation and fauna

Under the EPA's environmental factor guideline (EPA 2016a), flora and vegetation may be considered significant for a range of reasons other than listing as a Threatened or Priority species or ecological community. EPA (2016a) identifies the following:

- Flora may be significant for:
 - local endemism or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
 - new species or anomalous features that indicate a potential new species
 - representing the range of a species (particularly, at the extremes of range recently discovered range extensions, or isolated outliers of the main range)
 - being unusual species, including restricted subspecies, varieties or naturally occurring hybrids
 - having relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.
- Vegetation may be significant for:
 - having restricted distribution
 - subject to a degree of historical impact from threatening processes
 - having a role as a refuge
 - providing an important function required to maintain ecological integrity of a significant ecosystem.

2.2.5 Clearing of native vegetation

The clearing of native vegetation in WA is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected. Any clearing of native vegetation in WA requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under the Act, or is prescribed by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (the Regulations), and the vegetation is not in an Environmentally Sensitive Area (ESA). Permit applications to clear native vegetation require assessment against the '10 Clearing Principles', as outlined in the regulations.

2.2.6 Environmentally Sensitive Areas

Under section 51B of the EP Act the Minister for Environment may declare by notice either a specified area of the State or a class of areas of the State to be ESAs. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (DMP 2008). ESAs are areas where the vegetation has high conservation value. Several types of areas are declared ESAs including:

- the area covered by vegetation within 50 m of Threatened Flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened Flora is located
- the area covered by a TEC
- a defined wetland (Ramsar wetlands, conservation category wetlands and nationally important wetlands) and the area within 50 m of the wetland
- Bush Forever sites.

2.3 INTRODUCED FLORA

Introduced flora pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural structural and biological diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting; and altering fire regimes, often making fires hotter and more destructive (AWC 2007).

Management of some weed species is required under Commonwealth or State frameworks. Key classifications for significant introduced flora that are relevant to this report are:

- Declared Pest – the *Biosecurity and Agriculture Management Act 2007* (BAM Act), Section 22 makes provision for a plant taxon to be listed as a declared pest organism in parts of, or the entire State. Under the *Biosecurity and Agriculture Management Regulations 2013* Declared Pests are assigned to one of three control categories that dictate level of management required (DPIRD 2018).
- Weed of National Significance (WoNS) – high impact, established introduced flora causing major economic, environmental, social and/or cultural impacts in a number of states/territories, and which have strong potential for further spread (Australian Weeds Committee 2012). Management is required in accordance with Department of Primary Industries and Regional Development (DPIRD) guidelines for particular WoNS.

Throughout this report, introduced flora species are indicated with an asterisk (*).

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The study area is located in the Eastern Goldfields subregion (COO03) of the Coolgardie bioregion (DSEWPac 2012) which is characterised by Cowan (2001) as:

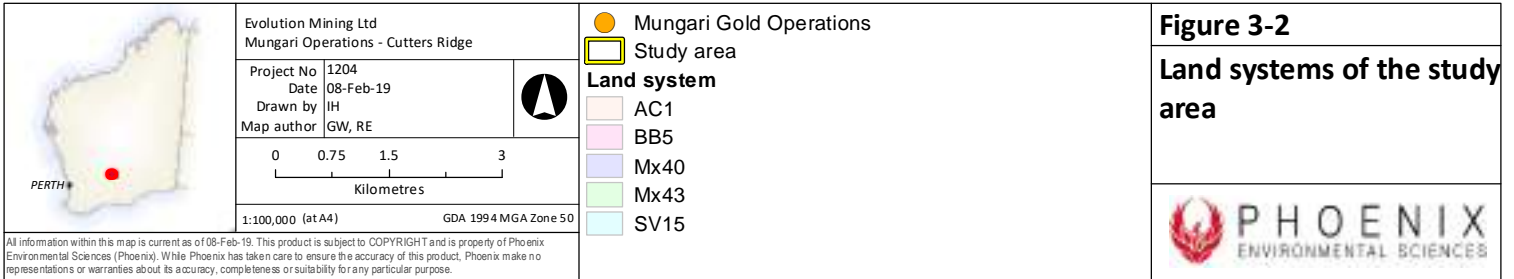
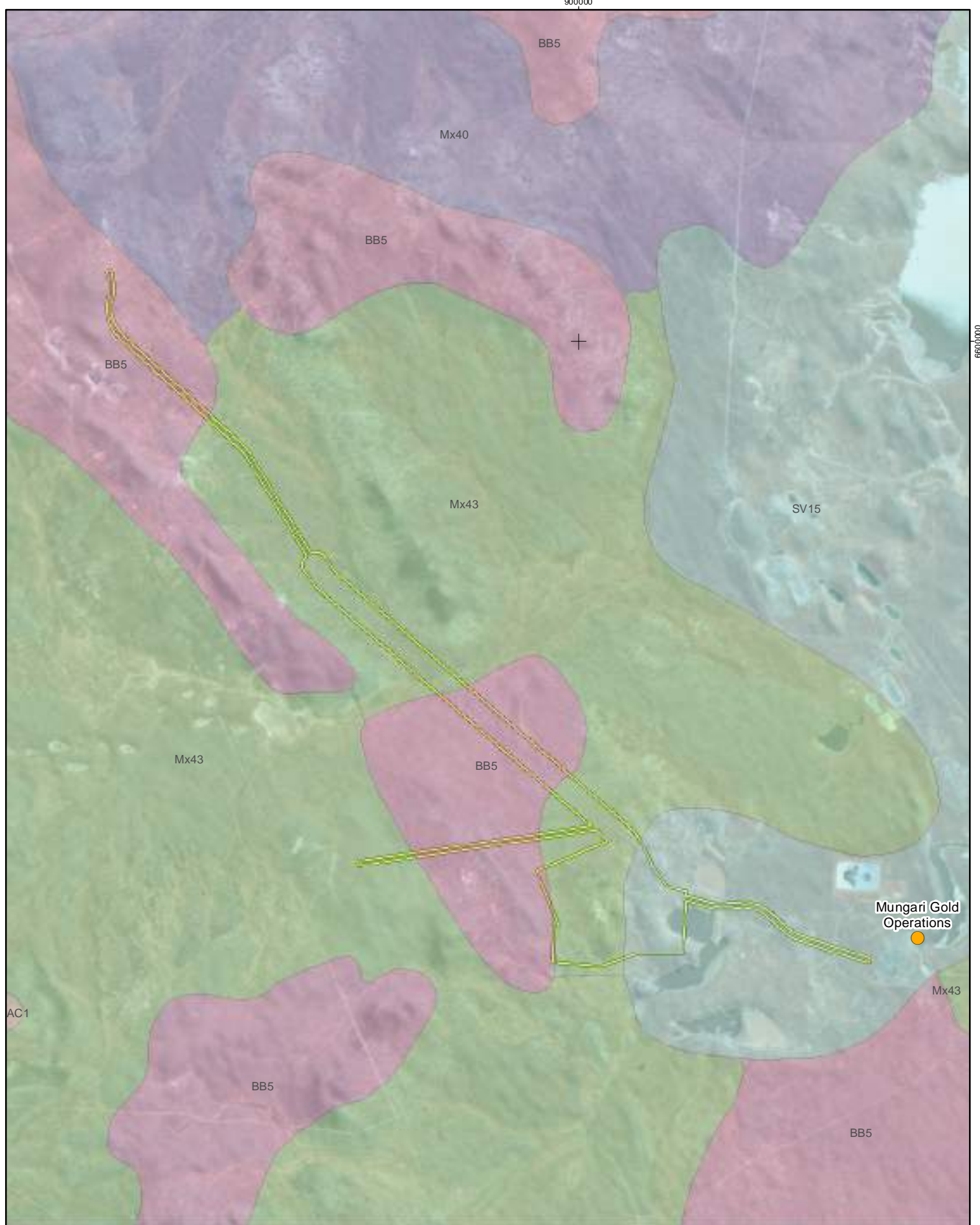
- gently undulating plains interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite
- tertiary soils dominated by calcareous earths overlay eroded gneisses and granites
- a series of large playa lakes, including Lake Lefroy, indicate the remnants of an ancient major drainage line in the western half
- vegetation consisting of mallees, *Acacia* thickets and shrub-heaths on sandplains
- dwarf shrublands of samphires persist on salt lakes, surrounded by diverse *Eucalyptus* woodlands, which also occur on ranges and in valleys.

The Eastern Goldfields subregion is regarded for its high floristic species and ecosystem diversity, in particular *Eucalyptus* spp., *Acacia* spp. and ephemeral flora communities of the Fraser Range vegetation complex and Woodline Hills and several notable wetlands including freshwater lakes, large salt lakes, claypans, and freshwater swamps such as Rowles Lagoon, Clear and Muddy Lakes and Swan Lake (Cowan 2001).

3.2 LAND SYSTEMS

According to Department of Agriculture and Food Western Australia mapping, three land systems occur in the study area (Figure 3-2):

- **BB5** – Rocky ranges and hills of greenstones-basic igneous rocks, representing 218.71 ha (18.53%) of the study area
- **Mx43** – Gently undulating valley plains and pediments; some outcrop of basic rock, representing 707.11 ha (59.92%) of the study area
- **SV15** – Salt lakes and their associated areas, representing 254.34 ha (21.55%) of the study area.



3.3 LAND USE AND CONSERVATION RESERVES

The dominant land use within the Eastern Goldfields subregion is Unallocated Crown Land (UCL) or Crown reserve and grazing-native pasture-leasehold and to a lesser extent conservation reserves and mining tenements (Cowan 2001).

The study area is not situated within any conservation reserves; however, eight reserves or former pastoral leases acquired by the DBCA for conservation occur within 40 km of the study area (Figure 1-1). Of these, the closest is Kurrawang Nature Reserve is, located approximately 12 km southeast of the study area. The former Credo pastoral lease tenement which also encompasses the Rowles Lagoon Conservation Park is located approximately 27 km northwest of the study area. The former pastoral lease was acquired by the DBCA in 2007 and is in the process of being gazetted into the reserves system to be managed for conservation. Several smaller Timber Reserves occur to the east and south of the study area (Figure 1-1).

3.4 CLIMATE AND WEATHER

The Eastern Goldfields subregion has an arid to semi-arid climate with 200–300 mm of annual rainfall which occurs mostly over winter months (Cowan 2001).

The nearest Bureau of Meteorology (BoM) weather station is located at Kalgoorlie-Boulder Airport (Latitude: 30.78°S Longitude: 121.45°E) approximately 20 km east-southeast of the study area. Kalgoorlie-Boulder Airport records the highest maximum mean monthly temperature (33.6°C) in January, the lowest maximum mean annual temperature (16.7°C) in July (BoM 2018) (Figure 3-3). The highest minimum mean monthly temp (18.3°C) is recorded in January with the lowest (5.0°C) recorded in July (BoM 2018) (Figure 3-3). Average annual rainfall is 266.3 mm with January, February and June recording the highest monthly averages (26.8, 30.4 and 27.7 mm respectively) (BoM 2018) (Figure 3-3).

Daily mean temperatures and rainfall for Kalgoorlie-Boulder Airport in the 12 months preceding the survey were comparable to annual long-term averages (Figure 3-3). Mean maximum temperatures were slightly above average for most months, with the exception of April and July – which were considerably higher – and January, February and October which were slightly below average (Figure 3-3).

Mean minimum temperatures were slightly above the average in the 12 months preceding the survey (Figure 3-3). Annual rainfall (November 2017 to October 2018) prior to the current survey was above average, with Kalgoorlie-Boulder Airport receiving 274.4 mm of rainfall compared to the long term annual average of 266.9 mm (BoM 2018) (Figure 3-3).

Rainfall for the three months before both the surveys was below average with the first season survey in June only receiving 20 mm in the three months previously (30% of the average rainfall for those months) and 39.6 mm (66% of the average rainfall) in the second season survey.

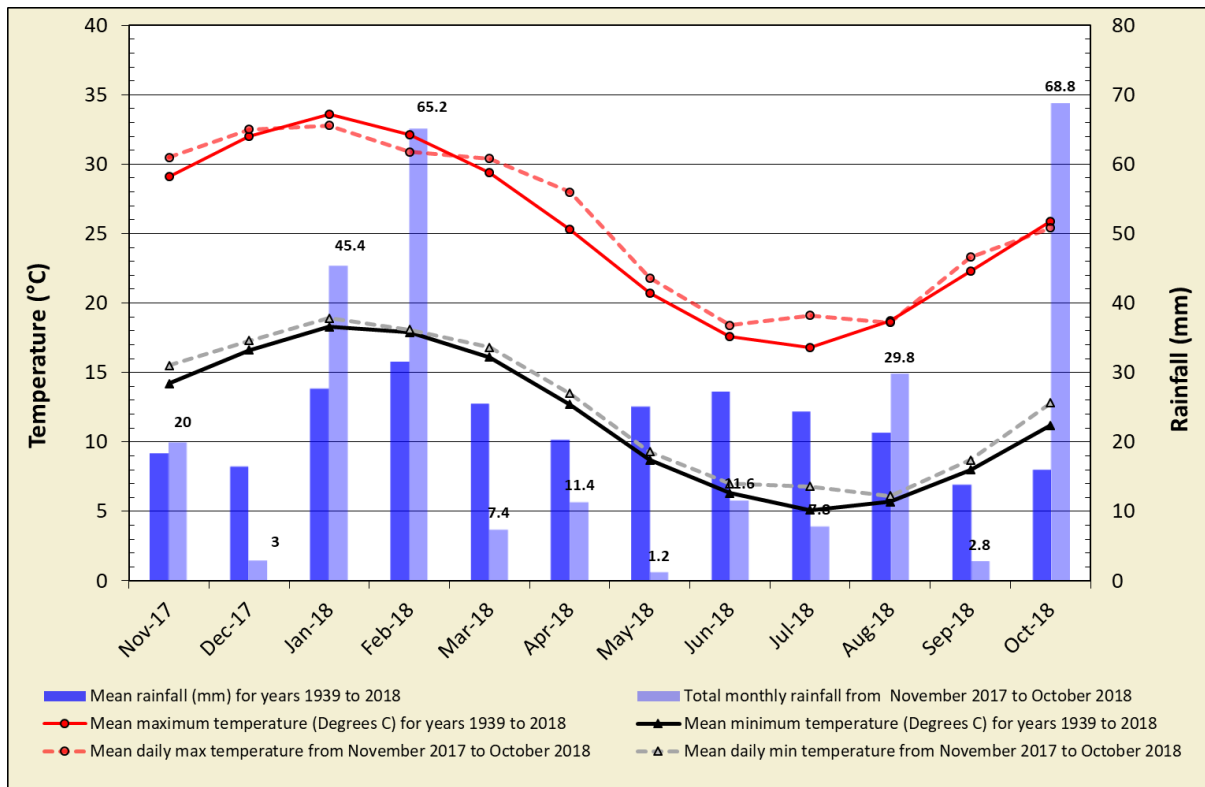


Figure 3-3 Annual climate data and mean monthly data for the 12 months preceding the field survey for Kalgoorlie-Boulder Airport (BoM 2018)

4 METHODS

The survey was undertaken in accordance with the following:

- *Environmental Factor Guideline. Flora and vegetation* (EPA 2016d)
- *Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment* (EPA 2016c).

4.1 DESKTOP ASSESSMENT

The focus of the desktop assessment was on identifying significant flora and vegetation that may be present in the study area, in particular:

- Threatened Flora listed under the EPBC Act
- Threatened Flora listed under the BC Act
- Priority Flora listed by DBCA
- TECs listed under the EPBC Act
- TECs listed under the BC Act
- PECs listed by DBCA.

Searches of relevant biological databases were undertaken for the study area with a 40 km buffer (Table 4-1). Available previous botanical reports for MGO were reviewed to build on the potential values identified from the database searches (Table 4-2).

Table 4-1 Database searches conducted for the desktop assessment

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (2018)	EPBC Act Threatened flora and ecological communities	Approximate centre point of study area (121.1729°, -30.7654°) with 40 km buffer
DPaW Threatened and Priority Flora Database (DBCA 2019)	Threatened and Priority flora	As above.
DPaW Threatened and Priority Ecological Communities Database (DBCA 2019)	Threatened and Priority ecological communities	As above.
DPaW NatureMap Database (DBCA 2018c)	Threatened and Priority flora	As above.

Table 4-2 Survey reports and datasets incorporated in the desktop assessment

Report author	Survey type	Project
Botanica Consulting (2010)	Level 2 Flora and Vegetation Survey	White Foil Area
Outback Ecology (2003)	Flora and Vegetation Survey	Proposed dewatering pipeline from Frog's Leg/White Foil Projects to Red Lake
Outback Ecology (2006)	Flora survey	Potential Cutback Areas of the Frog's Leg (M 15/688 Lease) and White Foil Open Pits (M 15/830 Lease)
Native Vegetation Solutions (2017)	Level 2 Flora and Vegetation Survey	Mungari TSF 2
Mattiske Consulting (2002)	Flora and vegetation survey	Frog's Leg project area

4.2 FIELD SURVEY

4.2.1 Quadrats, relevés and transects

Field work for flora and vegetation surveys was conducted over two trips, on 13-15 June and 2-9 October 2018 and involved a combination of sampling within bounded vegetation quadrats located in representative native vegetation, relevés (unbound areas), targeted searches for significant species and vegetation, as well as traversing the study area to record additional flora taxa present and condition of the vegetation (Figure 4-1). Survey site locations were selected to ensure that an accurate representation of the major vegetation types within the study area were sampled adequately. Preliminary survey locations were pre-selected using high-quality aerial photography with selection based on apparent changes in the vegetation visible in the aerial imagery. A total of 38 quadrats, three transects and six relevés were sampled throughout the study area (Figure 4-1; Appendix 1).

Sampling sites for the Eastern Goldfields subregion consist of quadrats of 20 m x 20 m (400 m²) in dimension. The intensity of sampling aimed to provide a minimum of three quadrats per vegetation unit (per EPA 2016b) and was determined by the complexity of the flora and vegetation. All quadrats were orientated (where possible) in a north-south direction measured out with a tape measure, the NW corner permanently marked with a steel fence dropper. The following attributes were recorded at each quadrat:

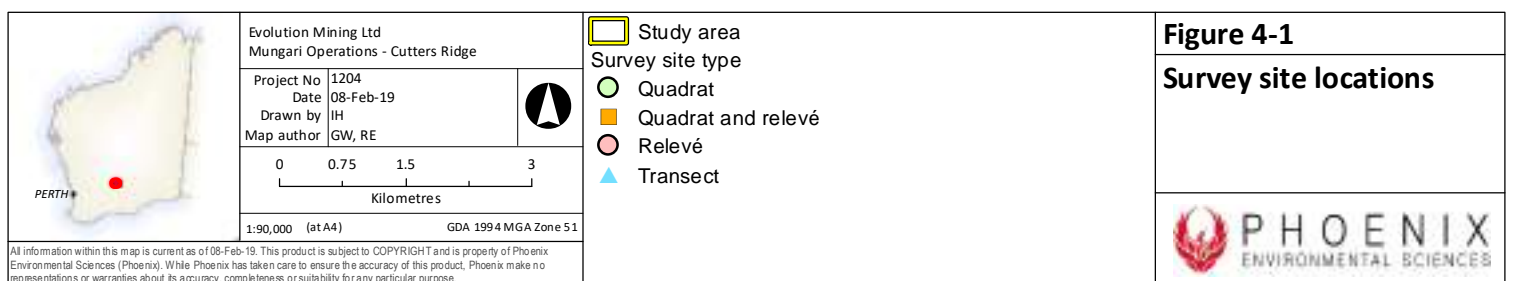
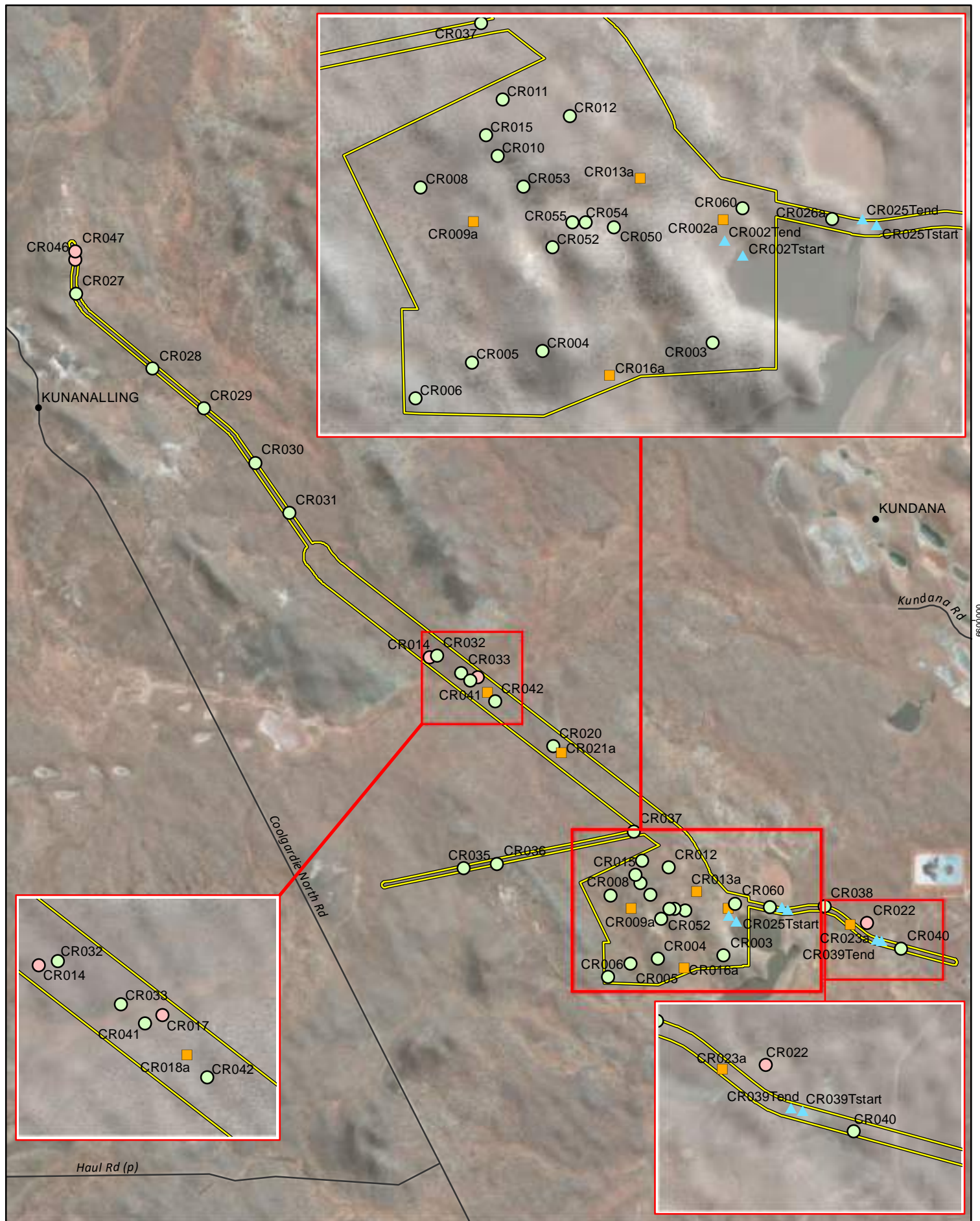
- location – the geographic coordinates of all four corners of each quadrat and single point for relevé in WGS84 datum using a handheld GPS
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (ESCAVI 2003a) and in accordance with EPA (2016c) (Table 4-3)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity

- vegetation condition – the condition of the vegetation was recorded utilising the appropriate condition scale for the South West Interzone botanical province (EPA 2016b) (Table 4-3)
- height and percentage foliage cover (PFC) – a visual estimate of the canopy cover of each species present within the quadrat was recorded as a percentage, as was the total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
- photograph – a colour photograph of the vegetation within each quadrat in a south-easterly direction from the north-west corner of the quadrat
- flora species list – a list including the name of every flora species present within the quadrat; to ensure accurate taxonomic identification of flora species present within the study area, collections were made of each specimen at least once and each collection was pressed and documented for identification using the WA Herbarium resources.

The following information was recorded for each relevé:

- location – the geographic coordinates of a single point in WGS84 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (ESCAVI 2003b) and in accordance with EPA (2016c) (Appendix 1)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity
- vegetation condition – the condition of the vegetation was recorded utilising the appropriate condition scale for the South West Interzone botanical province (EPA 2016b) (Table 4-3)
- photograph – a colour photograph of the vegetation.

Transect (defined straight line along which data are recorded) sampling was employed to describe riparian vegetation surrounding lake playas in the study area (per EPA 2016b). Transect surveys utilized 3 m x 3 m (9 m²) quadrats spaced evenly along linear transects to sample the riparian vegetation across the lakes to obtain detailed data (as specified for the 20 m x 20 m quadrats above).



4.2.2 Significant flora searches

Searches were undertaken for significant flora identified in the desktop review and – in the second phase survey – for significant flora recorded in the first phase. Greater survey effort was employed for significant species of higher conservation significance (i.e. Threatened, Priority 1) and, in the spring survey, in habitats suitable for spring-detectable species. Searches were intensified in low lying areas as these areas typically support a higher level of biodiversity.

The location of significant species previously recorded within the study area was targeted to confirm their presence, state (e.g. flowering) and abundance. Searches for further populations of targeted flora focused on similar habitat areas to the existing known populations. If a flora species was considered to potentially be a conservation significant species (i.e. similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable
- description of the habitat and floristic community in which the potential conservation significant species was located
- population size estimate (i.e. estimated number of individual plants) where applicable
- specimen collection for taxonomic identification and lodgement at the WA Herbarium
- photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

4.2.3 Vegetation mapping

The vegetation descriptions from quadrats and transects from the survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and combination of species and the prevalent community type (i.e. woodland, shrubland, etc.). To support delineation of vegetation types, cluster analyses were conducted based on species composition in each quadrat. As cover values for each species were recorded during the spring survey the analyses were conducted for species cover. In accordance to the current guidance (EPA 2016b) annual and short-lived (ephemeral) species were excluded from the dataset along with any taxon that could not be definitively identified to species level and singletons (species recorded at only one location with a cover value of 0.1%). Separate analyses were conducted for the 50 m x 50 m quadrats and the 3 m x 3 m quadrats scored for the transect surveys.

The fusion strategy for the site classification was flexible UPGMA with a beta value of -0.1 and Bray Curtis association measure in the software package PATN (Belbin 2003). A dendrogram was produced to illustrate the similarities between the vegetation units identified. Statistically distinct vegetation units (the floristic group) classified the vegetation at a local scale. Local scale vegetation units were described at NVIS Level V – Association (ESCAVI 2003b). The term ‘vegetation type’ was used for local scale vegetation units in accordance with (EPA 2016b).

The vegetation types thereby defined were then compared to relevé survey descriptions and the relevé assigned to the appropriate vegetation type.

The vegetation boundaries were mapped utilising high-quality colour aerial photography and from vegetation boundaries recorded on GPS during the field survey.

4.2.4 Condition mapping

The condition of vegetation was mapped across the study area based on the appropriate condition rating scale for the South West Interzone botanical province (EPA 2016b). The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranges from Pristine being the highest rating to Completely Degraded as the lowest (Table 4-3).

Table 4-3 Vegetation condition rating scale for South West Interzone botanical province (EPA 2016c)

Vegetation condition	Description
Pristine	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

4.2.5 Likelihood of occurrence assessment

The potential for occurrence in the study area of the significant flora and vegetation identified in the database searches was assessed. The assessment was based on reviewed information relating to habitat preference (soils, landforms, elevation and vegetation associations) and locality records from the database searches.

The flora assessments assigned each taxon to one of four ratings:

- definite – species recorded within the study area by previous or current survey
- likely – study area within known range of species; suitable habitat within the study area and/or records within 5 km of study area

- possible – study area within known range of species; optimal or potential habitat within the study area, no records within 5 km of study area
- unlikely – study area outside known range of species, no records within 5 km and/or no suitable habitat present in study area.

4.2.6 Taxonomy and nomenclature

Species that were well known to the survey botanists were identified in the field, while species that were unknown were collected and assigned a unique number to facilitate tracking. *Tecticornia* species are difficult to discern in the field as identification frequently relies on microscopic identification of reproductive structures, e.g. seeds. Specimens of all 'recognized' species of *Tecticornia* were therefore collected for identification.

Plant species collected during the survey were identified by the use of local and regional flora keys and by comparison with the named species held at the WA Herbarium. Plant taxonomists who are considered to be an authority on a particular plant group were consulted. All *Tecticornia* specimens were sent to Dr Kelly Shepherd at the WA Herbarium for identification.

Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DBCA 2018b) and the WA Herbarium.

4.3 SURVEY PERSONNEL

The personnel involved in the survey are presented in Table 4-4.

Table 4-4 Project team

Name	Qualifications	Role/s
Dr Grant Wells	PhD (Botany)	Project Manager, field surveys, flora taxonomy, data analyses and report review
Dr Grace Wells	PhD (Plant Conservation)	GIS, vegetation mapping and reporting
Alice Watt	BSc. Hons (Cons Bio. and Botany)	Field survey and reporting
Frank Obbens	BSc. Hons. (Env. Biol.)	Taxonomy
Karen Crews	BSc. (Env. Biol.) (Hons)	Report review
Ian Hay	B App Science (Surveying and mapping)	GIS

5 RESULTS

5.1 DESKTOP REVIEW

The database searches identified a high species diversity, with 844 flora taxa recorded within the area of the desktop assessment (Appendix 2).

5.1.1 Significant flora

Records of 48 significant flora were identified within the 40 km radius of the study area (Table 5-1). These comprised of two Threatened species, *Gastrolobium graniticum* (EN EPBC Act, VU BC Act) and *Thelymitra stellata* (EN EPBC Act and BC Act), 17 Priority 1 taxa, six Priority 2 taxa, 19 Priority 3 taxa and four Priority 4 taxa. None of the records of significant flora were located within the study area (Figure 5-1). None of the previous flora surveys from the desktop review found any Threatened or Priority species.

Table 5-1 Significant flora records from the area of the database searches

Species	Cons. code	Habitat
<i>Gastrolobium graniticum</i>	EN (EPBC Act); VU (BC Act)	Flowers yellow, orange and red, in Aug to Sep. Occurs in sand, sandy loam and granite, on the margins of rock outcrops and along drainage lines (DBCA 2018b).
<i>Thelymitra stellata</i>	EN (EPBC Act, BC Act)	Flowers yellow and brown, in Oct to Nov. Occurs in sand, gravel and lateritic loam (DBCA 2018b).
<i>Acacia coatesii</i>	P1	Open woodland dominated by <i>Eucalyptus clelandii</i> and <i>E. lesouefii</i> over open shrubland that includes <i>Acacia erinacea</i> , <i>A. hemiteles</i> , <i>Atriplex nummularia</i> , <i>Eremophila scoparia</i> , <i>Dodonaea stenozyga</i> and <i>Olearia muelleri</i> . Grows in shallow, red, sandy clay on flat or gently sloping ground towards the base of a low greenstone ridge. Flowers from mid-Aug to early Oct (Maslin 2014).
<i>Acacia epedunculata</i>	P1	Flowers in Aug. Grows in moderately exposed, gently undulating sandplains in deep, yellow, well-drained sand in <i>Eucalyptus leptopoda</i> very open shrub mallee (DBCA 2018b).
<i>Acacia sclerophylla</i> var. <i>teretiuscula</i>	P1	Flowers in Sep to Oct. Grows in clay & loamy soils (DBCA 2018b).
<i>Acacia websteri</i>	P1	Grows in red sand, clay or loam. Low-lying areas, flats (DBCA 2018b). <i>Acacia/Eucalyptus/Allocasuarina</i> woodland/shrubland.
<i>Austrostipa</i> sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)	P1	Grass to 40 cm. Occurs in loamy soils, sparse mallee woodland / tall open shrubland (DBCA 2018b).
<i>Dampiera plumosa</i>	P1	Flowers blue, in Oct. Grows in red sandy soils (DBCA 2018b).
<i>Eremophila praecox</i>	P1	Flowers purple, in Oct or Dec. Grows in red/brown sandy loam. Undulating plains (DBCA 2018b).
<i>Eucalyptus websteriana</i> subsp. <i>norsemanica</i>	P1	Flowers yellow, in Sep to Nov. Occurs on rocky rises (DBCA 2018b).
<i>Lepidosperma</i> sp. Parker Range (N. Gibson & M. Lyons 2094)	P1	Previously recorded on ridges and slopes, in brown clay loam/ clay-gravel over granite or laterite. Recorded from <i>Eucalyptus stricklandii</i> and <i>E. orbifolia</i> mallee shrubland, open <i>Acacia</i>

Species	Cons. code	Habitat
		shrubland, open <i>Eucalyptus</i> woodland, low sparse <i>Dodonaea lobulata</i> shrubland (DBCA 2018b).
<i>Melichrus</i> sp. Coolgardie	P1	Light pink pendent flowers in August. Previously recorded from Low <i>Eucalyptus concinna</i> woodland on slope; yellow sand on flats and undulating plains; sparse mallee over low heath; and scattered, open <i>Casuarina</i> shrubland on plain (DBCA 2018b).
<i>Phebalium appressum</i>	P1	Flowers white, in Jul. Occurs on yellow sandplain (DBCA 2018b).
<i>Philotheca pachyphylla</i>	P1	Flowers white, in May or Sep. Grows in sand, red loam and clay loam on sandplains and hill tops (DBCA 2018b).
<i>Ptilotus chortophytus</i>	P1	Recorded on breakaways, stony/rocky hills often with quartz. Brown loam often with shale (ALA 2018; DBCA 2018b).
<i>Ptilotus procumbens</i>	P1	Flowers pink-white, in Nov. Grows in red clay (DBCA 2018b).
<i>Rhodanthe uniflora</i>	P1	Flowers yellow, in Aug to Oct. Recorded from open <i>Eucalyptus</i> woodland and sparse <i>Maireana pyramidata</i> shrubland in red clay and brown soil (DBCA 2018b).
<i>Thryptomene</i> sp. Coolgardie (E. Kelso s.n. 1902)	P1	No habitat data for this species. Previously collected in Oct (DBCA 2018b).
<i>Thryptomene</i> sp. Londonderry (R.H. Kuchel 1763)	P1	Small pink/white flowers in Jun to Nov. <i>Acacia</i> and <i>Casuarina</i> shrubland, <i>Acacia</i> and <i>Allocasuarina</i> low woodland. Orange-brown sand, well-drained yellow sand (DBCA 2018b).
<i>Austrostipa</i> sp. Dowerin (G. Wiehl F 8004)	P2	Level crest of basalt and minor calcrete with red-brown skeletal light medium clay soils. Plain in reserve site. Dry red sand / loam (ALA 2018).
<i>Elachanthus pusillus</i>	P2	Low plains, drainage flats in red clay, red loam soils (DBCA 2018b).
<i>Goodenia salina</i>	P2	Well-drained, saline, grey or brown loamy clay. Low gypseous dunes near salt pans (DBCA 2018b).
<i>Hakea rigida</i>	P2	Flowers pink, in Sep to Oct. Sandy soils, yellow sand (DBCA 2018b).
<i>Lepidium merrallii</i>	P2	Clay loam (DBCA 2018b).
<i>Phebalium clavatum</i>	P2	Flowers white, in Aug to Sep. Sandy soils, sandplains (DBCA 2018b).
<i>Acacia crenulata</i>	P3	Clay, sandy clay, yellow sand. Rocky rises, granite outcrops, breakaways (DBCA 2018b).
<i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i>	P3	Stony loam, laterite clay. Granite outcrops (DBCA 2018b).
<i>Alyxia tetanifolia</i>	P3	Flowers white-cream, in May to Jun or Nov. Sandy clay, loam, concretionary gravel. Drainage lines, near lakes (DBCA 2018b).
<i>Angianthus prostratus</i>	P3	Flowers white-yellow, in Jul to Sep. Red clay or loamy soils. Saline depressions (DBCA 2018b).
<i>Austrostipa blackii</i>	P3	Flowers in Sep to Nov. Shaded areas atop rocky banded ironstone formation ridge. Clay soils, between outcroppings. Crest. Red clay loam (ALA 2018).

Species	Cons. code	Habitat
<i>Chrysocephalum apiculatum</i> subsp. <i>norsemanense</i>	P3	Recorded growing in various soil types including yellow or red sand, yellow sandy clay, and calcareous soil. Flowers yellow, in Aug to Oct. Occurs in open <i>Acacia</i> and <i>Eucalyptus</i> woodland (ALA 2018; DBCA 2018b).
<i>Cyathostemon verrucosus</i>	P3	White flowers. Recorded flowering in Apr, Jul, Sep, Oct, Nov, Found on yellow sand plains, recorded in shrublands, sometimes dominated by mallees or <i>Banksia</i> (ALA 2018; DBCA 2018b).
<i>Diocirea acutifolia</i>	P3	Flowers white, in Nov to Dec. Occurs in clay loam, gravelly loam on undulating flats (DBCA 2018b).
<i>Diocirea microphylla</i>	P3	Flowers white, in Nov to Dec. Grows in red-brown clay loam (DBCA 2018b).
<i>Eremophila veronica</i>	P3	Flowers purple, in Apr to May. Grows in stony clay, clay loam on lateritic breakaways (DBCA 2018b).
<i>Gompholobium cinereum</i>	P3	Recorded growing in yellow sand, clayey sand, brown loam, sandy gravel and laterite. Occurs in well-drained open sites, slopes, plains, roadsides (DBCA 2018b).
<i>Grevillea georgeana</i>	P3	Flowers red/red & pink & cream, in Jan or Mar or Sep to Nov. Occurs in stony loam/clay on ironstone hilltops & slopes (DBCA 2018b).
<i>Isolepis australiensis</i>	P3	Flowers in Jun or Sep. Grows in silty sand and sandy clay on lake margins and pools (DBCA 2018b).
<i>Lepidium fasciculatum</i>	P3	Habitat records include brown cracking clay plain and dry lake bed with red loam soil (DBCA 2018b).
<i>Melaleuca coccinea</i>	P3	Flowers red, in Sep to Nov or Jan. Occurs in sandy loam over granite, granite outcrops, sandplains, river valleys (DBCA 2018b).
<i>Notisia intonsa</i>	P3	Occurs in eucalypt woodlands on floodplains, lake edges, seasonally wet areas, in clayey soils (DBCA 2018b).
<i>Phlegmatospermum eremaeum</i>	P3	Flowers white-cream, in Jun or Aug to Oct. Occurs in chenopod and eucalypt shrubland on flats and edges of salt lakes, in stony loam – clay/loam soils (DBCA 2018b).
<i>Rinzia triplex</i>	P3	Flowers pink, in Jun, Jul, Aug, Sep. Recorded on sandy plains in yellow to red, often gravelly or lateritic soils (ALA 2018; DBCA 2018b).
<i>Styphelia</i> sp. Bullfinch	P3	Flowers white, in Jul to Sep. Recorded from laterite breakaways/outcroppings, in clay loams (DBCA 2018b).
<i>Eremophila caerulea</i> subsp. <i>merrallii</i>	P4	Flowers purple, Oct to Dec. Occurs in eucalypt woodlands (often <i>E. salubris</i>), growing in sand, clay or loam on flats and undulating plains (DBCA 2018b).
<i>Eucalyptus jutsonii</i> subsp. <i>jutsonii</i>	P4	Grows in deep yellow to orange sand in broad and subdued rises (DBCA 2018b).
<i>Eucalyptus x brachyphylla</i>	P4	Flowers white, in Jun. occurs in sandy loam, on granite outcrops.
<i>Frankenia glomerata</i>	P4	Flowers pink-white, in Nov. White sand. Occurs in floodplains, salt lake edges, saline flats in white, grey sand-loam (DBCA 2018b).



Evolution Mining Ltd Mungari Operations - Cutters Ridge		
Project No	1204	
Date	08-Feb-19	
Drawn by	IH	
Map author	GW, RE	
1:500,000 (at A4) GDA 1994 MGA Zone 50		

- Mungari Gold Operations
- Study area
- Significant flora conservation status**
 - P1
 - P2
 - P3
 - P4
 - T

Figure 5-1
DBCA records of significant flora



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5.1.2 Introduced flora

The desktop assessment identified records of 87 introduced species within the 40 km radius of the study area, of which 10 are a Declared Pest and seven are WoNS (Table 5-2; Appendix 2).

Table 5-2 Introduced flora records from the area of the database searches

Species name	Declared Pest	WoNS
* <i>Alhagi maurorum</i> (Camelthorn)	s22(2) (C3)	
* <i>Alyssum linifolium</i>	s22(2) (Exempt)	
* <i>Cylindropuntia fulgida</i> var. <i>mamillata</i>	s22(2) (C3 Restricted)	Y
* <i>Cylindropuntia imbricata</i>	s22(2) (C3 Restricted)	Y
* <i>Cylindropuntia kleiniae</i>	s22(2) (C3 Restricted)	Y
* <i>Cylindropuntia tunicata</i>	s22(2) (C3 Restricted)	Y
* <i>Echium plantagineum</i> (Paterson's Curse)	s22(2) (Exempt)	
* <i>Lycium ferocissimum</i>		Y
* <i>Opuntia elata</i>	s22(2) (C3 Restricted)	Y
* <i>Opuntia ficus-indica</i>	s22(2) (C3 Exempt)	Y
* <i>Xanthium spinosum</i> (Bathurst Burr)	s22(2) (C2, C3)	

5.1.3 Vegetation associations

Regional scale vegetation mapping by Shepherd *et al.* (2002) mapped five vegetation associations in the study area (Figure 5-2):

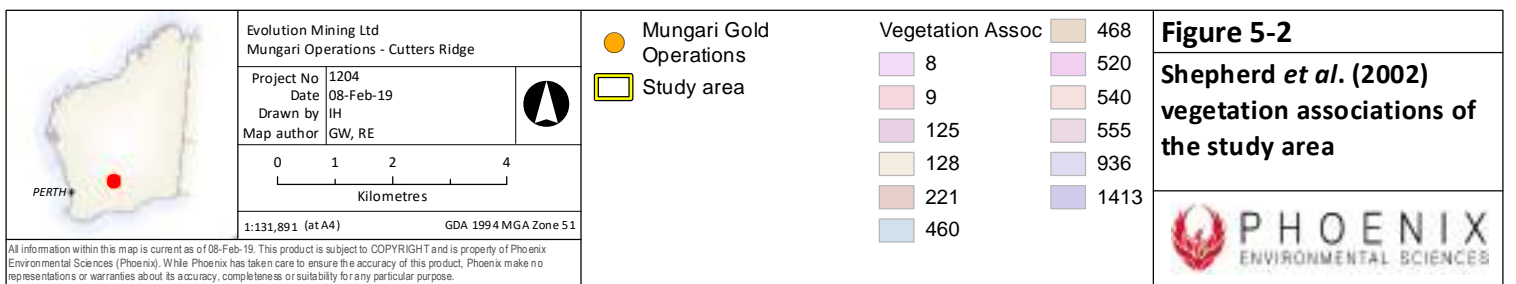
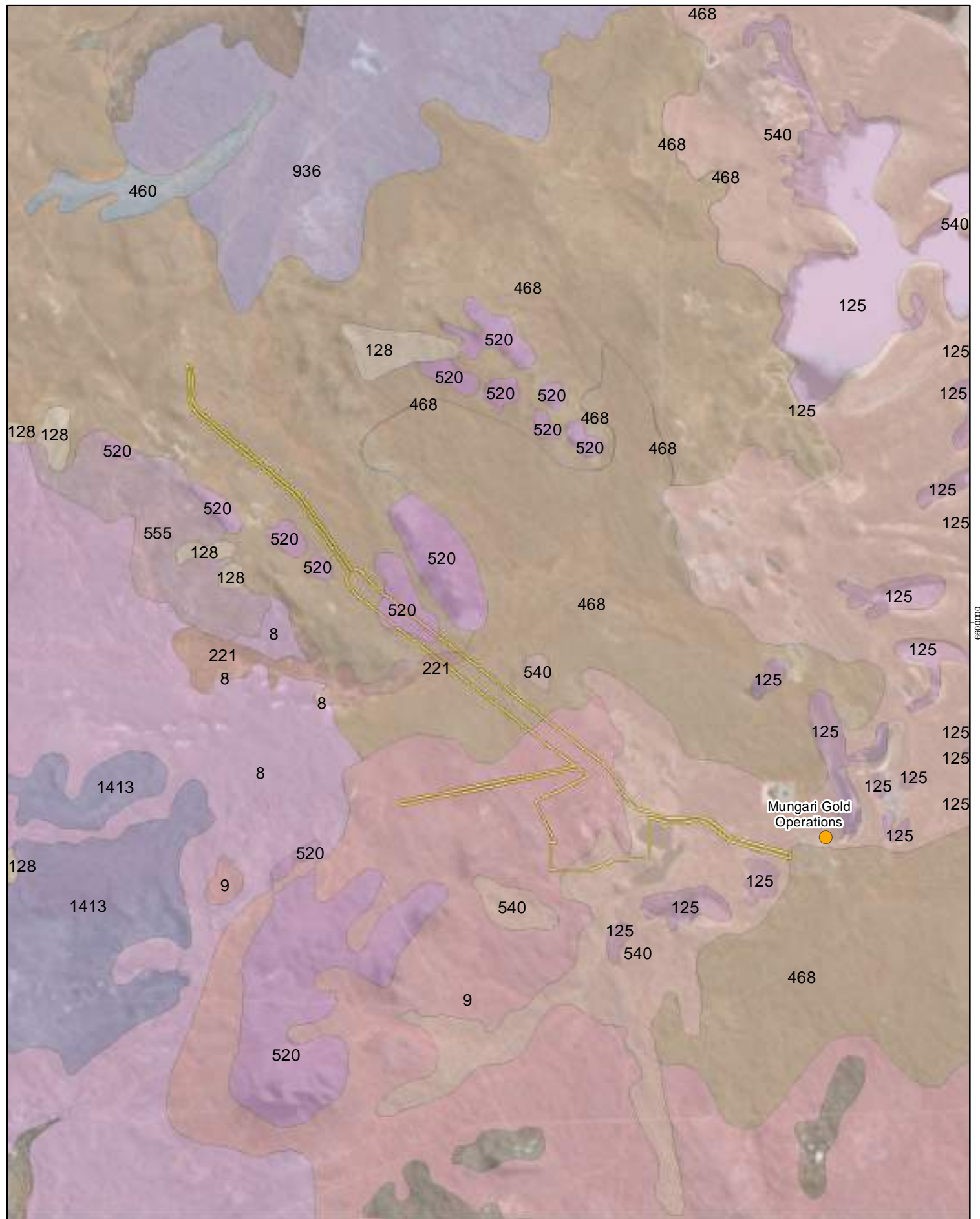
- Association 9: Medium woodland; coral gum (*Eucalyptus torquata*) & goldfields blackbutt (*E. lesouefii*), (also some e10,11)
- Association 221: Succulent steppe; saltbush
- Association 468: Medium woodland; salmon gum & goldfields blackbutt
- Association 520: Shrublands; *Acacia quadrimarginea* thicket
- Association 540: Succulent steppe with open low woodland; sheoak over saltbush.

The remaining extent of all vegetation associations at the Statewide scale exceeds 94% (DBCA 2018a) and they are therefore considered of Least Concern (Table 5-3). All five associations have over 95% remaining at the bioregional and subregional scales (DBCA 2018a).

Only one vegetation association has below 10% proportion of extent in DBCA managed lands (association 9) at the Statwide scale, the rest have above 17% extent and association 520 represented by almost half (45.5%) of extent in DBCA managed lands (Table 5-3).

Table 5-3 Statewide extent of Pre-European vegetation associations present in the study area (DBCA 2018a)

Vegetation association	Pre-European extent (ha)	Current extent (ha)	Remaining (%)	Current extent in DBCA managed lands (%)	% of study area
9	240,509.33	235,161.94	97.78	8.07	47.9
221	63,720.06	59,923.05	94.04	17.99	1.8
468	592,022.31	583,902.76	98.63	23.15	25.3
520	37,922.62	37,369.58	98.54	45.54	6.7
540	202,423.88	200,158.84	98.88	28.18	18.3
Total					100.0



5.1.4 Significant vegetation

No TECs listed under the EPBC Act or at the State level, nor any PECs listed by DBCA were returned in the database search results.

Mattiske Consulting (2002) defined 19 vegetation types comprised of *Eucalyptus* woodlands, chenopod shrublands and mixed shrublands dominated by *Eremophila* species all of which were described as “widespread and were not found to have any flora conservation issues associated with them”. Outback Ecology (2003) defined 26 vegetation types and described them as well represented in the surrounding areas and therefore not considered ecologically significant. Similarly, none of the previous survey reports reviewed identified any of the vegetation defined as significant vegetation (Botanica Consulting 2010; Native Vegetation Solutions 2017; Outback Ecology 2006).

5.2 FIELD SURVEY

A total of 215 flora taxa representing 36 families and 81 genera were recorded in the study area during the field surveys (Appendix 3), of which eight could not be definitively identified to species level and did not resemble any of the recorded species. A further ten specimens could not be identified to species level but were considered to represent one of the species recorded elsewhere. Species richness ranged from 8–34 species between quadrats (Appendix 1). The assemblage included 208 native species and seven introduced species, including 189 perennial species and 26 annual or short-lived species. The most prominent families recorded were Chenopodiaceae (56 species), Fabaceae (20 species), Scrophulariaceae (19 species), Myrtaceae (18 species) and Asteraceae (17 species).

5.2.1 Significant flora

No Commonwealth or State listed Threatened flora were recorded in the study area during the survey. Four Priority flora, *Eremophila praecox* (P1), *Allocasuarina eriochlamys* subsp. *grossa* (P3), *Austrostipa blackii* (P3) and *Calandrinia ?quartzitica/Calandrinia ?lefroyensis* (P1) were recorded in the study area (Figure 5-3).

A specimen of the *Calandrinia* taxon collected from the study area could not be definitively identified due to the seeds being too immature. The specimen was shown to Frank Obbens, the taxonomic specialist for *Calandrinia*, who identified it as either *C. ?quartzitica* (P1) or *C. ?lefroyensis* (P1) (see section 5.2.1.1.4 and 5.2.1.1.5).

Both the *Austrostipa blackii* and the *Calandrinia* specimens collected in the study area were not recognised as a significant species in the field and therefore the size and distribution of the population in the study area is unknown. Both the specimens were collected during a quadrat survey with a recorded foliage cover of 0.1% indicating the species was rare in the quadrat.

Assessment of the likelihood of occurrence in the study area for the remaining 45 significant flora identified from the desktop assessment (Table 5-1) determined six as possible and 39 unlikely (Table 5-4). Of those considered to possibly occur, one was Priority 1, one was Priority 2, three were Priority 3 and one was Priority 4.

The study area represented a range extension for two taxa:

- *Calandrinia* sp. Gypsum, ~110 km northern range extension, therefore considered a significant flora as it is a new range extension for this species
- both of the possible identifications of the *Calandrinia* specimen, *C. quartzitica* (P1), ~70 km southern extension or *C. lefroyensis* (P1), ~60 km north-west range extension.

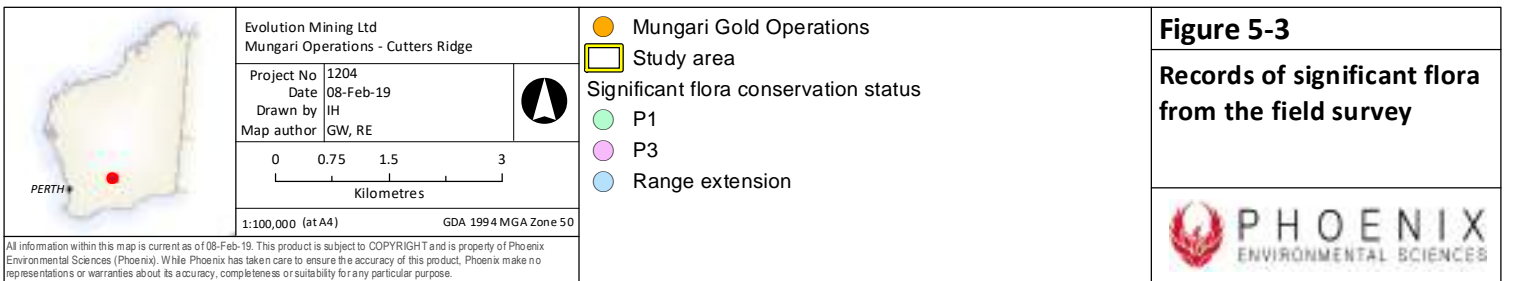


Table 5-4 Likelihood of occurrence for conservation significant flora in the study area

Species	Cons. code	Likelihood of occurrence
<i>Gastrolobium graniticum</i>	EN (EPBC Act); VU (BC Act)	Unlikely, lack of suitable habitat in the study area.
<i>Thelymitra stellata</i>	EN (EPBC Act, BC Act)	Unlikely, the record came up in the Protected Matters database search but the nearest records occur hundreds of kilometres from the study area.
<i>Acacia coatesii</i>	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Acacia epedunculata</i>	P1	Unlikely, possible suitable habitat but closest record over 40 km from the study area.
<i>Acacia sclerophylla</i> var. <i>teretiuscula</i>	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Acacia websteri</i>	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Austrostipa</i> sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Dampiera plumosa</i>	P1	Unlikely, limited suitable habitat in study area and record approximately 30km from study area.
<i>Eremophila praecox</i>	P1	Definite, found in study area.
<i>Eucalyptus websteriana</i> subsp. <i>norsemanica</i>	P1	Unlikely, some suitable habitat in study area but record >30km from study area.
<i>Lepidosperma</i> sp. Parker Range (N. Gibson & M. Lyons 2094)	P1	Unlikely, limited suitable habitat in study area but record approximately 30 km from study area.
<i>Melichrus</i> sp. Coolgardie	P1	Unlikely, limited suitable soil type in study area but record approximately 40 km from study area.
<i>Phebalium appressum</i>	P1	Possible, some suitable habitat in study area and record within 10 km.
<i>Philotheca pachyphylla</i>	P1	Unlikely, some suitable habitat in study area but record >30km from study area.
<i>Ptilotus chortophytus</i>	P1	Unlikely, some suitable habitat in study area but record >20 km from study area.
<i>Ptilotus procumbens</i>	P1	Unlikely, some suitable soil type in study area but record >20km from study area.
<i>Rhodanthe uniflora</i>	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Thryptomene</i> sp. Coolgardie (E. Kelso s.n. 1902)	P1	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Thryptomene</i> sp. Londonderry (R.H. Kuchel 1763)	P1	Unlikely, no suitable habitat in study area.
<i>Austrostipa</i> sp. Dowerin (G. Wiehl F 8004)	P2	Unlikely, no suitable habitat (basalt and minor calcrete) in study area.
<i>Elachanthus pusillus</i>	P2	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Goodenia salina</i>	P2	Unlikely, no suitable habitat (low gypseous dunes) in study area.

Species	Cons. code	Likelihood of occurrence
<i>Hakea rigida</i>	P2	Possible, some suitable soil type (yellow sand) in study area and record within 10 km of study area.
<i>Lepidium merrallii</i>	P2	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Phebalium clavatum</i>	P2	Unlikely, some suitable habitat in study area but record >30 km from study area.
<i>Acacia crenulata</i>	P3	Unlikely, some suitable habitat in study area but record >30 km from study area.
<i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i>	P3	Definite, found in study area.
<i>Alyxia tetanifolia</i>	P3	Possible, some suitable habitat (drainage lines, near lakes) in study area and record within 20km of study area.
<i>Angianthus prostratus</i>	P3	Possible, some suitable habitat in study area but record >30 km from study area.
<i>Austrostipa blackii</i>	P3	Definite, found in study area.
<i>Chrysocephalum apiculatum</i> subsp. <i>norsemanense</i>	P3	Unlikely, no suitable habitat in study area.
<i>Cyathostemon verrucosus</i>	P3	Unlikely, some suitable soil type (yellow sand) in study area but record >20km from study area.
<i>Diocirea acutifolia</i>	P3	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Diocirea microphylla</i>	P3	Unlikely, suitable habitat in study area but closest record approximately >20 km from study area.
<i>Eremophila veronica</i>	P3	Unlikely, no suitable habitat (lateritic breakaways) in study area.
<i>Gompholobium cinereum</i>	P3	Possible, suitable habitat in study area and record within 20 km of study area.
<i>Grevillea georgeana</i>	P3	Unlikely, some suitable habitat (ironstone hilltops & slopes) in study area but record >20km from study area.
<i>Isolepis australiensis</i>	P3	Unlikely, some suitable habitat (silty sand and sandy clay on lake margins and pools) in study area but record >20 km from study area.
<i>Lepidium fasciculatum</i>	P3	Unlikely, no suitable habitat (brown cracking clay plain and dry lake bed) in study area.
<i>Melaleuca coccinea</i>	P3	Unlikely, no suitable soil type (sandy loam over granite) in study area.
<i>Notisia intonsa</i>	P3	Unlikely no suitable habitat (eucalypt woodland on floodplain) in study area.
<i>Phlegmatospermum eremaeum</i>	P3	Unlikely, no suitable habitat (chenopod and eucalypt shrubland on flats and edges of salt lakes) in study area.
<i>Rinzia triplex</i>	P3	Unlikely, no suitable habitat (sandy plains) in study area.
<i>Styphelia</i> sp. Bullfinch	P3	Unlikely, no suitable habitat (laterite breakaways/outcroppings) in study area.

Species	Cons. code	Likelihood of occurrence
<i>Eremophila caerulea</i> subsp. <i>merrallii</i>	P4	Possible, suitable habitat in study area and record within 20 km of study area.
<i>Eucalyptus jutsonii</i> subsp. <i>jutsonii</i>	P4	Unlikely, no suitable soil type (deep yellow to orange sand) in study area.
<i>Eucalyptus x brachyphylla</i>	P4	Unlikely, some suitable habitat (granite outcrops) in study area but record >20km from study area.
<i>Frankenia glomerata</i>	P4	Unlikely, some suitable habitat (floodplains, salt lake edges, saline flats) in study area but record >20 km from study area.

5.2.1.1.1 *Eremophila praecox*

Status: Priority 1

Description: Broom-like shrub, 1.5-3 m high. Purple flowers October or December (Figure 5-4).



Figure 5-4 *Eremophila praecox*

Distribution and ecology: Occurs in the Eastern Goldfields subregion in the Coolgardie bioregion (DBCA 2019). This species is known from 15 records (ALA 2019), with habitat descriptions including eucalypt woodland over *Acacia*, *Melaleuca* and *Eremophila* shrubland on a loamy plain and *Eucalyptus oleosa* mallee over *Triodia* on red-brown loam sandy soil.

Population sizes provided in records for the species are limited to two plants recorded and a comment of 'infrequent' (DBCA 2019).

Survey records: Three individuals were found at two locations in the study area (Figure 5-3) in a mid *Eucalyptus transcontinentalis* and *E. clellandiorum* woodland over mid sparse *Atriplex nummularia*,

Maireana sedifolia and *Eremophila scoparia* shrubland over isolated low *Acacia erinacea*, *Eremophila parvifolia* subsp. *auricampa* and *Olearia muelleri* shrubs in a mid *Eucalyptus salubris*, *E. transcontinentalis* and *E. gracilis* woodland over mid open *Eremophila scoparia*, *Senna artemisioides* subsp. *filifolia* and *Atriplex nummularia* shrubland over isolated low *Olearia muelleri*, *Ptilotus obovatus* and *Eremophila parvifolia* subsp. *auricampa* shrubs.

5.2.1.1.2 *Allocasuarina eriochlamys* subsp. *grossa*

Status: Priority 3

Description: Dioecious or monoecious shrub, 1-3 m high, bracteoles prominently exceeding cone (Figure 5-5).



Figure 5-5 *Allocasuarina eriochlamys* subsp. *grossa*

Distribution and ecology: Occurs in the Coolgardie and Nullarbor bioregions (DBCA 2019). This species is known from 64 records (ALA 2019), with habitat descriptions including:

- tall shrubland of *Acacia acuminata* with an understory of *Lepidospermum* sp. on lower footslope of basalt hill
- tall shrubland of *Eucalyptus lesouefii* on low breakaway
- in *Casuarina campestris* scrub on stony loam hill
- on laterite or granite hill.

Population sizes range from counts of 1,000's of plants to comments of 'infrequent' to 'common' or 'locally frequent' (DBCA 2019).

Survey records: In the study area, 165 individuals were located in a Low *Eucalyptus clellandiorum* and *E. griffithsii* woodland over tall *Acacia burkittii*, *Allocasuarina eriochlamys* subsp. *grossa* and *Melaleuca pauperiflora* subsp. *fastigiata* shrubland over low open *Cryptandra aridicola*, *Dodonaea lobulata* and *Exocarpos aphyllus* shrubland (Figure 5-3).

5.2.1.1.3 *Austrostipa blackii*

Status: Priority 3

Description: Tufted perennial, grass-like or herb up to 1 m high. Flowers September to November.

Distribution and ecology: Occurs in the Avon Wheatbelt, Coolgardie and Yalgoo bioregions (DBCA 2019). This species is known from 46 records in Western Australia (ALA 2019), with habitat descriptions including:

- *Eucalyptus* aff. *oleosa* open woodland over *Acacia acuminata* and *A. resinimarginea* tall open shrubland, over *Phebalium canaliculatum*, *Euryomyrtus maidenii* and *Prostanthera grylloana* low shrubland, over *Triodia scariosa* very open hummock grassland on red silty sand with fine sandy gravel
- tall open scrub of *Acacia resinimarginea* and *Acacia* sp. narrow phyllode in a winter wet depression on orange clay loam soil
- *Eucalyptus longissima*, *Banksia arborea*, *Acacia* sp. Mt Jackson (B.Ryan 176), *Philotheca brucei* subsp. *brucei* on rocky banded ironstone formation
- open woodland of *Allocasuarina dielsiana* over open shrubland of *Allocasuarina tessellata* and *Acacia karina* over open forbland of *Podolepis gardneri*, *Ptilotus helipteroides*, *Schoenia cassiniana* and *Stenopetalum filifolium* on basalt outcrop with red brown shallow sandy clay soil.

Population sizes provided in records for the species ranged from one plant and comments of 'isolated' to comments of 'locally common'.

Survey records: In the study area, a cover value of 0.1% was given at a quadrat (CR004) in a tall *Acacia burkittii*, *Brachychiton gregorii* and *Grevillea berryana* shrubland over mid open *Eremophila gibbosa* and *Scaevola spinescens* and *Dodonaea lobulata* shrubland over low *Leiocarpa semiclava* subsp. *semiclava*, *Solanum lasiophyllum* and *P. obovatus* shrubland (Figure 5-3).

5.2.1.1.4 *Calandrinia quartzitica*

Status: Priority 1

Description: Semi-erect to erect herb with very fleshy leaves, up to 0.5 m high. White or pink flowers in September to October (Figure 5-6).



Figure 5-6 *Calandrinia quartzitica* (Obbens F.J. 2018), A – habitat, B – habit, photographs by Brian Moyle

Distribution and ecology: Occurs in the Eastern Murchison subregion (DBCA 2019). This species is known from nine records from the edge of five salt lakes (Obbens F.J. 2018). It occurs in samphire dominated lake edges close to quartzitic ridges and breakaways or quartzitic hummocky ground in brown silty sand or red-brown silty loam.

No population sizes are provided (DBCA 2019) but comments on frequency range from 'scattered' to 'locally common'.

Survey records: Specimen recorded from a single quadrat (CR002a) is either *Calandrinia quartzitica* or *C. lefroyensis* (Figure 5-3). Vegetation description for the site is isolated tall *Grevillea sarissa* subsp. *sarissa* and *Melaleuca halmaturorum* shrubs over low *Tecticornia indica* subsp. *bidens*, *T. sp.* Dennys Crossing and *T. pruinosa*. shrubland over isolated low *Disphyma crassifolium* and *Calandrinia ?quartzitica* forbs.

5.2.1.1.5 *Calandrinia lefroyensis*

Status: Priority 1

Description: semi-erect to erect herb with very fleshy leaves up to 0.26 m high. Pink flowers in October to November (Figure 5-7)



Figure 4. *Calandrinia lefroyensis* from Lake Cowan. A – habitat; inset – flower. Photographs by Lillian Hancock.

Figure 5-7 *Calandrinia lefroyensis* (Obbens F.J. 2018), A – habitat, B – flower, photographs by Lillian Hancock

Distribution and ecology: Occurs in the Eastern Goldfields subregion (DBCA 2019). This species is known from five records from salt lake flats among samphire communities on brown silty loam or brown-grey sandy clays (Obbens F.J. 2018).

Population sizes range from counts of 4, 10 and 34 plants to comments of 'occasional and scattered' to 'locally common' (DBCA 2019).

Survey records: See *C. quartzitica* above.

5.2.2 Introduced flora

A total of seven introduced flora species were recorded in the study area; none of these were Declared Pests or WoNS (Table 5-5; Appendix 3).

Table 5-5 Introduced flora species recorded during the field survey

Family	Species
Convolvulaceae	* <i>Cuscuta epithymum</i>
Geraniaceae	* <i>Erodium cicutarium</i>
Primulaceae	* <i>Lysimachia arvensis</i>
Fabaceae	* <i>Medicago minima</i>
Asteraceae	* <i>Monoculus monstrosus</i>
Oxalidaceae	* <i>Oxalis corniculata</i>
Lamiaceae	* <i>Salvia verbenaca</i>

5.2.3 Unidentified flora

A total of 18 taxa recorded in the study area could not be identified to species level, in most instances due to insufficient taxonomic characters as plants were sterile (lacking reproductive structures; Table 5-6).

Table 5-6 Unidentified flora taxa recorded during the field survey

Unidentified taxon	Comments
<i>Atriplex ?nana</i>	Sterile
<i>Atriplex ?vesicaria</i>	Sterile
<i>Calandrinia ?quartzitica</i>	Immature seeds
<i>Cassytha ?nodiflora</i>	Sterile
<i>Euphorbia ?philochalix</i>	Sterile
<i>Frankenia ?interioris</i>	Sterile
<i>Grevillea ?oncogyne</i>	Sterile
<i>Maireana ?amoena</i>	Sterile
<i>Maireana ?georgei</i>	Sterile
<i>Maireana</i> sp.	Sterile
<i>Maireana tomentosa ?subsp. tomentosa</i>	Sterile
<i>Olearia ?ciliata</i>	Sterile
<i>Roycea ?divaricata</i>	Sterile
<i>Sclerolaena ?brevifolia</i>	Sterile

Unidentified taxon	Comments
<i>Senna ?stowardii</i>	Sterile
<i>Tecticornia</i> sp. (sterile 1)	Sterile
<i>Tecticornia</i> sp. (sterile 2)	Sterile
<i>Thysanotus ?manglesianus</i>	Sterile

5.2.4 Vegetation types

Nineteen (19) vegetation types were defined for the study area based on statistical analyses (Figure 5-8; Figure 5-9). The vegetation comprised (Figure 5-10; Table 5-7):

- nine *Tecticornia* spp. shrublands
- one chenopod shrubland
- two shrublands
- seven woodlands.

One *Tecticornia* spp. shrubland (MhTiDc) that occurred on undulating sandy plain adjacent a salt lake was clearly distinguishable and was mapped as a distinct vegetation type. All remaining *Tecticornia* shrublands occurred on salt lake playa and it was not possible from aerial imagery or in the field to readily distinguish boundaries between the different vegetation types defined from the statistical analysis. These were therefore mapped as a single mosaic.

A small section of the study area (15.47 ha, 1.32%) comprised a salt lake playa that was inundated at the time of the surveys and was naturally devoid of vegetation. There were a number of areas recently cleared of vegetation from exploration activities.

The woodland vegetation types were the most dominant covering 1,026.13 ha and accounting for 88.71% of the vegetation in the study area (Table 5-8). A chenopod shrubland CsAvDc was the next most prevalent (4.08%) followed by shrublands (3.88%) and *Tecticornia* spp. shrublands (3.34%) (Table 5-8).

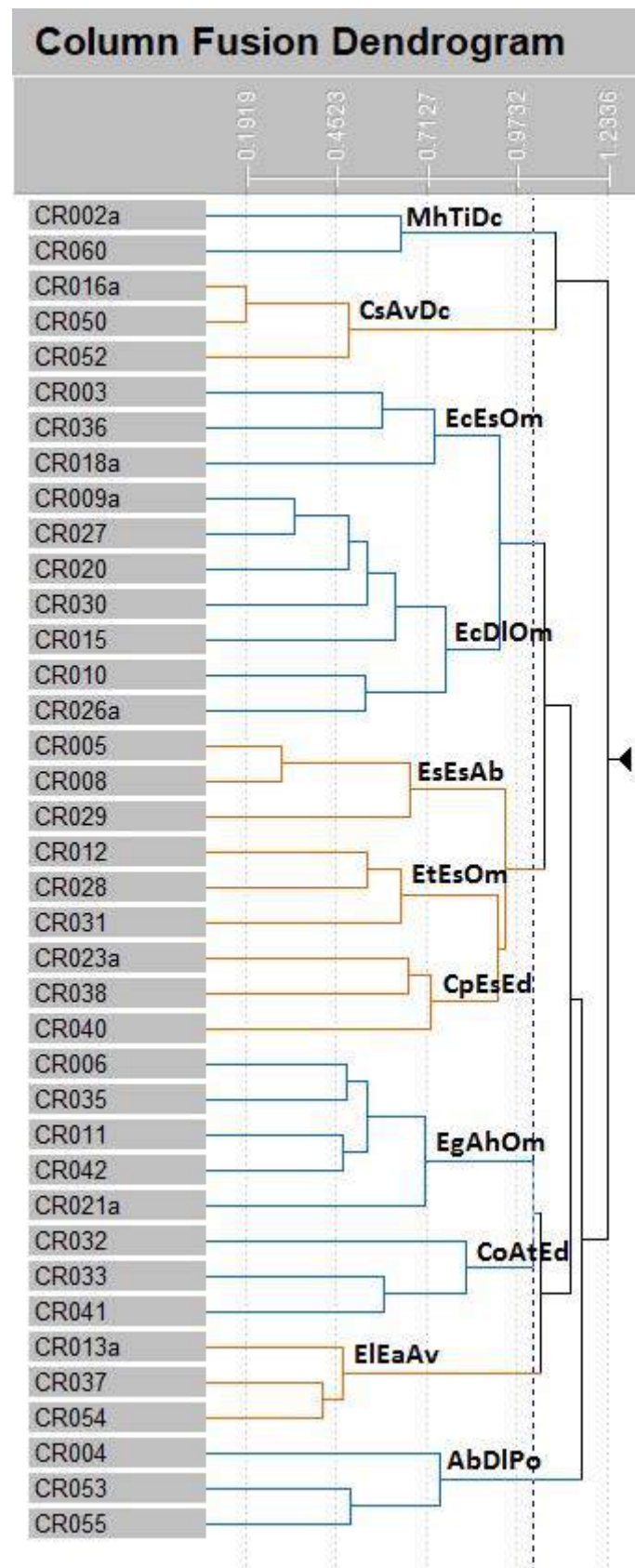


Figure 5-8 Vegetation types delineated from the dendrogram of 20 m x 20 m quadrats

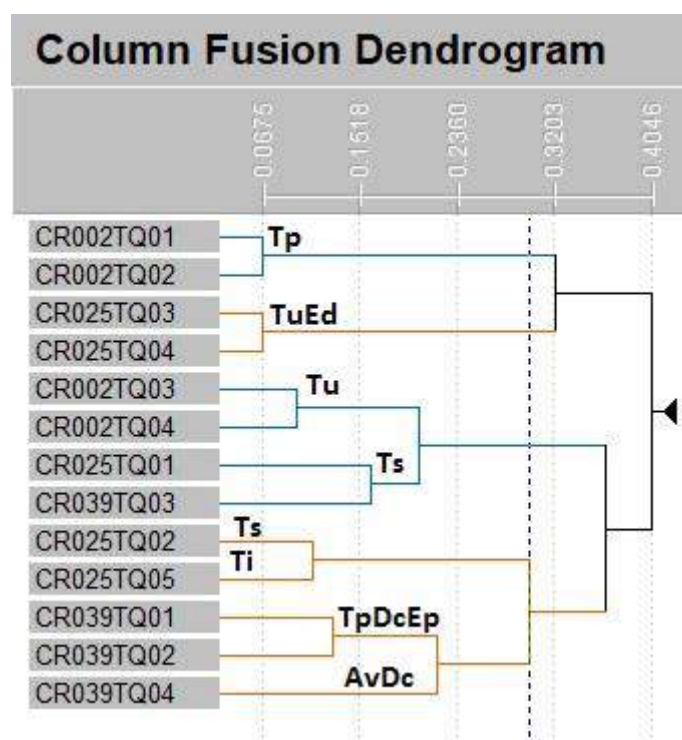


Figure 5-9 Vegetation types delineated from the dendrogram of 3 m x 3 m quadrats from transect surveys

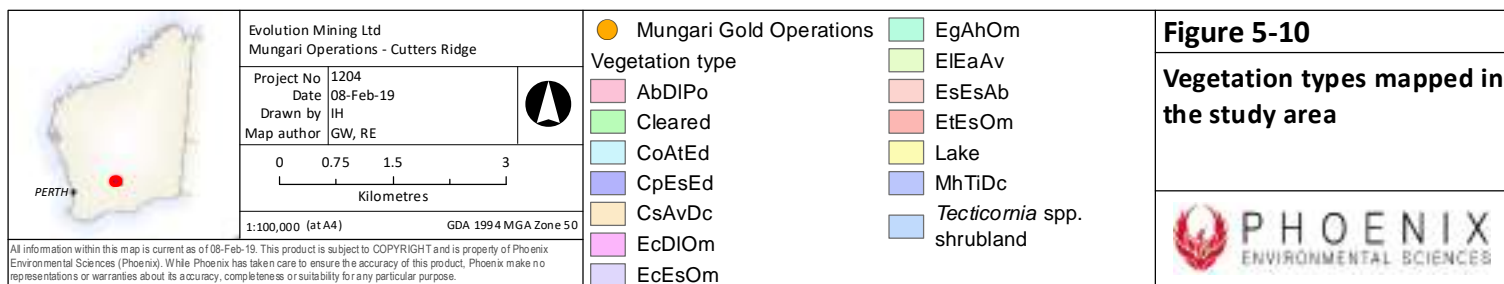







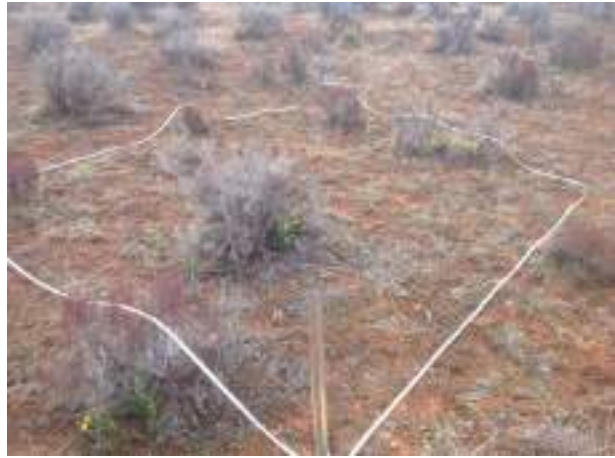




Table 5-7 Vegetation types recorded in the study area



Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
<i>Tecticornia</i> spp. shrubland	MhTiDc	CR002a, CR060	Isolated tall <i>Melaleuca halmatororum</i> and <i>Grevillea sarissa</i> subsp. <i>sarissa</i> shrubs over low <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>T. doliiformis</i> and <i>T. pruinosa</i> chenopod shrubland over isolated low <i>Disphyma crassifolium</i> , <i>Calandrinia ?quartzitica</i> and <i>Sclerolaena</i> spp. forbs.	
<i>Tecticornia</i> spp. shrubland	Tp	CR002TQ01, CR002TQ02	Isolated low shrubs to low <i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> and <i>T. doliiformis</i> chenopod shrubland.	



Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
<i>Tecticornia</i> spp. shrubland	TuEd	CR025TQ03, CR025TQ04	Low <i>Tecticornia undulata</i> , <i>Atriplex lindleyi</i> subsp. <i>inflata</i> and <i>Frankenia irregularis</i> shrubland over low isolated <i>Eragrostis dielsii</i> grasses.	
<i>Tecticornia</i> spp. shrubland	Tu	CR002TQ03, CR002TQ04	Low <i>Tecticornia undulata</i> , <i>T. sp.</i> Denny's Crossing and <i>T. doliiformis</i> chenopod shrubland.	



Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
<i>Tecticornia</i> spp. shrubland	Ts	CR039TQ03	Low <i>Tecticornia</i> sp. Denny's crossing shrubland over low sparse <i>Disphyma crassifolium</i> and <i>Surreya diandra</i> forbland over isolated low <i>Eragrostis dielsii</i> grasses.	
<i>Tecticornia</i> spp. shrubland	Ti	CR025TQ01	Low <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>T. sp.</i> Denny's crossing and <i>Atriplex ?vesicaria</i> shrubland over isolated <i>Disphyma crassifolium</i> , <i>Erodium cicutarium</i> and <i>Surreya diandra</i> forbs and low isolated clumps of <i>Eragrostis dielsii</i> grasses.	



Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
<i>Tecticornia</i> spp. shrubland	Td	CR025TQ02, CR025TQ05	Low <i>Tecticornia doliiformis</i> shrubland over isolated clumps of low <i>Disphyma crassifolium</i> , <i>Heliotropium curassavicum</i> and <i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i> forbs and isolated clumps of low <i>Eragrostis dielsii</i> grasses.	
<i>Tecticornia</i> spp. shrubland	TpDcEp	CR039TQ01, CR039TQ02	Low <i>Tecticornia pruinosa</i> chenopod shrubland over <i>Disphyma crassifolium</i> , <i>Surreya diandra</i> and <i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i> forbs over low open <i>Eragrostis dielsii</i> and <i>E. pergracilis</i> grassland.	

Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
<i>Tecticornia</i> spp. shrubland	AvDc	CR039TQ04	Low open <i>Atriplex vesicaria</i> , <i>Gunniopsis quadrifida</i> and <i>Tecticornia disarticulata</i> shrubland over isolated clumps of low <i>Disphyma crassifolium</i> , <i>Surreya diandra</i> and <i>Asteridea chaetopoda</i> forbs.	
Low chenopod shrubland	CsAvDc	CR016a, CR050, CR052	Isolated mid <i>Cratystylis subspinescens</i> , <i>Pimelea microcephala</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubs over low <i>Atriplex vesicaria</i> , <i>Tecticornia</i> sp. (sterile 1) and <i>Roycea divaricata</i> shrubland over isolated low <i>Disphyma crassifolium</i> , <i>Brachyscome ciliaris</i> and <i>Vittadinia dissecta</i> var. <i>hirta</i> forbs.	

Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
Shrubland	AbDIpo	CR004, CR053, CR055	Tall <i>Acacia burkittii</i> shrubland over sparse to open mid <i>Dodonaea lobulata</i> , <i>Acacia tetragonophylla</i> and <i>Eremophila oldfieldii</i> shrubland over isolated low <i>Ptilotus obovatus</i> , <i>Scaevola spinescens</i> and <i>Olearia pimelioides</i> shrubs.	
Shrubland	CpEsEd	CR023a, CR038, CR040	Isolated low <i>Casuarina pauper</i> trees over mid open <i>Eremophila scoparia</i> , <i>Dodonaea viscosa</i> and <i>Rhagodia drummondii</i> shrubland over isolated low shrubs to low open <i>Eremophila decipiens</i> subsp. <i>decipiens</i> , <i>Ptilotus obovatus</i> and <i>Enchylaena tomentosa</i> shrubland.	

Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
Woodland	EcEsOm	CR003, CR036, CR018a	Mid <i>Eucalyptus clelandiorum</i> and <i>E. oleosa</i> subsp. <i>oleosa</i> woodland over isolated mid <i>Eremophila scoparia</i> , <i>Exocarpos aphyllus</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubs to open shrubland over isolated low <i>Olearia muelleri</i> , <i>Ptilotus obovatus</i> and <i>Westringia rigida</i> shrubs to low pen shrubland.	
Woodland	EcDIOM	CR009a, CR027, CR020, CR030, CR015, CR010, CR026a	Mid <i>Eucalyptus clelandiorum</i> woodland with other <i>Eucalyptus</i> trees, frequently <i>E. celastroides</i> subsp. <i>celastroides</i> or <i>E. griffithsii</i> , over isolated shrubs to mid open <i>Dodonaea lobulata</i> , <i>Eremophila scoparia</i> and <i>Exocarpos aphyllus</i> shrubland over isolated low to sparse <i>Olearia muelleri</i> , <i>Ptilotus obovatus</i> and <i>Westringia rigida</i> shrubland.	

Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
Woodland	EsEsAb	CR005, CR008, CR029	Mid <i>Eucalyptus salmonophloia</i> and <i>E. salubris</i> woodland over mid <i>Eremophila scoparia</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Exocarpos aphyllus</i> shrubland over low open <i>Atriplex bunburyana</i> , <i>Maireana trichoptera</i> and <i>Ptilotus obovatus</i> shrubland.	
Woodland	EtEsOm	CR012, CR028, CR031	Mid <i>Eucalyptus transcontinentalis</i> woodland with other <i>Eucalyptus</i> trees frequently <i>E. clelandiorum</i> and <i>E. salubris</i> over mid open <i>Atriplex nummularia</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Olearia muelleri</i> , <i>Eremophila parvifolia</i> subsp. <i>auricampa</i> and <i>Ptilotus obovatus</i> shrubs.	

Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
Woodland	CoAtEd	CR032, CR033, CR041	Low to mid <i>Casuarina obesa</i> and <i>Eucalyptus griffithsii</i> woodland over mid to tall open <i>Acacia tetragonophylla</i> , <i>Exocarpos aphyllus</i> and <i>Cratystylis subspinescens</i> shrubland over isolated low <i>Eremophila decipiens</i> subsp. <i>decipiens</i> , <i>Grevillea acuaria</i> and <i>Rhagodia drummondii</i> shrubs.	
Woodland	ElEaAv	CR013a, CR037, CR054	Mid <i>Eucalyptus longicornis</i> woodland with <i>E. clelandiorum</i> and <i>E. griffithsii</i> trees over mid to tall open <i>Exocarpos aphyllus</i> , <i>Eremophila glabra</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Atriplex vesicaria</i> , <i>Ptilotus obovatus</i> and <i>Rhagodia drummondii</i> shrubs.	


Vegetation type	Vegetation code	Survey sites (quadrats)	Vegetation description	Photograph
Woodland	EgAhOm	CR006, CR035, CR011, CR042, CR021a	Mid <i>Eucalyptus griffithsii</i> woodland with other <i>Eucalyptus</i> trees including <i>E. oleosa</i> subsp. <i>oleosa</i> and <i>E. longicornis</i> over isolated shrubs to mid open <i>Acacia hemiteles</i> , <i>Exocarpos aphyllus</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Olearia muelleri</i> , <i>Scaevola spinescens</i> and <i>Westringia rigida</i> shrubs.	

Table 5-8 Extent of each vegetation type/feature in the study area

Vegetation type	Extent in study area (ha)	% of study area	% of vegetation in study area
AbDI Po	13.07	1.11	1.13
Cleared	4.29	0.37	-
CoAtEd	76.59	6.51	6.62
CpEsEd	31.80	2.70	2.75
CsAvDc	47.20	4.01	4.08
EcDI Om	254.92	21.67	22.04
EcEsOm	88.06	7.49	7.61
EgAhOm	54.05	4.59	4.67
ElEaAv	212.43	18.06	18.36
EsEsAb	269.91	22.94	23.33
EtEsOm	70.18	5.97	6.07
Lake	15.47	1.32	-
MhTiDc	26.90	2.29	2.33
<i>Tecticornia</i> spp shrublands	11.63	0.99	1.01
Total	1176.50	100	100

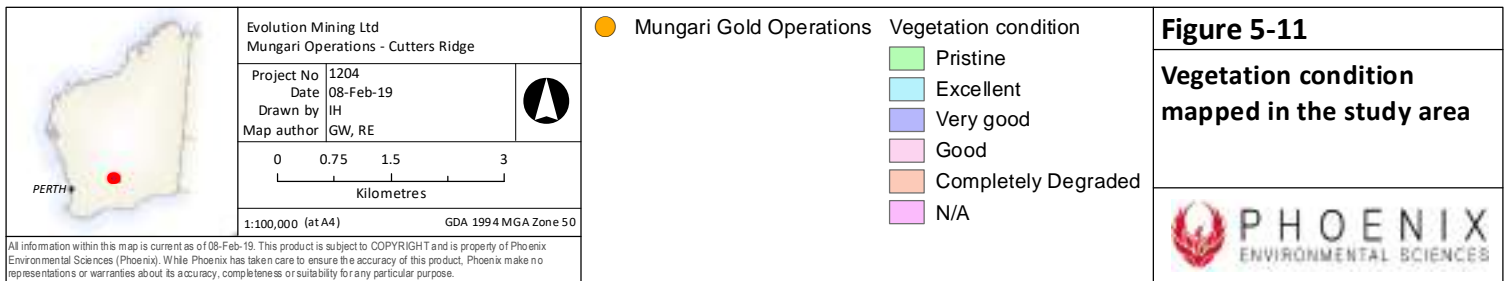
5.2.5 Vegetation condition

The condition of vegetation in the study area ranged from Completely Degraded to Pristine (Table 5-9, Figure 5-11). Areas naturally devoid of vegetation in the study area (1.32%) were assigned Not Applicable (N/A) condition rating.

The majority of the vegetation in the study area (86.69%) was recorded to be in Excellent to Pristine condition. A small proportion of the study area (0.37%) was recorded to be Completely Degraded, i.e. these areas had been cleared and were virtually devoid of any native vegetation. The remaining 12.94% of the study area was in Good to Very Good condition with disturbance primarily in the form of weed infestations, grazing damage from livestock, vehicle tracks and historic clearing.

Table 5-9 Extent of vegetation condition in the study area

Condition rating	Extent in study area (ha)	% of study area
Not Applicable (Lake)	15.47	1.32
Completely Degraded (Cleared)	4.29	0.37
Good	4.15	0.35
Very Good	132.64	11.27
Excellent	205.31	17.45
Pristine	814.64	69.24
Total	1,176.50	100



5.2.6 Significant vegetation

No listed TEC or PEC was returned from the database searches in the desktop assessment and none of the vegetation types defined for the study area were considered to resemble any listed TEC or PEC.

Vegetation types that contained significant flora were considered significant vegetation as they represent a refuge for the significant species:

- EcDIOM – *Allocasuarina eriochlamys* subsp. *grossa* (P3)
- AbDIPO – *Austrostipa blackii* (P3)
- CsAvDc – *Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) (range extension)
- EtEsOm – *Eremophila praecox* (P1)
- MhTiDc – *Calandrinia ?quartzitica/Calandrinia ?lefroyensis* (P1).

Combined, the *Tecticornia* spp. shrublands mapped as a mosaic represented just over 1% of vegetation in the study area indicating that the individual vegetation types would comprise less than 1% of the study area and therefore may be considered significant due to restricted distribution. Similarly vegetation type AbDIOM represented just over 1% of the vegetation and may be considered significant vegetation due to restricted distribution.

5.3 SURVEY LIMITATIONS

The limitations of the survey have been considered (Table 5-10) in accordance with EPA technical guidance (EPA 2016c).

Table 5-10 Survey limitations

Limitations	Limitation for this survey?	Comments
Availability of adequate contextual information at a regional and local scale	Yes	There is a lack of information pertaining to the regional values of vegetation in the bioregion. However, several prior flora and vegetation surveys conducted within the immediate vicinity (some overlapping) the current study area provided adequate information on a local scale.
Competency/experience of survey personnel, including taxonomy	No	The lead botanist for the field surveys, Dr Grant Wells, has in excess of 20 years experience conducting surveys in the Goldfields. Taxonomic specialists, Dr Kelly Shepherd (<i>Tecticornia</i>) and Frank Obbens (<i>Calandrinia</i>) were engaged and all Priority flora specimens were lodged with the WA Herbarium.
Proportion of flora recorded and/or collected, any identification issues	Yes	A proportion of the specimens recorded in survey quadrats could not be definitively identified to species level and, as some areas were only surveyed in the spring season, autumn annual species may not have been present.
Was the appropriate area fully surveyed (effort and extent)	Yes	Changes to the study area between survey events resulted in some areas only being surveyed once during the spring season. It is therefore possible annual species that occur in autumn were not recorded during the survey. Searches for significant flora were not exhaustive and some areas of suitable habitat were not thoroughly foot searched for significant flora.
Access restrictions	Yes	Some sections of the road corridor were inaccessible and vegetation boundaries are extrapolated from aerial imagery.
Timing, rainfall, season	Possible	Rainfall in the months prior to both seasonal surveys was below average and it is possible that the number of annual species present may be lower than in seasons with higher rainfall events.
Disturbances which affected the results of the survey	No	There were not recent disturbances, such as fire, that may have affected the results of the survey.

6 DISCUSSION

6.1 FLORA AND VEGETATION

6.1.1 Flora assemblage

The number of species recorded in the current survey was higher than for the previous surveys reviewed in the desktop assessment (Table 6-1). The current survey also recorded a similar diversity based on average number of species per unit area (between 0.1 and 0.2 species per ha) to the previous surveys, aside from Outback Ecology (2003), which was considerably higher with nearly 1 species per ha. The higher number of species per unit area from Outback Ecology (2003) may be because it was a linear corridor for a pipeline and intersected a higher number of vegetation types.

Table 6-1 Comparison of floristic data from the current survey with previous surveys

Survey	Area (ha)	Survey effort	No. vegetation types	No. of identified species	No. of families	No. of genera	No. of weeds
Native Vegetation Solutions (2017)	932	30 quadrats, 2 season	12	130	29	75	3
Botanica Consulting (2010)	820	16 quadrats, 2 season	4	82	22	42	0
Outback Ecology (2003)	85		26	76	20	30	1
Mattiske Consulting (2002)	1,050		19	120	30	53	2
Current survey	1,176.45		19	215	36	81	7

The current survey recorded all prominent families identified in previous surveys and these were similar throughout all flora and vegetation assessments (Table 6-2).

Table 6-2 Dominant plant families recorded in the current survey and previous surveys

Family	Current survey	Native Vegetation Solutions (2017)	Botanica Consulting (2010)	Outback Ecology (2003)	Mattiske Consulting (2002)
Chenopodiaceae	56	29	22	12	26
Asteraceae	17	19	4	5	9
Poaceae	12	11	3	1	6
Scrophulariaceae	19	10	11	-	-
Fabaceae	20	9	9	11	9
Myrtaceae	18	9	13	14	14

Total number of species	215	130	82	76	120
% dominant families	66.0	66.9	75.6	56.6	53.3

6.1.2 Significant flora

Three of the 48 significant flora identified from the desktop review, *Eremophila praecox* (P1), *Allocasuarina eriochlamys* subsp. *grossa* (P3) and *Austrostipa blackii* (P3), were recorded in the study area. The fourth Priority species, which is either *Calandrinia ?quartzitica* or *Calandrinia ?lefroyensis* (P1), was not identified through the desktop review; the record from the survey represents a range extension for either species. Following identification of habitats in the study area from the field surveys, assessment of the likelihood of occurrence of the significant flora determined a further six to be possibly present, with the remaining 39 species considered unlikely to be present.

The two records for *Eremophila praecox* (P1) represent 11.8% of the records for the species as recorded in ALA (2019). It is not possible to determine what proportion of the entire population of *E. praecox* the three plants recorded in the study area represent as there is no population size recorded for the majority of records.

The record for *Allocasuarina eriochlamys* subsp. *grossa* (P3) represents 1.5% of records for the species as recorded in ALA (2019). The 165 individuals recorded in the study area are likely to represent less than 10% of the total population recorded for the species as some records provide an estimate of population sizes in the thousands.

The record for *Austrostipa blackii* represents 2.12% of the records for the species as recorded in ALA (2019). It is not possible to determine what proportion this represents of the entire population as population size within the study area was not determined and there is no population size recorded for the majority of known records.

The record for *Calandrinia ?quartzitica*/*Calandrinia ?lefroyensis* (P1) would represent 10% of records for *C. quartzitica* and 16.7% of records for *C. lefroyensis* as recorded in ALA (2019). It is not possible to determine what proportion of the entire population these would represent as population size within the study area was not determined and there is no population size recorded for the majority of records for either Priority Flora.

With the exception to the *Calandrinia* specimen, none of the specimens that could not be identified to species level were considered likely to represent any listed significant flora:

- the *Atriplex* specimens were both perennial shrubs and did not resemble *A. lindleyi* subsp. *conduplicata* (P3) which is the only significant *Atriplex* species recorded for the Eastern Goldfields subregion that is herbaceous (DBCA 2019)
- the *Frankenia* specimen was recorded in low chenopod shrubland and did not resemble either *F. georgei* (P1) recorded on rocky hills, or the low prostrate *Frankenia glomerata* (P4) which are the only significant *Frankenia* species recorded for the Eastern Goldfields subregion (DBCA 2019)
- the plant habit and leaves of the *Grevillea* specimen were not commensurate with any of the three significant *Grevillea* spp. recorded for the Eastern Goldfields subregion, *G. georgeana* (P3), *G. phillipsiana* (P1) and *G. secunda* (P4)
- the *Thysanotus* specimen was a trailing climbing plant and not commensurate with the caespitose (grass-like) habit of *T. brachyantherus* (P2) which is the only significant *Thysanotus* species recorded for the Eastern Goldfields subregion (DBCA 2019)

- the *Tecticornia* specimens were erect shrubs recorded on undulating plain and hillslopes and the habit and habitat were not commensurate with the low spreading shrubs of *T. flabelliformis* (P1) and *T. mellarium* (P1) which are largely restricted to the margins and playa of salt lakes and are the only two significant *Tecticornia* species recorded for the Eastern Goldfields subregion (DBCA 2019); both Priority species are well known to the lead botanist on the current survey, Dr Grant Wells, who has made several recent collections of both species
- there are no listed significant *Cassytha*, *Euphorbia*, *Maireana*, *Olearia*, *Roycea*, *Sclerolaena* or *Senna* species in the Eastern Goldfields subregion (DBCA 2019).

6.1.3 Vegetation

Each of the vegetation types defined for the current survey align with one or more vegetation types recorded in previous surveys indicating a broader distribution outside the study area:

- the *Tecticornia* ssp. shrublands (including MhTiDc) align with Association 221, succulent steppe, saltbush of Shepherd *et al.* (2002), the chenopod shrublands (community 4a-4e) of Mattiske Consulting (2002) and the *Tecticornia* shrubland of Native Vegetation Solutions (2017)
- the chenopod shrubland (CsAvDc) aligns with Association 221, succulent steppe, saltbush of Shepherd *et al.* (2002), the mixed shrubland (2e) of Mattiske Consulting (2002) and the chenopod shrubland (4b) of Outback Ecology (2003)
- the AbDIPO shrubland aligns with the scrubland (2b) of Outback Ecology (2006)
- the CpEsEd shrubland aligns with the *Casuarina* shrubland (5a) of Mattiske Consulting (2002), the *Casuarina* woodland of Botanica Consulting (2010) and the *Casuarina pauper* over sclerophyll shrubland of Native Vegetation Solutions (2017)
- the *Eucalyptus* woodlands align broadly with Associations 468 and 540 of Shepherd *et al.* (2002), woodlands 1a, 1b, 1d, 1g, 1k and 1l of Mattiske Consulting (2002) and the mixed *Eucalyptus* woodlands over sclerophyll shrublands, *Eucalyptus griffithsii* woodland over sclerophyll shrubland and *Eucalyptus* woodland over hummock spinifex vegetation types of Native Vegetation Solutions (2017).

None of the vegetation types represented a listed TEC or PEC. Five vegetation types defined for the study area EcDIOM, AbDIPO, CsAvDc, -EtEsOm and MhTiDc, were considered significant vegetation as they represent a refuge for significant flora species.

The *Tecticornia* spp. shrublands mapped as a mosaic had a limited distribution in the study area; however, a large proportion of these vegetation types were recorded in the haul road corridor which intercepted only a small portion of the overall distribution of these vegetation types.

The shrubland AbDIPO had a limited distribution within the study area but did align with vegetation type 'scrubland (2b)' recorded by Outback Ecology (2006) indicating a broader distribution in the surrounding area. This vegetation type was restricted to the crests and slopes of low rocky hills and similar habitat outside of the study area may be targeted to identify the broader distribution of this vegetation type should it become apparent that a high proportion within the study area will be impacted.

All other vegetation types defined for the study area had distributions that extended out of the study area and aligned with vegetation types from other studies indicating a broader distribution in the surrounding area.

6.1.4 Commentary against the 10 clearing principles – Cutters Ridge Mine and haul road from Mungari to Cutters Ridge

A preliminary assessment has been conducted against the 10 clearing principles to support a native vegetation clearing permit application for the proposed Cutters Ridge Mine and a haul road between Mungari and Cutters Ridge (Table 6-3). The indicative disturbance footprint (IDF) is shown in Figure 6-1.

The preliminary assessment has considered whether the proposed clearing within the IDF has potential to be at variance with any of the clearing principles in accordance with *A guide to the assessment of applications to clear native vegetation, under Part V Division 2 of the Environmental Protection Act 1986* (DER 2014). It is noted that this assessment has been based on the information available in this report, the terrestrial fauna survey report (Phoenix 2019) and the physical extent of the IDF. A detailed impact assessment was beyond the scope of this report and limited information was available on which to assess potential for variance against principle G, I and J. Further consideration of these principles may therefore be required.

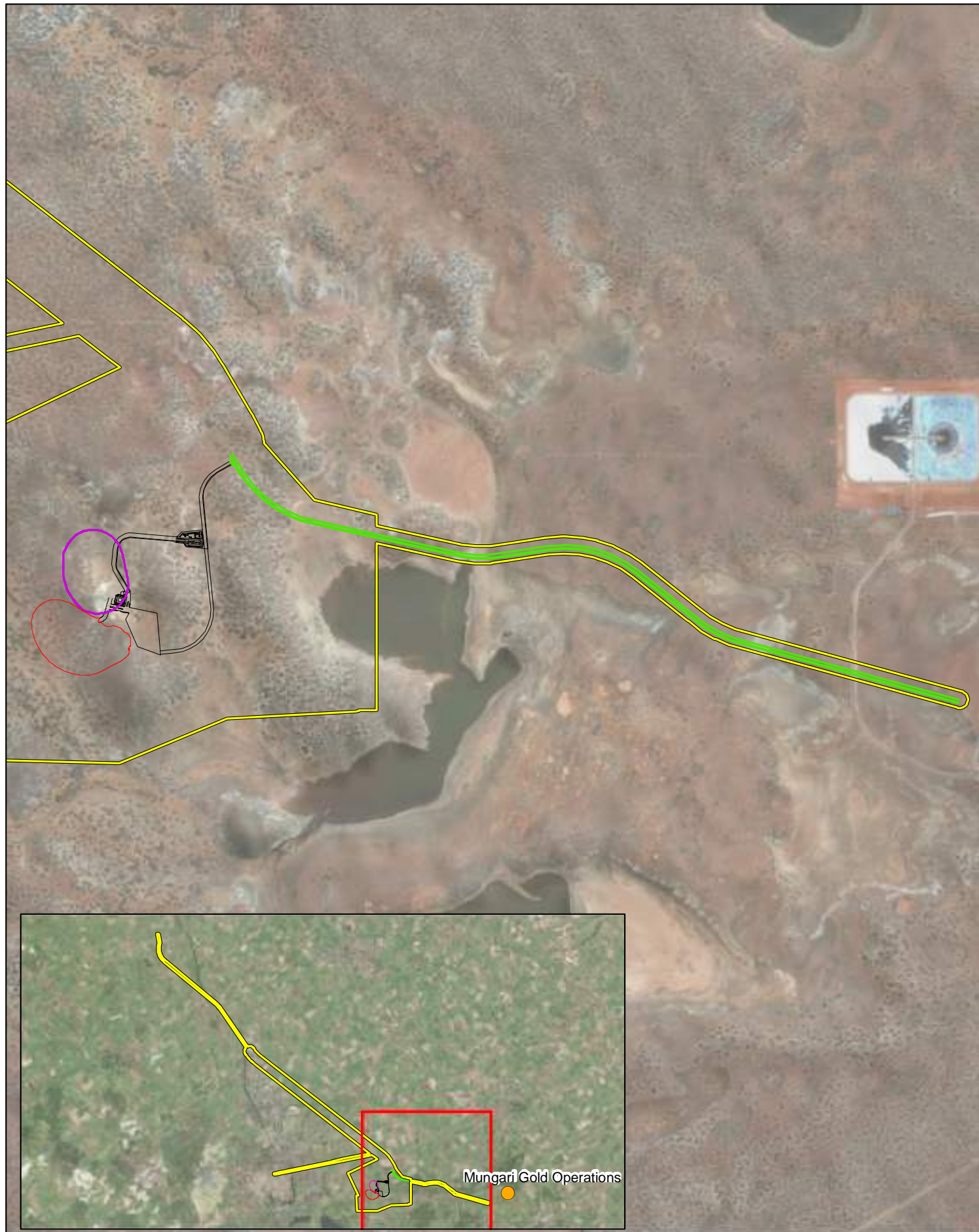
Table 6-3 **Commentary against the clearing principles for proposed clearing for Cutters Ridge Mine and haul road from Mungari to Cutters Ridge**


Principle	Statement against principle
A) Native vegetation should not be cleared if it comprises a high level of biological diversity	<p>Potential for variance with Principle A: unlikely</p> <p>Vegetation in the IDF does not contain particularly high species diversity. The IDF is not located within a recognised biodiversity hotspot. Diversity recorded in the study area during the current survey was comparable to that of previous surveys within the locality.</p> <p>High biodiversity values are recognised in the Eastern Goldfields IBRA subregion, including <i>Eucalyptus</i> Woodlands (high diversity of <i>Eucalyptus</i> species), high diversity in <i>Acacia</i> species and ephemeral flora communities of tertiary sandplain shrublands and valley floor woodlands (Cowan 2001). The study area is not representative of any of these high biodiversity areas; diversity of <i>Acacia</i> species and <i>Eucalyptus</i> species recorded within the study area was relatively low (13 and 15 species respectively) in comparison to numbers of species identified in the desktop review (54 and 55 species respectively).</p> <p>Nine vegetation types were recorded within the IDF:</p> <ul style="list-style-type: none"> • AbDIPO – Tall <i>Acacia burkittii</i> shrubland over sparse to open mid <i>Dodonaea lobulata</i> shrubland over isolated low <i>Ptilotus obovatus</i> shrubs • CpEsEd – Isolated low <i>Casuarina pauper</i> trees over mid open <i>Eremophila scoparia</i> shrubland over isolated low shrubs to low open <i>Eremophila decipiens</i> subsp. <i>decipiens</i> shrubland • CsAvDc – Isolated mid <i>Cratystylis subspinescens</i> shrubs over low <i>Atriplex vesicaria</i> shrubland over isolated low <i>Disphyma crassifolium</i> forbs • EcDIOM – Mid <i>Eucalyptus clelandiorum</i> woodland over isolated shrubs to mid open <i>Dodonaea lobulata</i> shrubland over isolated low to sparse <i>Olearia muelleri</i> shrubland • EcEsOm – Mid <i>Eucalyptus clelandiorum</i> woodland over isolated mid <i>Eremophila scoparia</i> shrubs to open shrubland over isolated low <i>Olearia muelleri</i> shrubland

Principle	Statement against principle
	<ul style="list-style-type: none"> • ElEaAv – Mid <i>Eucalyptus longicornis</i> woodland over mid to tall open <i>Exocarpos aphyllus</i> shrubland over isolated low <i>Atriplex vesicaria</i> shrubs • EsEsAb – Mid <i>Eucalyptus salmonophloia</i> woodland over mid <i>Eremophila scoparia</i> shrubland over low open <i>Atriplex bunburyana</i> shrubland • MhTiDc – Isolated tall <i>Melaleuca halmatororum</i> shrubs over low <i>Tecticornia indica</i> subsp. <i>bidens</i> chenopod shrubland over isolated low <i>Disphyma crassifolium</i> forbs • Tecticornias – Mosaic of <i>Tecticornia</i> spp. <p>None of these are restricted to the IDF, all are well represented in the wider study area and all were determined to align with vegetation types mapped in previous surveys in the locality indicating a broader distribution outside the study area.</p> <p>The vegetation within the IDF does not comprise any PECs.</p> <p>Vegetation within the IDF may support Priority flora; however, no plants of any Priority flora have been recorded within the IDF:</p> <ul style="list-style-type: none"> • Vegetation type MhTiDc within the study area supports a population of <i>C. ?quartzitica</i> (P1) or <i>C. ?leeroyensis</i> (P1). Specimens were recorded in close proximity (~30 m) to the IDF. <i>C. ?quartzitica</i> or <i>C. ?leeroyensis</i> from the study area may be considered a significant population of Priority flora as either record would represent a range extension for the species. Both species are known from multiple salt lakes. Additional plants likely to occur in MhTiDc; however, only a very small proportion of the total mapped extent of MhTiDc intersects the IDF. • Vegetation type AbDIPO within the study area supports a population of <i>Austrostipa blackii</i> (P3). The species was recorded ~190 m from the IDF. <i>A. blackii</i> is a widely distributed species known from three bioregions (Avon Wheatbelt, Coolgardie and Yalgoo bioregions) and 46 records in ALA (2019). Additional plants likely to occur in AbDIPO; however, only a very small proportion of the total mapped extent of MhTiDc intersects the IDF. • Vegetation type EcDIOM within the study area supports a population of <i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i> (P3). The species was recorded ~620 m from the IDF. <i>A. e.</i> subsp. <i>grossa</i> is known from two bioregions and 64 records in ALA (2019). Only a small proportion of EcDIOM intersects the IDF.
B) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia	<p>Potential for variance with Principle B: unlikely</p> <p>The IDF contains three broad fauna habitats: open eucalypt woodland, shrubland and chenopod shrubland all of which are well represented outside the IDF in the wider study area and more broadly across parts of the Eastern Goldfields subregion.</p> <p>The IDF contains suitable habitat for 16 significant fauna species. Twelve of these are EPBC Act and BC Act listed Migratory shorebirds (Oriental Pratincole, Common Sandpiper, Sharp-tailed Sandpiper, Sanderling, Curlew Sandpiper, Pectoral Sandpiper, Red-necked Stint, Long-toed Stint, Grey-tailed Tattler, Grey-tailed Tattler, Common Greenshank and Glossy Ibis) that may utilize the chenopod shrubland and adjacent saltlake habitat (present in the study area but not the IDF) for feeding intermittently during inundation events. Similarly,</p>

Principle	Statement against principle
	<p>the Hooded Plover (P4) may also feed in the chenopod shrubland habitat on occasion during periods of inundation.</p> <p>The chenopod shrubland within the IDF is not considered significant habitat for any of the twelve Migratory shorebirds or the Hooded Plover. The proposed haul road intersects a very small proportion of the mapped extent of chenopod shrubland. The chenopod shrubland and saltlake habitats of the study area were considered unlikely to represent significant habitat for migratory shorebirds due to limited extent of potential roosting habitat. In addition, the saltlake present in the study area is part of a series of regional saltlakes that include the 33 km² White Flag Lake, 13 km to the north. Similar feeding habitat is likely to be extensive within this lake system during inundation events. The chenopod shrubland within the IDF is likely to represent marginal feeding habitat for shorebirds during inundation events in comparison to the saltlake proper and, more significantly, the expansive White Flag Lake.</p> <p><i>Leipoa ocellata</i> Malleefowl (VU EBPC Act, BC Act) was recorded in open eucalypt woodland in the study area, outside the IDF. The habitat of the IDF is considered suitable for foraging by the species but less suitable for nesting due to patchiness of vegetation cover. The open eucalypt woodland and shrubland habitats of the IDF may be significant habitat for Malleefowl if the species is found to be nesting in the vicinity and utilising the study area as important foraging habitat. However, the open eucalypt woodland and shrubland habitats are well represented outside the IDF in the wider study area and more broadly across parts of the Eastern Goldfields subregion. Only a small proportion of the mapped extent of each occurs within the IDF.</p> <p>The two remaining significant species that may occur within the IDF, Peregrine Falcon (SP BC Act) and Fork-tailed Swift (Mig. EPBC Act, BC Act), inhabit a broad range of habitats and may occur only occasionally to forage in the study area. The habitats of the study area are not considered significant habitats for these species.</p>
C) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora	<p>Potential for variance with Principle C: unlikely</p> <p>No Threatened flora species were recorded in the Study Area during the flora and vegetation survey. Two Threatened flora were identified in the desktop review, <i>Gastrolobium graniticum</i> (EN EPBC Act, VU BC Act) and <i>Thelymitra stellata</i> (EN EPBC Act, BC Act); both are considered likely to occur in the IDF or wider study area.</p>
D) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a Threatened Ecological Community (TEC)	<p>Potential for variance with Principle D: unlikely</p> <p>No TEC was recorded within the IDF or wider study area during the survey.</p> <p>No TECs listed under the EPBC Act or BC Act were returned in the DBCA Threatened and Priority Ecological Community database search results in the desktop review.</p>
E) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has extensively cleared	<p>Potential for variance with Principle E: unlikely</p> <p>The IDF does not occur in an area that has been extensively cleared.</p> <p>The broad vegetation associations mapped by Beard for the IDF (Shepherd <i>et al.</i> 2002) – association 9 (Medium woodland; coral gum (<i>Eucalyptus torquata</i>) & goldfields blackbutt (<i>E. le soufii</i>)), 540 (Succulent steppe with open low woodland; sheoak over saltbush) and 468 (Medium woodland; salmon gum &</p>

Principle	Statement against principle
	goldfields blackbutt) – all have over 95% remaining at the bioregional and subregional scales based on DBCA (2018a).
F) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse of wetland	<p>Potential for variance with Principle F: possible</p> <p>The IDF contains two vegetation types that are growing in association with a saltlake:</p> <ul style="list-style-type: none"> MhTiDc – Isolated tall <i>Melaleuca halmatororum</i> shrubs over low <i>Tecticornia indica</i> subsp. <i>bidens</i> chenopod shrubland over isolated low <i>Disphyma crassifolium</i> forbs Tecticornias – Mosaic of <i>Tecticornia</i> spp. <p>The saltlake is not listed as a significant wetland under any formal listings (for example RAMSAR, Directory of Important Wetlands, Conservation Category wetlands).</p> <p>Only minor clearing of these vegetation types is proposed and is unlikely to cause significant impact to the vegetation types or the wetland. Possible minor, localised erosion or water quality decline may occur from the proposed clearing. Measures should be implemented to minimise impacts to the salt lake system.</p>
G) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation	<p>Potential for variance with Principle G: unlikely</p> <p>The potential for land degradation from arising from vegetation clearing includes wind and soil</p> <p>Proposed clearing within the IDF is unlikely to result in appreciable land degradation. Minor localised wind erosion may occur, particularly in and around the saltlake; this can be mitigated through implementation of appropriate management measures during construction and operation.</p>
H) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area	<p>Potential for variance with Principle H: unlikely</p> <p>The IDF is not situated within or adjacent to any conservation reserves.</p>
I) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	<p>Potential for variance with Principle I: unlikely</p> <p>Other than the saltlake, no surface water systems are present within or in the vicinity of the IDF. Clearing is considered unlikely to cause any deterioration in surface water quality other than possibly very minor, localised impacts where the IDF intersects the saltlake and adjacent vegetation.</p> <p>The IDF is located within the Goldfields Groundwater Area, as proclaimed under the <i>Rights in Water and Irrigation Act 1914</i> (RIWI Act). Clearing within the IDF is unlikely to cause major deterioration in groundwater quality, although very minor, localised impacts may occur temporarily during clearing.</p>
J) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding	<p>Potential for variance with Principle J: unlikely</p> <p>The IDF intersects part of a saltlake and associated vegetation communities which are naturally prone to periodic inundation. Clearing within the IDF is unlikely to exacerbate the incidence of flooding, although there may be some minor shifts in inundation patterns.</p>



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Appendix 1 Flora survey site descriptions

Site details			
Site:	CR002a	Type:	Quadrat (20 m x 20 m)
Date(s):	09 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.768105, 121.196957 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	25	Topography:	undulating plain
Tree/shrub cover >2 m (%):	5	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sand, sandy loam,
Grass cover (%):	0.1	Rock type:	quartz;
Herb cover (%):	0.2	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Isolated tall <i>Grevillea sarissa</i> subsp. <i>sarissa</i> and <i>Melaleuca halmaturorum</i> shrubs over low <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>T. sp.</i> Dennys Crossing and <i>T. pruinosa</i> . shrubland over isolated low <i>Disphyma crassifolium</i> and <i>Calandrinia ?quartzitica</i> forbs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia pruinosa</i>	15.0	00.50		
<i>Tecticornia indica</i> subsp. <i>bidens</i>	05.0	00.40		
<i>Grevillea sarissa</i> subsp. <i>sarissa</i>	03.0	02.50		
<i>Dodonaea viscosa</i>	02.0	01.50		
<i>Melaleuca halmaturorum</i>	01.0	02.10		
<i>Frankenia setosa</i>	01.0	00.30		
<i>Maireana glomerifolia</i>	01.0	00.30		
<i>Disphyma crassifolium</i>	01.0	00.10		
<i>Enchylaena tomentosa</i>	00.5	00.50		
<i>Rhagodia drummondii</i>	00.5	00.50		
<i>Maireana ?amoena</i>	00.5	00.20		
<i>Eremophila scoparia</i>	00.1	00.80		
<i>Solanum nummularium</i>	00.1	00.40		
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	00.1	00.40		

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<i>Atriplex vesicaria</i>	00.1	00.30
<i>Calandrinia ?quartzitica</i>	00.1	00.30
<i>Maireana carnososa</i>	00.1	00.25
<i>Aristida contorta</i>	00.1	00.15
<i>Surreya diandra</i>	00.1	00.15
<i>Sclerolaena diacantha</i>	00.1	00.10

Site details			
Site:	CR002TQ01	Type:	Transect (3 m x 3 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.770379, 121.198438 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	3	Topography:	salt lake (playa)
Tree/shrub cover >2 m (%):	0	Soil colour:	red-brown,
Shrub cover <2 m (%):	3	Soil:	clay,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Isolated low <i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>	03.0	00.20		

Site details			
Site:	CR002TQ02	Type:	Transect (3 m x 3 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.770051, 121.198014 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	4	Topography:	salt lake (playa)
Tree/shrub cover >2 m (%):	0	Soil colour:	red-brown,
Shrub cover <2 m (%):	4	Soil:	sandy clay,
Grass cover (%):	0	Rock type:	quartz;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Low <i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i> , and <i>T. doliiformis</i> chenopod shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>	03.0	00.15		
<i>Tecticornia doliiformis</i>	01.0	00.15		

Site details			
Site:	CR002TQ03	Type:	Transect (3 m x 3 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.769704, 121.197531 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	15	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	yellow, whitish,
Shrub cover <2 m (%):	15	Soil:	sand,
Grass cover (%):	0	Rock type:	quartz;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Low <i>Tecticornia undulata</i> , <i>T. sp.</i> Dennys Crossing and <i>T. doliiformis</i> chenopod shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia sp.</i> Dennys Crossing (K.A. Shepherd & J. English KS 552)	10.0	00.40		
<i>Tecticornia undulata</i>	04.0	00.30		
<i>Tecticornia doliiformis</i>	01.0	00.25		
<i>Maireana amoena</i>	00.1	00.15		
<i>Maireana eriosphaera</i>	00.1	00.15		

Site details			
Site:	CR002TQ04	Type:	Transect (3 m x 3 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.769414, 121.197065 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	10	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	yellow, whitish,
Shrub cover <2 m (%):	10	Soil:	sand,
Grass cover (%):	0	Rock type:	quartz;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Low open <i>Tecticornia</i> sp. Dennys Crossing and <i>T. doliiformis</i> chenopod shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	10.0	00.20		
<i>Tecticornia doliiformis</i>	00.1	00.15		

Site details			
Site:	CR003	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.775984, 121.196064 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	30	Topography:	hill slope
Tree/shrub cover >2 m (%):	25	Soil colour:	brown,
Shrub cover <2 m (%):	20	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	granite rocks
Herb cover (%):	0.2	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus clelandiorum</i> , <i>E. oleosa</i> subsp. <i>oleosa</i> and <i>E. longicornis</i> woodland over isolated tall <i>Eremophila interstans</i> subsp. <i>interstans</i> shrubs over low open <i>Atriplex vesicaria</i> , <i>Maireana pentatropis</i> and <i>Enchylaena tomentosa</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Atriplex vesicaria</i>	20.0	00.50		
<i>Eucalyptus longicornis</i>	15.0	20.00		
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	10.0	20.00		
<i>Eucalyptus clelandiorum</i>	10.0	12.00		
<i>Eremophila interstans</i> subsp. <i>interstans</i>	01.0	01.10		
<i>Maireana pentatropis</i>	01.0	00.50		
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>	00.1	05.00		
<i>Senna artemisioides</i> subsp. <i>artemisioides</i>	00.1	01.20		
<i>Pittosporum angustifolium</i>	00.1	00.50		
<i>Dodonaea viscosa</i>	00.1	00.40		
<i>Enchylaena tomentosa</i>	00.1	00.40		
<i>Eremophila glabra</i>	00.1	00.40		
<i>Ptilotus obovatus</i>	00.1	00.40		
<i>Olearia muelleri</i>	00.1	00.25		
<i>Maireana georgei</i>	00.1	00.15		

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<i>Maireana trichoptera</i>	00.1	00.15
<i>Rhagodia drummondii</i>	00.1	00.10
<i>Roepera aurantiaca</i>	00.1	00.10
<i>Sclerolaena brevifolia</i>	00.1	00.10
<i>Sclerolaena diacantha</i>	00.1	00.10

Site details			
Site:	CR004	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.776369, 121.18336 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	60	Topography:	hill top
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	35	Soil:	clay loam,
Grass cover (%):	0.1	Rock type:	granite rocks
Herb cover (%):	0.1	Fire age:	not evident
Vegetation condition:	Good, EPA (2016)	Disturbance	exploration drill pads, erosion, clearing, vehicle tracks

Land system:

Vegetation description and type:

Tall *Acacia burkittii*, *Brachychiton gregorii* and *Grevillea berryana* shrubland over mid open *Eremophila gibbosa* and *Scaevola spinescens* and *Dodonaea lobulata* shrubland over low *Leiocarpa semiclava* subsp. *semiclava* *Solanum lasiophyllum* and *Ptilotus obovatus* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Leiocarpa semicalva</i> subsp. <i>semicalva</i>	30.0	00.20		
<i>Grevillea berryana</i>	10.0	05.00		
<i>Brachychiton gregorii</i>	10.0	03.00		
<i>Acacia burkittii</i>	10.0	02.50		
<i>Acacia tetragonophylla</i>	05.0	02.00		
<i>Acacia gibbosa</i>	05.0	01.50		
<i>Eremophila gibbosa</i>	03.0	01.50		
<i>Scaevola spinescens</i>	02.0	01.10		
<i>Exocarpos aphyllus</i>	01.0	01.50		
<i>Dodonaea lobulata</i>	01.0	01.00		
<i>Amyema gibberula</i> var. <i>gibberula</i>	00.1	02.00		
<i>Prostanthera althoferi</i>	00.1	01.20		
<i>Cassytha ?nodiflora</i>	00.1	01.00		
<i>Rhyncharrhena linearis</i>	00.1	01.00		

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<i>Olearia pimeleoides</i>	00.1	00.50	
<i>Ptilotus obovatus</i>	00.1	00.50	
<i>Solanum lasiophyllum</i>	00.1	00.50	
<i>Austrostipa blackii</i>	00.1	00.10	P3 (DBCA list)
<i>Austrostipa scabra</i>	00.1	00.10	
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	00.1	00.10	
<i>Goodenia havilandii</i>	00.1	00.04	
<i>Ptilotus helipteroides</i>	00.1	00.02	
<i>Euphorbia porcata</i>	00.1	00.01	

Site details			
Site:	CR005	Type:	Quadrat (20 m x 20 m)
Date(s):	15 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.777041, 121.178069 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	50	Topography:	plain
Tree/shrub cover >2 m (%):	30	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	clay loam, clay,
Grass cover (%):	0.1	Rock type:	none
Herb cover (%):	0.1	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus salmonophloia</i> , <i>E. salubris</i> and <i>E. griffithsii</i> woodland over mid open <i>Acacia jennerae</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low open <i>Atriplex ?vesicaria</i> , <i>Maireana triptera</i> and <i>Tecticornia doliiformis</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus salmonophloia</i>	20.0	25.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	15.0	01.20		
<i>Eucalyptus salubris</i>	10.0	15.00		
<i>Tecticornia doliiformis</i>	10.0	00.60		
<i>Eremophila scoparia</i>	07.0	01.50		
<i>Atriplex ?vesicaria</i>	03.0	00.50		
<i>Eremophila dempsteri</i>	01.0	04.00		
<i>Acacia jennerae</i>	01.0	02.00		
<i>Exocarpos aphyllus</i>	01.0	02.00		
<i>Eucalyptus griffithsii</i>	00.1	08.00		
<i>Eremophila ionantha</i>	00.1	01.20		
<i>Pimelea microcephala</i>	00.1	01.00		
<i>Pittosporum angustifolium</i>	00.1	01.00		
<i>Rhagodia drummondii</i>	00.1	01.00		
<i>Lycium australe</i>	00.1	00.60		

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<i>Enchylaena tomentosa</i>	00.1	00.50
<i>Maireana sedifolia</i>	00.1	00.50
<i>Ptilotus obovatus</i>	00.1	00.50
<i>Scaevola spinescens</i>	00.1	00.50
<i>Austrostipa elegantissima</i>	00.1	00.40
<i>Frankenia ?interioris</i>	00.1	00.30
<i>Maireana triptera</i>	00.1	00.30
<i>Austrostipa nitida</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Vittadinia dissecta</i> var. <i>hirta</i>	00.1	00.20
<i>Sclerolaena diacantha</i>	00.1	00.15
<i>Ptilotus exaltatus</i>	00.1	00.02

Site details			
Site:	CR006	Type:	Quadrat (20 m x 20 m)
Date(s):	15 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.779269, 121.173808 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	hill slope
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	25	Soil:	clay loam,
Grass cover (%):	5	Rock type:	granite rocks
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	livestock tracks, vehicle tracks, weed infestation

Land system:

Vegetation description and type: Mid *Eucalyptus griffithsii* mallee woodland over isolated mid *Acacia dissona* var. *dissona*, *A. hemiteles* and *Senna artemisioides* subsp. *filifolia* shrubs over low open *Acacia merrallii*, *Eremophila parvifolia* subsp. *auricampa* and *Westringia rigida* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	25.0	06.00		
<i>Acacia merrallii</i>	05.0	00.80		
<i>Westringia rigida</i>	05.0	00.30		
<i>Acacia dissona</i> var. <i>dissona</i>	01.0	02.00		
<i>Acacia hemiteles</i>	01.0	01.50		
<i>Triodia scariosa</i>	01.0	00.35		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.5	01.10		
<i>Acacia densiflora</i>	00.1	01.80		
<i>Exocarpos aphyllus</i>	00.1	01.50		
<i>Eremophila oppositifolia</i>	00.1	01.40		
<i>Eremophila glabra</i>	00.1	01.20		
<i>Eremophila scoparia</i>	00.1	01.00		
<i>Acacia erinacea</i>	00.1	00.80		
<i>Cryptandra aridicola</i>	00.1	00.70		

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<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.50	
<i>Scaevola spinescens</i>	00.1	00.50	
<i>Grevillea acuaria</i>	00.1	00.40	
<i>Ptilotus obovatus</i>	00.1	00.40	
<i>Atriplex nummularia</i>	00.1	00.30	
<i>Dodonaea lobulata</i>	00.1	00.20	
<i>Olearia muelleri</i>	00.1	00.20	
<i>Solanum hoplopetalum</i>	00.1	00.20	
<i>Enneapogon caeruleus</i>	00.1	00.15	
<i>Haloragis trigonocarpa</i>	00.1	00.15	
<i>Lysimachia arvensis</i>	00.1	00.10	*
<i>Salvia verbenaca</i>	00.1	00.05	*
<i>Ptilotus exaltatus</i>	00.1	00.02	
<i>Euphorbia ?philochalix</i>	00.1	00.01	

Site details			
Site:	CR008	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.765669, 121.174482 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	50	Topography:	hill slope
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	35	Soil:	sandy clay, clay loam,
Grass cover (%):	0.5	Rock type:	none
Herb cover (%):	1	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid open <i>Eucalyptus salmonophloia</i> woodland over low <i>E. salubris</i> and <i>E. clelandiorum</i> woodland over mid <i>Acacia hemiteles</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus salmonophloia</i>	20.0	15.00		
<i>Eremophila scoparia</i>	15.0	01.90		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	15.0	01.50		
<i>Eucalyptus clelandiorum</i>	05.0	08.00		
<i>Eucalyptus salubris</i>	05.0	08.00		
<i>Acacia hemiteles</i>	05.0	01.20		
<i>Atriplex bunburyana</i>	03.0	00.80		
<i>Exocarpos aphyllus</i>	01.0	04.00		
<i>Scaevola spinescens</i>	01.0	00.60		
<i>Ptilotus obovatus</i>	01.0	00.50		
<i>Santalum spicatum</i>	00.1	02.50		
<i>Rhagodia drummondii</i>	00.1	01.50		
<i>Eremophila ionantha</i>	00.1	01.40		
<i>Eremophila oldfieldii</i>	00.1	01.20		
<i>Enchylaena tomentosa</i>	00.1	01.00		
<i>Lycium australe</i>	00.1	01.00		

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<i>Senna stowardii</i>	00.1	00.50
<i>Austrostipa elegantissima</i>	00.1	00.40
<i>Maireana convexa</i>	00.1	00.40
<i>Maireana triptera</i>	00.1	00.40
<i>Olearia muelleri</i>	00.1	00.30
<i>Maireana trichoptera</i>	00.1	00.20
<i>Maireana georgei</i>	00.1	00.15
<i>Sclerolaena diacantha</i>	00.1	00.15
<i>Paspalidium gracile</i>	00.1	00.10

Site details			
Site:	CR009a	Type:	Quadrat (20 m x 20 m)
Date(s):	05 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.767917, 121.178289 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	undulating plain
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	sandy clay, clay loam,
Grass cover (%):	1	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	grazing – low, livestock tracks,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus clelandiorum</i> and <i>E. longicornis</i> woodland over mid open <i>Eremophila scoparia</i> , <i>Exocarpos aphyllus</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Atriplex ?vesicaria</i> , <i>Olearia muelleri</i> and <i>Cratystylis</i> spp. shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	25.0	18.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	10.0	01.50		
<i>Eremophila scoparia</i>	07.0	01.20		
<i>Exocarpos aphyllus</i>	02.0	01.80		
<i>Eremophila interstans</i> subsp. <i>interstans</i>	01.0	01.90		
<i>Eremophila glabra</i>	01.0	01.40		
<i>Acacia hemiteles</i>	01.0	01.00		
<i>Austrostipa elegantissima</i>	01.0	01.00		
<i>Senna cardiosperma</i>	01.0	01.00		
<i>Olearia muelleri</i>	01.0	00.30		
<i>Cratystylis microphylla</i>	00.5	00.50		
<i>Atriplex ?vesicaria</i>	00.5	00.40		
<i>Eucalyptus longicornis</i>	00.1	20.00		
<i>Eremophila alternifolia</i>	00.1	01.20		
<i>Dodonaea viscosa</i>	00.1	01.00		

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<i>Atriplex nummularia</i>	00.1	00.60
<i>Chenopodium curvispicatum</i>	00.1	00.50
<i>Cratystylis conocephala</i>	00.1	00.50
<i>Eremophila parvifolia</i>	00.1	00.50
<i>Scaevola spinescens</i>	00.1	00.50
<i>Lycium australe</i>	00.1	00.45
<i>Eremophila miniata</i>	00.1	00.40
<i>Solanum nummularium</i>	00.1	00.30

Site details			
Site:	CR010	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.763716, 121.180255 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	55	Topography:	hill slope
Tree/shrub cover >2 m (%):	30	Soil colour:	brown,
Shrub cover <2 m (%):	40	Soil:	sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals,
Land system:			
Vegetation description and type:	Low <i>Eucalyptus celastroides</i> subsp. <i>celastroides</i> and <i>E. clelandiorum</i> woodland over mid open <i>Eremophila scoparia</i> , <i>E. glabra</i> and <i>E. oppositifolia</i> shrubland over low <i>Cratystlis microphylla</i> , <i>Olearia muelleri</i> and <i>Atriplex stipitata</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>	20.0	09.00		
<i>Eucalyptus clelandiorum</i>	10.0	09.00		
<i>Eremophila scoparia</i>	10.0	01.50		
<i>Cratystlis microphylla</i>	10.0	01.00		
<i>Eremophila oppositifolia</i>	02.0	01.90		
<i>Eremophila glabra</i>	02.0	01.10		
<i>Atriplex stipitata</i>	02.0	00.40		
<i>Olearia muelleri</i>	02.0	00.40		
<i>Exocarpos aphyllus</i>	01.0	02.50		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	01.0	01.20		
<i>Westringia rigida</i>	01.0	00.30		
<i>Santalum acuminatum</i>	00.5	01.50		
<i>Enchylaena tomentosa</i>	00.1	01.20		
<i>Acacia erinacea</i>	00.1	01.00		
<i>Acacia hemiteles</i>	00.1	01.00		
<i>Cratystlis conocephala</i>	00.1	01.00		

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<i>Dodonaea lobulata</i>	00.1	01.00
<i>Eremophila parvifolia</i>	00.1	01.00
<i>Pomaderris forrestiana</i>	00.1	01.00
<i>Atriplex nummularia</i>	00.1	00.50
<i>Casuarina obesa</i>	00.1	00.50
<i>Lycium australe</i>	00.1	00.50
<i>Rhagodia drummondii</i>	00.1	00.50
<i>Ptilotus obovatus</i>	00.1	00.40
<i>Solanum nummularium</i>	00.1	00.40
<i>Tecticornia</i> sp. (sterile 1)	00.1	00.40
<i>Austrostipa elegantissima</i>	00.1	00.30
<i>Maireana convexa</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.15

Site details			
Site:	CR011	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.760096, 121.180682 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	plain
Tree/shrub cover >2 m (%):	20	Soil colour:	red-brown,
Shrub cover <2 m (%):	35	Soil:	sandy loam,
Grass cover (%):	5	Rock type:	ferrous – ironstone
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus griffithsii</i> and <i>E. oleosa</i> subsp. <i>oleosa</i> woodland over mid open <i>Senna artemisioides</i> subsp <i>filifolia</i> , <i>Eremophila glabra</i> and <i>Halgania andromedifolia</i> shrubland over low sparse <i>Triodia scariosa</i> hummock grassland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	20.0	15.00		
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	10.0	15.00		
<i>Halgania andromedifolia</i>	06.0	01.10		
<i>Triodia scariosa</i>	06.0	00.40		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	05.0	01.40		
<i>Eremophila glabra</i>	02.0	01.60		
<i>Scaevola spinescens</i>	02.0	01.00		
<i>Westringia rigida</i>	02.0	00.50		
<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>	01.0	02.00		
<i>Acacia erinacea</i>	01.0	01.20		
<i>Dodonaea lobulata</i>	00.1	01.50		
<i>Exocarpos aphyllus</i>	00.1	01.40		
<i>Eremophila interstans</i> subsp. <i>interstans</i>	00.1	01.20		
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	01.20		
<i>Eremophila pustulata</i>	00.1	01.20		
<i>Atriplex nummularia</i>	00.1	00.50		

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<i>Atriplex acutibractea</i> subsp. <i>acutibractea</i>	00.1	00.40
<i>Olearia muelleri</i>	00.1	00.30
<i>Sclerolaena diacantha</i>	00.1	00.15

Site details			
Site:	CR012	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.761223, 121.185682 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	plain
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus transcontinentalis</i> , <i>E. oleosa</i> subsp. <i>oleosa</i> and <i>E. clelandiorum</i> woodland over mid open <i>Eremophila scoparia</i> , <i>E. ionantha</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low sparse <i>Atriplex eardleyae</i> , <i>A. ? vesicaria</i> and <i>Olearia muelleri</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus transcontinentalis</i>	15.0	15.00		
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	05.0	15.00		
<i>Eremophila ionantha</i>	05.0	01.80		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	05.0	01.80		
<i>Eremophila scoparia</i>	05.0	01.50		
<i>Atriplex ?vesicaria</i>	02.0	00.50		
<i>Atriplex eardleyae</i>	02.0	00.50		
<i>Casuarina pauper</i>	01.0	06.00		
<i>Olearia muelleri</i>	01.0	00.30		
<i>Scaevola spinescens</i>	00.5	00.50		
<i>Eucalyptus griffithsii</i>	00.1	12.00		
<i>Eucalyptus clelandiorum</i>	00.1	08.00		
<i>Santalum spicatum</i>	00.1	02.20		
<i>Dodonaea lobulata</i>	00.1	01.70		
<i>Eremophila glabra</i>	00.1	01.50		

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<i>Exocarpos aphyllus</i>	00.1	01.50
<i>Acacia hemiteles</i>	00.1	01.20
<i>Cratystylis microphylla</i>	00.1	01.20
<i>Acacia erinacea</i>	00.1	01.00
<i>Atriplex nummularia</i>	00.1	01.00
<i>Casuarina obesa</i>	00.1	01.00
<i>Alyxia buxifolia</i>	00.1	00.60
<i>Dianella revoluta</i>	00.1	00.60
<i>Psydrax suaveolens</i>	00.1	00.60
<i>Ptilotus obovatus</i>	00.1	00.50
<i>Maireana triptera</i>	00.1	00.40
<i>Austrostipa elegantissima</i>	00.1	00.30
<i>Sclerolaena obliquicuspis</i>	00.1	00.30
<i>Sclerolaena ?brevifolia</i>	00.1	00.20
<i>Sclerolaena diacantha</i>	00.1	00.10
<i>Sclerolaena drummondii</i>	00.1	00.10

Site details			
Site:	CR013a	Type:	Quadrat (20 m x 20 m)
Date(s):	06 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.765333, 121.19086 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	35	Topography:	hill slope
Tree/shrub cover >2 m (%):	25	Soil colour:	red-brown,
Shrub cover <2 m (%):	20	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	granite outcropping; granite rocks;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	evidence of feral animals, grazing – low, vehicle tracks,

Land system:

Vegetation description and type: Mid *Eucalyptus clelandiorum*, *E. longicornis* and *E. griffithsii* woodland over mid open *Eremophila glabra*, *Exocarpos aphyllus* and *Senna artemisioides* subsp. *filifolia* shrubland over isolated low *Atriplex ?vesicaria*, *Acacia xerophila* var. *brevior* and *Ptilotus obovatus* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus longicornis</i>	20.0	15.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	07.0	01.20		
<i>Eremophila glabra</i>	06.0	01.20		
<i>Eucalyptus griffithsii</i>	05.0	10.00		
<i>Atriplex ?vesicaria</i>	02.0	00.40		
<i>Exocarpos aphyllus</i>	01.0	01.50		
<i>Ptilotus obovatus</i>	01.0	00.50		
<i>Acacia xerophila</i> var. <i>brevior</i>	01.0	00.40		
<i>Olearia muelleri</i>	00.5	00.25		
<i>Rhagodia drummondii</i>	00.2	00.50		
<i>Eucalyptus clelandiorum</i>	00.1	12.00		
<i>Atriplex nummularia</i>	00.1	05.00		
<i>Eremophila oppositifolia</i>	00.1	02.00		
<i>Santalum spicatum</i>	00.1	02.00		

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<i>Eremophila scoparia</i>	00.1	01.40
<i>Eremophila longifolia</i>	00.1	01.20
<i>Dodonaea lobulata</i>	00.1	01.00
<i>Casuarina pauper</i>	00.1	00.80
<i>Eremophila alternifolia</i>	00.1	00.50
<i>Solanum nummularium</i>	00.1	00.50
<i>Marsdenia australis</i>	00.1	00.40
<i>Austrostipa elegantissima</i>	00.1	00.30
<i>Maireana sedifolia</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.15
<i>Sclerolaena diacantha</i>	00.1	00.10
<i>Ptilotus holosericeus</i>	00.1	00.01

Site details			
Site:	CR015	Type:	Quadrat (20 m x 20 m)
Date(s):	14 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.762397, 121.179421 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	hill top
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	15	Soil:	clay loam,
Grass cover (%):	0	Rock type:	ferrous – ironstone
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	vehicle tracks,
Land system:			
Vegetation description and type:	Low <i>Eucalyptus clelandiorum</i> and <i>E. griffithsii</i> woodland over tall <i>Acacia burkittii</i> , <i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i> and <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubland over low open <i>Cryptandra aridicola</i> , <i>Dodonaea lobulata</i> and <i>Exocarpos aphyllus</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	25.0	09.00		
<i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i>	20.0	03.00		P3 (DBCA list)
<i>Acacia burkittii</i>	10.0	02.50		
<i>Dodonaea lobulata</i>	10.0	01.00		
<i>Cryptandra aridicola</i>	05.0	01.00		
<i>Eucalyptus griffithsii</i>	03.0	08.00		
<i>Scaevola spinescens</i>	01.0	01.50		
<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	00.1	02.00		
<i>Acacia erinacea</i>	00.1	01.00		
<i>Acacia tetragonophylla</i>	00.1	01.00		
<i>Eremophila gibbosa</i>	00.1	01.00		
<i>Eremophila glabra</i>	00.1	01.00		
<i>Eremophila oppositifolia</i>	00.1	01.00		
<i>Exocarpos aphyllus</i>	00.1	01.00		
<i>Thysanotus manglesianus</i>	00.1	00.60		

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<i>Prostanthera althoferi</i>	00.1	00.50
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	00.50
<i>Halgania andromedifolia</i>	00.1	00.45
<i>Olearia muelleri</i>	00.1	00.40
<i>Santalum spicatum</i>	00.1	00.40
<i>Triodia scariosa</i>	00.1	00.30
<i>Westringia rigida</i>	00.1	00.30
<i>Halgania cyanea</i>	00.1	00.25

Site details			
Site:	CR016a	Type:	Quadrat (20 m x 20 m)
Date(s):	06 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.777945, 121.188308 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	50	Topography:	floodplain
Tree/shrub cover >2 m (%):	0	Soil colour:	red-brown,
Shrub cover <2 m (%):	50	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	grazing – low, livestock tracks, vehicle tracks, weed infestation,

Land system:

Vegetation description and type: Isolated mid *Cratystylis subspinescens* and *Pimelea microcephala* shrubs over low *Atriplex vesicaria*, *Roycea divaricata* and *Tecticornia* sp. (sterile 1) chenopod shrubland over isolated low *Calandrinia* sp. Gypsum, *Disphyma crassifolium* and *Sclerolaena obliquicuspis* forbs.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Atriplex vesicaria</i>	35.0	00.50		
<i>Tecticornia</i> sp. (sterile 1)	10.0	00.60		
<i>Roycea divaricata</i>	10.0	00.40		
<i>Sclerolaena obliquicuspis</i>	02.0	00.10		
<i>Cratystylis subspinescens</i>	01.0	01.20		
<i>Enteropogon ramosus</i>	01.0	00.30		
<i>Disphyma crassifolium</i>	01.0	00.08		
<i>Frankenia ?interioris</i>	00.5	00.30		
<i>Maireana amoena</i>	00.5	00.20		
<i>Maireana appressa</i>	00.5	00.20		
<i>Salvia verbenaca</i>	00.5	00.10	*	
<i>Monoculus monstrosus</i>	00.5	00.03	*	
<i>Eragrostis dielsii</i>	00.5	00.02		
<i>Calandrinia</i> sp. Gypsum (F. Obbens & L. Hancock FO 10/14)	00.2	00.40		

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<i>Sclerolaena cuneata</i>	00.2	00.25	
<i>Pimelea microcephala</i>	00.1	01.20	
<i>Enchylaena tomentosa</i>	00.1	00.60	
<i>Eremophila scoparia</i>	00.1	00.60	
<i>Lycium australe</i>	00.1	00.60	
<i>Solanum nummularium</i>	00.1	00.50	
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.40	
<i>Sclerolaena eurotioides</i>	00.1	00.30	
<i>Austrostipa nitida</i>	00.1	00.20	
<i>Cuscuta epithymum</i>	00.1	00.20	*
<i>Enneapogon caeruleus</i>	00.1	00.15	
<i>Heliotropium curassavicum</i>	00.1	00.15	
<i>Maireana turbinata</i>	00.1	00.15	
<i>Minuria cunninghamii</i>	00.1	00.15	
<i>Osteocarpum salsuginosum</i>	00.1	00.15	
<i>Sida spodochroma</i>	00.1	00.10	
<i>Vittadinia dissecta</i> var. <i>hirta</i>	00.1	00.10	
<i>Brachyscome ciliaris</i>	00.1	00.08	
<i>Medicago minima</i>	00.1	00.01	*

Site details			
Site:	CR018a	Type:	Quadrat (20 m x 20 m)
Date(s):	09 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.731759, 121.151423 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	plain
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus clelandiorum</i> and <i>E. oleosa</i> subsp. <i>oleosa</i> woodland over mid open <i>Acacia hemiteles</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Olearia muelleri</i> , <i>Scaevola spinescens</i> and <i>Westringia rigida</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	25.0	12.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	15.0	01.20		
<i>Acacia hemiteles</i>	07.0	01.10		
<i>Westringia rigida</i>	02.0	00.40		
<i>Eremophila scoparia</i>	01.0	01.10		
<i>Olearia muelleri</i>	01.0	00.25		
<i>Scaevola spinescens</i>	00.5	00.40		
<i>Eucalyptus clelandiorum</i>	00.1	12.00		
<i>Casuarina obesa</i>	00.1	04.00		
<i>Alectryon oleifolius</i> subsp. <i>canescens</i>	00.1	02.50		
<i>Eremophila ionantha</i>	00.1	01.30		
<i>Marsdenia australis</i>	00.1	01.20		
<i>Acacia nyssophylla</i>	00.1	01.00		
<i>Dodonaea lobulata</i>	00.1	01.00		
<i>Exocarpos aphyllus</i>	00.1	01.00		

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<i>Eremophila parvifolia</i>	00.1	00.50
<i>Austrostipa elegantissima</i>	00.1	00.40
<i>Eremophila glabra</i>	00.1	00.40
<i>Maireana convexa</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Ptilotus obovatus</i>	00.1	00.20
<i>Aristida contorta</i>	00.1	00.15

Site details			
Site:	CR020	Type:	Quadrat (20 m x 20 m)
Date(s):	15 June 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.740835, 121.163976 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	undulating plain
Tree/shrub cover >2 m (%):	20	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus clelandiorum</i> , <i>E. celastroides</i> subsp. <i>celastroides</i> , <i>E. transcontinentalis</i> woodland over mid open <i>Dodonaea lobulata</i> , <i>Eremophila oppositifolia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low open <i>Scaevola spinescens</i> , <i>Ptilotus obovatus</i> and <i>Westringia rigida</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	20.0	18.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	10.0	01.50		
<i>Scaevola spinescens</i>	10.0	00.80		
<i>Dodonaea lobulata</i>	06.0	01.20		
<i>Westringia rigida</i>	03.0	00.30		
<i>Eremophila oppositifolia</i>	02.0	01.80		
<i>Exocarpos aphyllus</i>	01.0	02.00		
<i>Cryptandra aridicola</i>	01.0	01.00		
<i>Triodia scariosa</i>	00.5	00.25		
<i>Eucalyptus transcontinentalis</i>	00.1	15.00		
<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>	00.1	05.00		
<i>Eremophila caperata</i>	00.1	03.00		
<i>Alyxia buxifolia</i>	00.1	01.20		
<i>Eremophila glabra</i>	00.1	01.20		
<i>Eremophila oldfieldii</i>	00.1	01.20		

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<i>Acacia colletioides</i>	00.1	00.50
<i>Atriplex vesicaria</i>	00.1	00.40
<i>Ptilotus obovatus</i>	00.1	00.40
<i>Maireana convexa</i>	00.1	00.20
<i>Maireana radiata</i>	00.1	00.20
<i>Maireana triptera</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.15

Site details			
Site:	CR021a	Type:	Quadrat (20 m x 20 m)
Date(s):	09 October 2018	Permanent:	No
Observer(s):	Grant Wells	Position:	-30.74199, 121.165461 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	hill top
Tree/shrub cover >2 m (%):	30	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	sandy clay, sandy loam,
Grass cover (%):	1	Rock type:	ferrous – ironstone;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus griffithsii</i> woodland over tall sparse <i>Allocasuarina helmsii</i> , <i>Grevillea sarissa</i> subsp. <i>bicolor</i> and <i>Eremophila oppositifolia</i> shrubland over mid open <i>Dodonaea lobulata</i> , <i>Cryptandra aridicola</i> and <i>Scaevola spinescens</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	12.0	30.00		
<i>Cryptandra aridicola</i>	06.0	01.20		
<i>Triodia scariosa</i>	05.0	00.25		
<i>Dodonaea lobulata</i>	04.0	01.30		
<i>Allocasuarina helmsii</i>	03.0	02.10		
<i>Eremophila oppositifolia</i>	02.0	02.20		
<i>Scaevola spinescens</i>	02.0	00.60		
<i>Grevillea sarissa</i> subsp. <i>bicolor</i>	01.0	04.00		
<i>Amyema gibberula</i> var. <i>gibberula</i>	00.1	01.80		
<i>Acacia burkittii</i>	00.1	01.70		
<i>Acacia hemiteles</i>	00.1	01.00		
<i>Exocarpos aphyllus</i>	00.1	01.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	01.00		
<i>Eremophila glabra</i>	00.1	00.40		
<i>Westringia rigida</i>	00.1	00.30		

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<i>Olearia muelleri</i>	00.1	00.25
<i>Ptilotus exaltatus</i>	00.1	00.25

Site details			
Site:	CR023a	Type:	Quadrat (20 m x 20 m)
Date(s):	08 October 2018	Permanent:	No
Observer(s):	Grant Wells	Position:	-30.771199, 121.220283 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	undulating plain
Tree/shrub cover >2 m (%):	7	Soil colour:	red-orange,
Shrub cover <2 m (%):	35	Soil:	sandy clay, sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Isolated low <i>Casuarina pauper</i> trees over mid sparse <i>Eremophila scoparia</i> shrubland over low open <i>Cratystylis microphylla</i> , <i>Eremophila decipiens</i> subsp. <i>decipiens</i> and <i>Maireana glomerifolia</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eremophila scoparia</i>	06.0	01.30		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	06.0	00.40		
<i>Casuarina pauper</i>	05.0	05.00		
<i>Cratystylis microphylla</i>	03.0	01.00		
<i>Maireana glomerifolia</i>	03.0	00.30		
<i>Acacia kalgoorliensis</i>	02.0	02.00		
<i>Surreya diandra</i>	02.0	00.30		
<i>Maireana triptera</i>	01.0	00.30		
<i>Scaevola spinescens</i>	00.5	01.00		
<i>Atriplex ?vesicaria</i>	00.5	00.35		
<i>Frankenia ?interioris</i>	00.5	00.25		
<i>Amyema preissii</i>	00.1	01.50		
<i>Dodonaea viscosa</i>	00.1	01.00		
<i>Lycium australe</i>	00.1	01.00		
<i>Senna cardiosperma</i>	00.1	01.00		
<i>Tecticornia doliiformis</i>	00.1	00.60		

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<i>Maireana convexa</i>	00.1	00.50
<i>Maireana sedifolia</i>	00.1	00.50
<i>Marsdenia australis</i>	00.1	00.50
<i>Ptilotus obovatus</i>	00.1	00.50
<i>Gunniopsis quadrifida</i>	00.1	00.40
<i>Olearia pimeleoides</i>	00.1	00.40
<i>Maireana carnosae</i>	00.1	00.30
<i>Rhagodia drummondii</i>	00.1	00.30
<i>Minuria cunninghamii</i>	00.1	00.25
<i>Olearia muelleri</i>	00.1	00.25
<i>Enchylaena tomentosa</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Sclerolaena diacantha</i>	00.1	00.15
<i>Disphyma crassifolium</i>	00.1	00.10

Site details			
Site:	CR025TQ01	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.76856, 121.208434 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	35	Soil:	sand, sandy loam,
Grass cover (%):	5	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	evidence of feral animals, livestock tracks, vehicle tracks,

Land system:

Vegetation description and type:

Low *Tecticornia indica* subsp. *bidens*, *T. sp.* Dennys Crossing and *Atriplex ? vesicaria* shrubland over isolated *Disphyma crassifolium*, *Erodium cicutarium* and *Surreya diandra* forbs and low isolated clumps of *Eragrostis dielsii* grasses.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia indica</i> subsp. <i>bidens</i>	30.0	00.50		
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	05.0	00.40		
<i>Disphyma crassifolium</i>	05.0	00.10		
<i>Atriplex ?vesicaria</i>	02.0	00.50		
<i>Enchylaena tomentosa</i>	00.2	00.30		
<i>Maireana eriosphaera</i>	00.2	00.25		
<i>Maireana trichoptera</i>	00.2	00.25		
<i>Erodium cicutarium</i>	00.1	00.06	*	
<i>Surreya diandra</i>	00.1	00.05		
<i>Eragrostis dielsii</i>	00.1	00.01		

Site details			
Site:	CR025TQ02	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.768447, 121.208221 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	25	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	25	Soil:	sandy clay, sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	evidence of feral animals, grazing – low, livestock tracks, vehicle tracks,
Land system:			
Vegetation description and type:	Low <i>Tecticornia undulata</i> and <i>T. doliiformis</i> chenopod shrubland over isolated clumps of low <i>Eragrostis dielsii</i> grasses.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia doliiformis</i>	24.0	00.40		
<i>Tecticornia undulata</i>	01.0	00.30		
<i>Eragrostis dielsii</i>	00.1	00.01		

Site details			
Site:	CR025TQ03	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.76838, 121.207938 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	20	Topography:	salt lake (playa)
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sandy clay, clay,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none
Land system:			
Vegetation description and type:	Low <i>Tecticornia undulata</i> , <i>Atriplex lindleyi</i> subsp. <i>inflata</i> and <i>Frankenia irregularis</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia undulata</i>	18.0	00.20		
<i>Atriplex lindleyi</i> subsp. <i>inflata</i>	01.0	00.20		
<i>Frankenia irregularis</i>	01.0	00.15		

Site details			
Site:	CR025TQ04	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.768259, 121.207624 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	20	Topography:	salt lake (playa)
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	18	Soil:	sandy clay, clay,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	2	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	livestock tracks, vehicle tracks,
Land system:			
Vegetation description and type:	Low <i>Tecticornia undulata</i> , <i>T. pergranulata</i> subsp. <i>pergranulata</i> and <i>T. doliiformis</i> chenopod shrubland over low isolated <i>Eragrostis dielsii</i> grasses.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia undulata</i>	16.0	00.15		
<i>Tecticornia doliiformis</i>	02.0	00.25		
<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>	01.0	00.25		
<i>Atriplex lindleyi</i> subsp. <i>inflata</i>	01.0	00.20		
<i>Eragrostis dielsii</i>	01.0	00.01		
<i>Frankenia irregularis</i>	00.1	00.15		

Site details			
Site:	CR025TQ05	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.768153, 121.20736 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	20	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sand, sandy loam,
Grass cover (%):	0	Rock type:	granite rocks;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals, livestock tracks,

Land system:

Vegetation description and type: Low *Tecticornia indica* subsp. *bidens*, *T. sp.* Dennys Crossing and *T. doliiformis* chenopod shrubland over isolated clumps of low *Disphyma crassifolium*, *Heliotropium curassavicum* and *Senecio pinnatifolius* var. *pinnatifolius* forbs.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia doliiformis</i>	10.0	00.25		
<i>Tecticornia indica</i> subsp. <i>bidens</i>	05.0	00.20		
<i>Maireana amoena</i>	01.0	00.20		
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	01.0	00.15		
<i>Frankenia cinerea</i>	01.0	00.05		
<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>	00.1	00.20		
<i>Disphyma crassifolium</i>	00.1	00.10		
<i>Heliotropium curassavicum</i>	00.1	00.01		

Site details			
Site:	CR026a	Type:	Quadrat (20 m x 20 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.76812, 121.20513 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	hill slope
Tree/shrub cover >2 m (%):	30	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sand, sandy loam,
Grass cover (%):	0	Rock type:	granite outcropping;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals,
Land system:			
Vegetation description and type:	Low <i>Eucalyptus clelandiorum</i> and <i>E. griffithsii</i> woodland over mid open <i>Eremophila scoparia</i> , <i>E. oppositifolia</i> and <i>E. glabra</i> shrubland over low sparse <i>Olearia muelleri</i> , <i>Ptilotus obovatus</i> and <i>Atriplex vesicaria</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	15.0	10.00		
<i>Eucalyptus griffithsii</i>	15.0	10.00		
<i>Eremophila scoparia</i>	10.0	01.20		
<i>Eremophila oppositifolia</i>	05.0	01.10		
<i>Ptilotus obovatus</i>	03.0	00.50		
<i>Olearia muelleri</i>	03.0	00.30		
<i>Eremophila glabra</i>	02.0	01.50		
<i>Casuarina pauper</i>	01.0	02.50		
<i>Cratystylis microphylla</i>	01.0	01.20		
<i>Dodonaea viscosa</i>	01.0	00.60		
<i>Rhagodia drummondii</i>	01.0	00.50		
<i>Exocarpos aphyllus</i>	00.5	01.70		
<i>Dodonaea lobulata</i>	00.5	01.00		
<i>Atriplex vesicaria</i>	00.5	00.40		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	00.1	00.60		
<i>Eremophila granitica</i>	00.1	00.50		

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<i>Lycium australe</i>	00.1	00.50
<i>Rhagodia spinescens</i>	00.1	00.50
<i>Maireana pentatropis</i>	00.1	00.40
<i>Solanum nummularium</i>	00.1	00.40
<i>Triodia scariosa</i>	00.1	00.30
<i>Westringia rigida</i>	00.1	00.30
<i>Maireana convexa</i>	00.1	00.25
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Sclerolaena diacantha</i>	00.1	00.10

Site details			
Site:	CR027	Type:	Quadrat (20 m x 20 m)
Date(s):	02 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.664589, 121.073926 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	30	Topography:	hill slope
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	10	Soil:	clay loam,
Grass cover (%):	0	Rock type:	ferrous – ironstone;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Good, EPA (2016)	Disturbance	excavation, exploration (drill pads and access tracks), historic clearing, historic operations, vehicle tracks,

Land system:

Vegetation description and type:

Low *Eucalyptus clelandiorum* woodland over isolated tall *Eremophila interstans* subsp. *interstans* shrubs over mid sparse *Eremophila scoparia*, *Atriplex nummularia* and *A. ?vesicaria* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	25.0	08.00		
<i>Eremophila interstans</i> subsp. <i>interstans</i>	03.0	02.50		
<i>Atriplex nummularia</i>	03.0	01.20		
<i>Atriplex ?vesicaria</i>	03.0	00.60		
<i>Eremophila scoparia</i>	02.0	01.10		
<i>Dodonaea lobulata</i>	00.1	01.00		
<i>Exocarpos aphyllus</i>	00.1	01.00		
<i>Eremophila oldfieldii</i>	00.1	00.80		
<i>Eremophila alternifolia</i>	00.1	00.50		
<i>Scaevola spinescens</i>	00.1	00.50		
<i>Ptilotus obovatus</i>	00.1	00.40		
<i>Maireana ?georgei</i>	00.1	00.30		
<i>Olearia muelleri</i>	00.1	00.25		
<i>Maireana triptera</i>	00.1	00.20		

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<i>Maireana trichoptera</i>	00.1	00.15
<i>Sclerolaena fusiformis</i>	00.1	00.15
<i>Sclerolaena diacantha</i>	00.1	00.10

Site details			
Site:	CR028	Type:	Quadrat (20 m x 20 m)
Date(s):	02 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.677138, 121.088422 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	35	Topography:	undulating plain
Tree/shrub cover >2 m (%):	30	Soil colour:	red-brown,
Shrub cover <2 m (%):	5	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	vehicle tracks,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus transcontinentalis</i> and <i>E. clelandiorum</i> woodland over mid sparse <i>Atriplex nummularia</i> , <i>Maireana sedifolia</i> and <i>Eremophila scoparia</i> shrubland over isolated low <i>Acacia erinacea</i> , <i>Eremophila parvifolia</i> subsp. <i>auricampa</i> and <i>Olearia muelleri</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus transcontinentalis</i>	30.0	12.00		
<i>Eremophila scoparia</i>	02.0	01.80		
<i>Maireana sedifolia</i>	02.0	01.40		
<i>Atriplex nummularia</i>	01.0	01.10		
<i>Eucalyptus clelandiorum</i>	00.1	11.00		
<i>Eremophila praecox</i>	00.1	01.20		P1 (DBCA list)
<i>Dodonaea lobulata</i>	00.1	01.00		
<i>Acacia erinacea</i>	00.1	00.80		
<i>Scaevola spinescens</i>	00.1	00.80		
<i>Austrostipa elegantissima</i>	00.1	00.40		
<i>Maireana radiata</i>	00.1	00.40		
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.25		
<i>Olearia muelleri</i>	00.1	00.25		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	00.25		

Site details			
Site:	CR029	Type:	Quadrat (20 m x 20 m)
Date(s):	02 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.683935, 121.098124 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	50	Topography:	plain
Tree/shrub cover >2 m (%):	30	Soil colour:	red-orange,
Shrub cover <2 m (%):	40	Soil:	clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	historic clearing, vehicle tracks,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus salmonophloia</i> and <i>E. gracilis</i> woodland over mid <i>Atriplex nummularia</i> , <i>Maireana sedifolia</i> and <i>Eremophila scoparia</i> shrubland over isolated low <i>Ptilotus obovatus</i> , <i>Atriplex bunburyana</i> and <i>Maireana trichoptera</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus salmonophloia</i>	25.0	15.00		
<i>Maireana sedifolia</i>	20.0	01.50		
<i>Atriplex nummularia</i>	15.0	01.40		
<i>Eucalyptus gracilis</i>	05.0	06.00		
<i>Eremophila scoparia</i>	05.0	01.80		
<i>Atriplex bunburyana</i>	01.0	00.50		
<i>Maireana trichoptera</i>	01.0	00.25		
<i>Sclerolaena diacantha</i>	00.5	00.15		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	01.50		
<i>Maireana radiata</i>	00.1	00.50		
<i>Ptilotus obovatus</i>	00.1	00.50		
<i>Scaevola spinescens</i>	00.1	00.50		
<i>Atriplex ?nana</i>	00.1	00.40		
<i>Eremophila dempsteri</i>	00.1	00.40		
<i>Chenopodium curvispicatum</i>	00.1	00.35		

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<i>Maireana pyramidata</i>	00.1	00.30
<i>Maireana ?georgei</i>	00.1	00.20
<i>Ptilotus exaltatus</i>	00.1	00.05

Site details			
Site:	CR030	Type:	Quadrat (20 m x 20 m)
Date(s):	02 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.693087, 121.107778 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	50	Topography:	plain
Tree/shrub cover >2 m (%):	40	Soil colour:	red-orange,
Shrub cover <2 m (%):	40	Soil:	clay loam,
Grass cover (%):	1	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	evidence of feral animals, livestock tracks,
Land system:			
Vegetation description and type:		Mid <i>Eucalyptus clelandiorum</i> , <i>E. salmonophloia</i> and <i>E. salubris</i> woodland over mid <i>Eremophila ionantha</i> , <i>E. scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Acacia hemiteles</i> , <i>Olearia muelleri</i> and <i>Ptilotus obovatus</i> shrubs.	



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus clelandiorum</i>	40.0	11.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	30.0	01.60		
<i>Eucalyptus salmonophloia</i>	05.0	15.00		
<i>Eucalyptus salubris</i>	05.0	12.00		
<i>Eremophila scoparia</i>	05.0	01.80		
<i>Eremophila ionantha</i>	05.0	01.50		
<i>Olearia muelleri</i>	01.0	00.40		
<i>Eragrostis dielsii</i>	01.0	00.05		
<i>Acacia tetragonophylla</i>	00.5	02.00		
<i>Ptilotus obovatus</i>	00.5	00.50		
<i>Pimelea microcephala</i>	00.1	01.20		
<i>Scaevola spinescens</i>	00.1	01.00		
<i>Exocarpos aphyllus</i>	00.1	00.70		
<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>	00.1	00.60		

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<i>Pittosporum angustifolium</i>	00.1	00.50
<i>Acacia hemiteles</i>	00.1	00.40
<i>Austrostipa elegantissima</i>	00.1	00.40
<i>Solanum nummularium</i>	00.1	00.30
<i>Maireana tomentosa</i> ?subsp. <i>tomentosa</i>	00.1	00.15

Site details			
Site:	CR031	Type:	Quadrat (20 m x 20 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.701465, 121.114131 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	plain
Tree/shrub cover >2 m (%):	30	Soil colour:	red-brown,
Shrub cover <2 m (%):	20	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	ferrous – ironstone;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Good, EPA (2016)	Disturbance	exploration (drill pads and access tracks), historic clearing, historic operations,

Land system:

Vegetation description and type:

Mid *Eucalyptus salubris*, *E. transcontinentalis* and *E. gracilis* woodland over mid open *Eremophila scoparia*, *Senna artemisioides* subsp. *filifolia* and *Atriplex nummularia* shrubland over isolated low *Olearia muelleri*, *Ptilotus obovatus* and *Eremophila parvifolia* subsp. *auricampa* shrubs.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus salubris</i>	20.0	15.00		
<i>Eucalyptus transcontinentalis</i>	10.0	15.00		
<i>Eremophila scoparia</i>	10.0	01.80		
<i>Atriplex nummularia</i>	01.0	01.60		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	01.0	01.50		
<i>Olearia muelleri</i>	01.0	00.50		
<i>Eucalyptus gracilis</i>	00.1	08.00		
<i>Exocarpos aphyllus</i>	00.1	01.00		
<i>Atriplex ?vesicaria</i>	00.1	00.70		
<i>Ptilotus obovatus</i>	00.1	00.50		
<i>Rhagodia drummondii</i>	00.1	00.50		
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.40		
<i>Eremophila praecox</i>	00.1	00.40		P1 (DBCA list)

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<i>Maireana erioclada</i>	00.1	00.40
<i>Maireana ?georgei</i>	00.1	00.30
<i>Maireana</i> sp.	00.1	00.30
<i>Maireana triptera</i>	00.1	00.30
<i>Maireana trichoptera</i>	00.1	00.15
<i>Sclerolaena cuneata</i>	00.1	00.10
<i>Sclerolaena diacantha</i>	00.1	00.10

Site details			
Site:	CR032	Type:	Quadrat (20 m x 20 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.725565, 121.141931 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	plain
Tree/shrub cover >2 m (%):	15	Soil colour:	red-orange,
Shrub cover <2 m (%):	40	Soil:	clay loam,
Grass cover (%):	0	Rock type:	ferrous – ironstone;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals,
Land system:			
Vegetation description and type:	Low <i>Casuarina obesa</i> woodland over mid <i>Atriplex nummularia</i> , <i>Eremophila ionantha</i> and <i>E. scoparia</i> shrubland over isolated low <i>Rhagodia drummondii</i> , <i>Maireana sedifolia</i> and <i>Olearia muelleri</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Atriplex nummularia</i>	20.0	01.30		
<i>Casuarina obesa</i>	15.0	08.00		
<i>Eremophila ionantha</i>	15.0	01.20		
<i>Exocarpos aphyllus</i>	01.0	01.40		
<i>Acacia tetragonophylla</i>	01.0	01.20		
<i>Eremophila scoparia</i>	01.0	01.20		
<i>Lycium australe</i>	01.0	01.20		
<i>Olearia muelleri</i>	01.0	00.30		
<i>Rhagodia drummondii</i>	00.5	01.20		
<i>Amyema gibberula</i> var. <i>gibberula</i>	00.1	01.50		
<i>Pimelea microcephala</i>	00.1	01.20		
<i>Senna stowardii</i>	00.1	01.20		
<i>Cratystylis subspinescens</i>	00.1	01.00		
<i>Dodonaea viscosa</i>	00.1	01.00		
<i>Acacia hemiteles</i>	00.1	00.80		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	00.1	00.50		

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<i>Grevillea acuaria</i>	00.1	00.50
<i>Scaevola spinescens</i>	00.1	00.50
<i>Maireana sedifolia</i>	00.1	00.25
<i>Maireana georgei</i>	00.1	00.20

Site details			
Site:	CR033	Type:	Quadrat (20 m x 20 m)
Date(s):	03 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.728414, 121.146614 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	60	Topography:	drainage line
Tree/shrub cover >2 m (%):	50	Soil colour:	red-orange,
Shrub cover <2 m (%):	10	Soil:	clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus griffithsii</i> and <i>Casuarina obesa</i> woodland over tall open <i>Acacia tetragonophylla</i> , <i>Eremophila alternifolia</i> and <i>Exocarpos aphylla</i> shrubland over low sparse <i>Grevillea acuaria</i> , <i>Lycium australe</i> and <i>Rhagodia drummondii</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	10.0	15.00		
<i>Eremophila alternifolia</i>	10.0	03.00		
<i>Acacia tetragonophylla</i>	10.0	02.80		
<i>Grevillea acuaria</i>	06.0	00.60		
<i>Casuarina obesa</i>	05.0	10.00		
<i>Exocarpos aphyllus</i>	02.0	03.00		
<i>Rhagodia drummondii</i>	02.0	00.90		
<i>Lycium australe</i>	01.0	01.00		
<i>Alyxia buxifolia</i>	00.5	02.00		
<i>Santalum spicatum</i>	00.1	02.00		
<i>Marsdenia australis</i>	00.1	01.50		
<i>Amyema preissii</i>	00.1	01.20		
<i>Cratystylis subspinescens</i>	00.1	01.00		
<i>Pimelea microcephala</i>	00.1	01.00		
<i>Pittosporum angustifolium</i>	00.1	01.00		

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<i>Dianella revoluta</i>	00.1	00.70
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	00.1	00.30

Site details			
Site:	CR035	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.760798, 121.146465 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	55	Topography:	undulating plain
Tree/shrub cover >2 m (%):	35	Soil colour:	red-orange,
Shrub cover <2 m (%):	6	Soil:	sand, sandy loam,
Grass cover (%):	25	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:	Low open <i>Eucalyptus griffithsii</i> and <i>E. gracilis</i> forest over isolated mid <i>Acacia hemiteles</i> , <i>A. nyssophylla</i> and <i>Eremophila caperata</i> shrubs over low open <i>Triodia scariosa</i> hummock grassland.		
Vegetation description and type:			



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	35.0	07.00		
<i>Triodia scariosa</i>	25.0	00.30		
<i>Acacia hemiteles</i>	02.0	01.40		
<i>Acacia nyssophylla</i>	01.0	01.50		
<i>Eremophila caperata</i>	01.0	01.50		
<i>Santalum acuminatum</i>	00.5	01.70		
<i>Olearia muelleri</i>	00.2	00.30		
<i>Eucalyptus gracilis</i>	00.1	05.00		
<i>Eremophila oldfieldii</i>	00.1	02.00		
<i>Amyema preissii</i>	00.1	01.50		
<i>Eremophila scoparia</i>	00.1	01.20		
<i>Thysanotus manglesianus</i>	00.1	00.30		

Site details			
Site:	CR036	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.760173, 121.152879 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	undulating plain
Tree/shrub cover >2 m (%):	35	Soil colour:	red-orange, whitish,
Shrub cover <2 m (%):	10	Soil:	sandy clay, sandy loam,
Grass cover (%):	0	Rock type:	granite rocks;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	historic clearing, historic operations, vehicle tracks,

Land system:

Vegetation description and type: Low *Eucalyptus clelandiorum*, *E. oleosa* subsp. *oleosa* and *E. celastroides* subsp. *celastroides* woodland over isolated tall *Eremophila dempsteri* and *E. scoparia* shrubs over low sparse *Eremophila pustulata*, *Scaevola spinescens* and *Acacia erinacea* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	15.0	10.00		
<i>Eucalyptus clelandiorum</i>	10.0	07.00		
<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>	05.0	05.00		
<i>Eremophila pustulata</i>	03.0	01.00		
<i>Eremophila dempsteri</i>	02.0	02.20		
<i>Scaevola spinescens</i>	02.0	00.50		
<i>Eremophila scoparia</i>	01.0	02.00		
<i>Acacia erinacea</i>	01.0	00.80		
<i>Eucalyptus hypolaena</i>	00.1	15.00		
<i>Eucalyptus torquata</i>	00.1	04.00		
<i>Eremophila oppositifolia</i>	00.1	01.50		
<i>Santalum acuminatum</i>	00.1	01.50		
<i>Cratystylis conocephala</i>	00.1	01.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	01.00		

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<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.60
<i>Exocarpos aphyllus</i>	00.1	00.50
<i>Senna stowardii</i>	00.1	00.50
<i>Atriplex nummularia</i>	00.1	00.40
<i>Ptilotus obovatus</i>	00.1	00.40
<i>Atriplex ?vesicaria</i>	00.1	00.30
<i>Olearia muelleri</i>	00.1	00.30
<i>Westringia rigida</i>	00.1	00.30
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	00.1	00.20
<i>Ptilotus holosericeus</i>	00.1	00.01

Site details			
Site:	CR037	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.755173, 121.179198 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	60	Topography:	undulating plain
Tree/shrub cover >2 m (%):	40	Soil colour:	red-orange,
Shrub cover <2 m (%):	25	Soil:	sandy clay, sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals, vehicle tracks,

Land system:

Vegetation description and type: Mid *Eucalyptus longicornis* woodland over tall open *Dodonaea viscosa*, *Exocarpos aphyllus* and *Senna artemisioides* subsp. *filifolia* shrubland over low sparse *Atriplex ?vesicaria*, *Ptilotus obovatus* and *Scaevola spinescens* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus longicornis</i>	30.0	15.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	10.0	02.00		
<i>Exocarpos aphyllus</i>	07.0	02.50		
<i>Dodonaea viscosa</i>	03.0	02.50		
<i>Ptilotus obovatus</i>	03.0	00.40		
<i>Triodia scariosa</i>	03.0	00.30		
<i>Acacia hemiteles</i>	02.0	02.00		
<i>Scaevola spinescens</i>	02.0	00.50		
<i>Eremophila scoparia</i>	01.0	01.50		
<i>Atriplex ?vesicaria</i>	01.0	00.50		
<i>Eremophila glabra</i>	00.5	01.50		
<i>Eremophila ionantha</i>	00.1	01.80		
<i>Santalum spicatum</i>	00.1	01.80		
<i>Pittosporum angustifolium</i>	00.1	01.00		
<i>Rhagodia drummondii</i>	00.1	00.60		

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<i>Austrostipa elegantissima</i>	00.1	00.50
<i>Solanum nummularium</i>	00.1	00.50
<i>Marsdenia australis</i>	00.1	00.40
<i>Maireana triptera</i>	00.1	00.30
<i>Olearia muelleri</i>	00.1	00.30
<i>Roepera similis</i>	00.1	00.30
<i>Maireana trichoptera</i>	00.1	00.20
<i>Austrostipa nitida</i>	00.1	00.15

Site details			
Site:	CR038	Type:	Quadrat (20 m x 20 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.76804, 121.215512 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	undulating plain
Tree/shrub cover >2 m (%):	7	Soil colour:	red-orange,
Shrub cover <2 m (%):	35	Soil:	sand, sandy loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	livestock tracks,
Land system:			
Vegetation description and type:	Isolated low <i>Casuarina pauper</i> and <i>Alectryon oleifolius</i> subsp. <i>canescens</i> trees over mid open <i>Eremophila scoparia</i> , <i>Exocarpos aphyllus</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low sparse <i>Atriplex nana</i> , <i>Maireana triptera</i> and <i>Lycium australe</i> shrubland.		



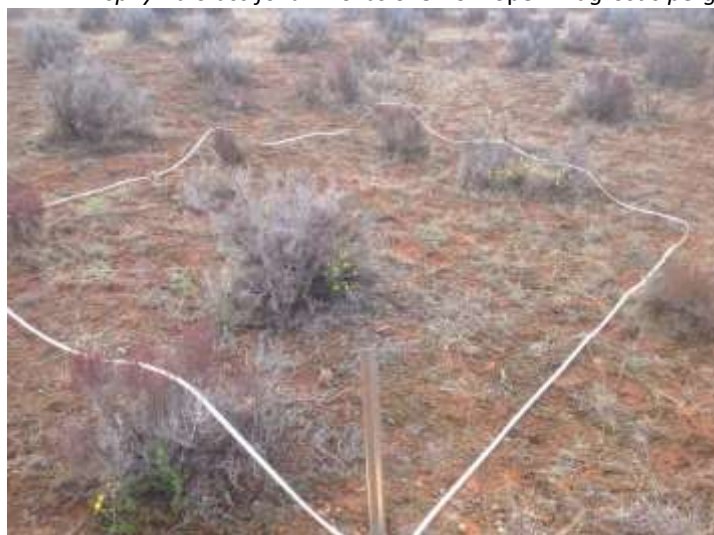
Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	08.0	01.60		
<i>Eremophila scoparia</i>	06.0	01.70		
<i>Atriplex nana</i>	04.0	00.25		
<i>Lycium australe</i>	03.0	00.80		
<i>Casuarina pauper</i>	02.0	06.00		
<i>Alectryon oleifolius</i> subsp. <i>canescens</i>	02.0	05.00		
<i>Exocarpos aphyllus</i>	02.0	01.50		
<i>Maireana triptera</i>	02.0	00.30		
<i>Cratystylis subspinescens</i>	01.0	00.60		
<i>Acacia tetragonophylla</i>	00.5	01.00		
<i>Dodonaea viscosa</i>	00.5	01.00		
<i>Ptilotus obovatus</i>	00.5	00.50		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	00.5	00.40		
<i>Acacia kalgoorliensis</i>	00.1	01.00		
<i>Cratystylis microphylla</i>	00.1	00.50		

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<i>Rhagodia drummondii</i>	00.1	00.50
<i>Thysanotus manglesianus</i>	00.1	00.50
<i>Maireana pyramidata</i>	00.1	00.40
<i>Maireana thesioides</i>	00.1	00.40
<i>Maireana convexa</i>	00.1	00.30
<i>Maireana georgei</i>	00.1	00.30
<i>Minuria cunninghamii</i>	00.1	00.30
<i>Solanum nummularium</i>	00.1	00.30
<i>Maireana carnosa</i>	00.1	00.25
<i>Sclerolaena cuneata</i>	00.1	00.25
<i>Enchylaena tomentosa</i>	00.1	00.20
<i>Enteropogon ramosus</i>	00.1	00.20
<i>Frankenia ?interioris</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Marsdenia australis</i>	00.1	00.20
<i>Paspalidium gracile</i>	00.1	00.20
<i>Disphyma crassifolium</i>	00.1	00.10
<i>Sclerolaena diacantha</i>	00.1	00.10
<i>Erymophyllum ramosum</i> subsp. <i>ramosum</i>	00.1	00.05

Site details			
Site:	CR039TQ01	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.77394, 121.226247 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	25	Topography:	seasonally wet area
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	10	Soil:	sandy clay, sandy loam,
Grass cover (%):	15	Rock type:	none
Herb cover (%):	3	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	livestock tracks,
Land system:			
Vegetation description and type:	Low <i>Tecticornia pruinosa</i> , <i>Atriplex holocarpa</i> and <i>Maireana erioclada</i> chenopod shrubland over isolated low <i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i> and <i>Disphyma crassifolium</i> forbs over low open <i>Eragrostis pergracilis</i> grassland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eragrostis pergracilis</i>	15.0	00.02		
<i>Tecticornia pruinosa</i>	10.0	00.50		
<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>	03.0	00.20		
<i>Maireana erioclada</i>	00.1	00.40		
<i>Disphyma crassifolium</i>	00.1	00.10		
<i>Atriplex holocarpa</i>	00.1	00.08		

Site details			
Site:	CR039TQ02	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.773885, 121.225921 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	20	Topography:	seasonally wet area
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	10	Soil:	sandy clay, sandy loam,
Grass cover (%):	15	Rock type:	none
Herb cover (%):	2	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	evidence of feral animals, livestock tracks,

Land system:

Vegetation description and type: Low *Tecticornia pruinosa* shrubland over isolated low *Disphyma crassifolium*, *Surreya diandra* and *Senecio pinnatifolius* var. *pinnatifolius* forbs over low open *Eragrostis dielsii* and *E. pergracilis* grassland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia pruinosa</i>	10.0	00.50		
<i>Eragrostis dielsii</i>	10.0	00.01		
<i>Disphyma crassifolium</i>	03.0	00.10		
<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>	00.2	00.25		
<i>Roepera reticulata</i>	00.1	00.40		
<i>Surreya diandra</i>	00.1	00.15		
<i>Eragrostis pergracilis</i>	00.1	00.02		

Site details			
Site:	CR039TQ03	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.77383, 121.22564 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	30	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	red-brown,
Shrub cover <2 m (%):	25	Soil:	sand, sandy loam,
Grass cover (%):	1	Rock type:	none
Herb cover (%):	6	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	livestock tracks,
Land system:			
Vegetation description and type:	Low <i>Tecticornia</i> sp. Dennys Crossing shrubland over low sparse <i>Disphyma crassifolium</i> and <i>Surreya diandra</i> forbland over isolated low <i>Eragrostis dielsii</i> grasses.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	25.0	00.60		
<i>Disphyma crassifolium</i>	05.0	00.10		
<i>Surreya diandra</i>	01.0	00.10		
<i>Eragrostis dielsii</i>	01.0	00.01		

Site details			
Site:	CR039TQ04	Type:	Transect (3 m x 3 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.773787, 121.225371 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	20	Topography:	sand dune
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sand,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	livestock tracks,
Land system:			
Vegetation description and type:	Low open <i>Atriplex vesicaria</i> , <i>Gunniopsis quadrifida</i> and <i>Tecticornia disarticulata</i> shubland over isolated clumps of low <i>Disphyma crassifolium</i> , <i>Surreya diandra</i> and <i>Asteridea chaetopoda</i> forbs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Gunniopsis quadrifida</i>	10.0	00.40		
<i>Tecticornia disarticulata</i>	05.0	00.60		
<i>Atriplex vesicaria</i>	04.0	00.35		
<i>Maireana triptera</i>	01.0	00.25		
<i>Frankenia ?interioris</i>	00.1	00.30		
<i>Asteridea chaetopoda</i>	00.1	00.15		
<i>Surreya diandra</i>	00.1	00.10		

Site details			
Site:	CR040	Type:	Quadrat (20 m x 20 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.775366, 121.230027 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	plain
Tree/shrub cover >2 m (%):	5	Soil colour:	red-orange,
Shrub cover <2 m (%):	40	Soil:	sand,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	evidence of feral animals, historic clearing, livestock tracks,

Land system:

Vegetation description and type: Isolated low *Eucalyptus celastroides* subsp. *celastroides* and *Casuarina pauper* trees over mid open *Dodonaea viscosa*, *Eremophila caperata* and *E. scoparia* shrubland over low *Eremophila decipiens* subsp. *decipiens*, *Ptilotus obovatus* and *Rhagodia drummondii* shrubland.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eremophila caperata</i>	05.0	01.90		
<i>Ptilotus obovatus</i>	05.0	00.50		
<i>Dodonaea viscosa</i>	04.0	01.80		
<i>Eremophila scoparia</i>	04.0	01.80		
<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>	03.0	05.00		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	02.0	00.40		
<i>Casuarina pauper</i>	01.0	03.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	01.0	01.90		
<i>Exocarpos aphyllus</i>	01.0	01.40		
<i>Rhagodia drummondii</i>	01.0	00.40		
<i>Acacia hemiteles</i>	00.1	01.50		
<i>Olearia pimeleoides</i>	00.1	00.60		
<i>Enchylaena tomentosa</i>	00.1	00.50		
<i>Solanum nummularium</i>	00.1	00.40		

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<i>Atriplex vesicaria</i>	00.1	00.30
<i>Austrostipa elegantissima</i>	00.1	00.30
<i>Rhyncharrhena linearis</i>	00.1	00.30
<i>Olearia muelleri</i>	00.1	00.25
<i>Maireana georgei</i>	00.1	00.20
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	00.1	00.20
<i>Maireana trichoptera</i>	00.1	00.20
<i>Paspalidium gracile</i>	00.1	00.20
<i>Thysanotus ? manglesianus</i>	00.1	00.15
<i>Sclerolaena diacantha</i>	00.1	00.10
<i>Aristida contorta</i>	00.1	00.05

Site details			
Site:	CR041	Type:	Quadrat (20 m x 20 m)
Date(s):	08 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.729711, 121.148352 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	plain
Tree/shrub cover >2 m (%):	5	Soil colour:	red-brown,
Shrub cover <2 m (%):	40	Soil:	clay loam, clay,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Low open <i>Casuarina obesa</i> woodland over mid open <i>Acacia hemiteles</i> , <i>Grevillea acuaria</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Rhagodia drummondii</i> , <i>Eremophila decipiens</i> subsp. <i>decipiens</i> and <i>Cratystylis subspinescens</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Grevillea acuaria</i>	06.0	01.10		
<i>Casuarina obesa</i>	05.0	05.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	05.0	01.70		
<i>Acacia hemiteles</i>	05.0	01.60		
<i>Rhagodia drummondii</i>	03.0	00.60		
<i>Acacia tetragonophylla</i>	02.0	02.50		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	02.0	00.40		
<i>Atriplex nummularia</i>	01.0	01.70		
<i>Eremophila ionantha</i>	01.0	01.60		
<i>Cratystylis subspinescens</i>	01.0	01.00		
<i>Lycium australe</i>	00.5	01.00		
<i>Eucalyptus griffithsii</i>	00.1	04.00		
<i>Marsdenia australis</i>	00.1	01.80		
<i>Pimelea microcephala</i>	00.1	01.80		
<i>Eremophila alternifolia</i>	00.1	01.60		

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<i>Dodonaea viscosa</i>	00.1	01.50
<i>Grevillea sarissa</i> subsp. <i>sarissa</i>	00.1	01.30
<i>Exocarpos aphyllus</i>	00.1	01.20
<i>Scaevola spinescens</i>	00.1	01.20
<i>Dianella revoluta</i>	00.1	00.80
<i>Enchylaena tomentosa</i>	00.1	00.30
<i>Pittosporum angustifolium</i>	00.1	00.25
<i>Vittadinia dissecta</i> var. <i>hirta</i>	00.1	00.25
<i>Paspalidium gracile</i>	00.1	00.20

Site details			
Site:	CR042	Type:	Quadrat (20 m x 20 m)
Date(s):	09 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.733257, 121.152965 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	35	Topography:	plain
Tree/shrub cover >2 m (%):	20	Soil colour:	red-orange,
Shrub cover <2 m (%):	20	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	none
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Mid <i>Eucalyptus griffithsii</i> and <i>E. longicornis</i> woodland over isolated tall <i>Exocarpos aphyllus</i> shrubs over mid open <i>Acacia hemiteles</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus griffithsii</i>	20.0	11.00		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	12.0	01.50		
<i>Eucalyptus longicornis</i>	05.0	12.00		
<i>Exocarpos aphyllus</i>	02.0	02.20		
<i>Eremophila scoparia</i>	02.0	01.20		
<i>Santalum spicatum</i>	01.0	01.80		
<i>Acacia hemiteles</i>	01.0	01.10		
<i>Scaevola spinescens</i>	01.0	01.10		
<i>Acacia nyssophylla</i>	01.0	00.40		
<i>Olearia muelleri</i>	01.0	00.30		
<i>Triodia scariosa</i>	01.0	00.30		
<i>Amyema miquelii</i>	00.1	01.50		
<i>Amyema preissii</i>	00.1	01.00		
<i>Olearia pimeleoides</i>	00.1	00.70		
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.50		
<i>Austrostipa elegantissima</i>	00.1	00.40		

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Westringia rigida

00.1

00.30

Site details			
Site:	CR050	Type:	Quadrat (20 m x 20 m)
Date(s):	06 October 2018	Permanent:	Yes
Observer(s):	Alice Watt	Position:	-30.768472, 121.188853 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	undulating plain
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	43	Soil:	sandy clay, sandy loam,
Grass cover (%):	1	Rock type:	none
Herb cover (%):	2	Fire age:	not evident
Vegetation condition:	Very Good, EPA (2016)	Disturbance	grazing – low, livestock tracks, vehicle tracks, weed infestation,

Land system:

Vegetation description and type: Isolated mid *Senna artemisioides* subsp. *filifolia* and *Dodonaea viscosa* shrubs over low *Atriplex vesicaria*, *Tecticornia* sp. (sterile 1) and *Frankenia ?interioris* shrubland over isolated low *Disphyma crassifolium*, **Salvia verbeneca* and *Surreya diandra* forbs.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Atriplex vesicaria</i>	35.0	00.40		
<i>Tecticornia</i> sp. (sterile 1)	05.0	00.45		
<i>Frankenia ?interioris</i>	03.0	00.25		
<i>Disphyma crassifolium</i>	02.0	00.05		
<i>Solanum nummularium</i>	01.0	00.50		
<i>Enteropogon ramosus</i>	01.0	00.20		
<i>Salvia verbeneca</i>	00.5	00.15	*	
<i>Dodonaea viscosa</i>	00.3	01.10		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.3	01.10		
<i>Surreya diandra</i>	00.3	00.10		
<i>Calandrinia eremaea</i>	00.1	00.30		
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	00.1	00.30		
<i>Minuria cunninghamii</i>	00.1	00.30		
<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	00.1	00.25		

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<i>Sclerolaena eurotioides</i>	00.1	00.25	
<i>Austrostipa nitida</i>	00.1	00.20	
<i>Vittadinia dissecta</i> var. <i>hirta</i>	00.1	00.20	
<i>Brachyscome ciliaris</i>	00.1	00.15	
<i>Maireana turbinata</i>	00.1	00.15	
<i>Podolepis capillaris</i>	00.1	00.15	
<i>Sclerolaena recurvicauspis</i>	00.1	00.10	
<i>Goodenia havilandii</i>	00.1	00.08	
<i>Rytidosperma caespitosum</i>	00.1	00.05	
<i>Brachyscome perpusilla</i>	00.1	00.02	
<i>Enneapogon caeruleus</i>	00.1	00.02	
<i>Eragrostis dielsii</i>	00.1	00.02	
<i>Oxalis corniculata</i>	00.1	00.02	*

Site details			
Site:	CR052	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.769691, 121.18423 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	undulating plain
Tree/shrub cover >2 m (%):	0	Soil colour:	red-orange,
Shrub cover <2 m (%):	38	Soil:	sandy clay, clay loam,
Grass cover (%):	2	Rock type:	none
Herb cover (%):	1	Fire age:	not evident
Vegetation condition:	Good, EPA (2016)	Disturbance	evidence of feral animals, grazing – low, historic clearing, historic operations, vehicle tracks,

Land system:

Vegetation description and type:

Low *Atriplex vesicaria*, *Tecticornia* sp. (sterile 1) and *Surreya diandra* shrubland over isolated low *Disphyma crassifolium*, *Calandrinia eremaea* and *Sclerolaena cuneata* forbs over isolated low *Enteropogon ramosus* and *Eragrostis dielsii* grasses.



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia</i> sp. (sterile 1)	25.0	00.50		
<i>Atriplex vesicaria</i>	15.0	00.50		
<i>Disphyma crassifolium</i>	02.0	00.05		
<i>Enteropogon ramosus</i>	01.0	00.20		
<i>Surreya diandra</i>	01.0	00.10		
<i>Sclerolaena cuneata</i>	00.5	00.30		
<i>Frankenia setosa</i>	00.5	00.25		
<i>Eremophila scoparia</i>	00.1	00.45		
<i>Roycea divaricata</i>	00.1	00.40		
<i>Solanum nummularium</i>	00.1	00.40		
<i>Calandrinia eremaea</i>	00.1	00.30		
<i>Minuria cunninghamii</i>	00.1	00.30		
<i>Maireana eriosphaera</i>	00.1	00.25		

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<i>Maireana triptera</i>	00.1	00.25
<i>Maireana georgei</i>	00.1	00.20
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	00.1	00.20
<i>Paspalidium gracile</i>	00.1	00.20
<i>Thysanotus patersonii</i>	00.1	00.15
<i>Brachyscome ciliaris</i>	00.1	00.10
<i>Eragrostis dielsii</i>	00.1	00.01

Site details			
Site:	CR053	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.765715, 121.182157 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	30	Topography:	mesa
Tree/shrub cover >2 m (%):	25	Soil colour:	red-orange,
Shrub cover <2 m (%):	5	Soil:	clay loam, clay,
Grass cover (%):	0	Rock type:	ferrous – ironstone;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Tall open <i>Acacia burkittii</i> , <i>A. tetragonophylla</i> and <i>Eremophila oldfieldii</i> shrubland over sparse mid <i>Dodonaea lobulata</i> , <i>Eremophila alternifolia</i> and <i>Scaevola spinescens</i> shrubs over isolated low <i>Ptilotus obovatus</i> and <i>Prostanthera grylloana</i> shrubs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Acacia burkittii</i>	15.0	03.00		
<i>Acacia tetragonophylla</i>	05.0	04.00		
<i>Dodonaea lobulata</i>	03.0	01.80		
<i>Eremophila alternifolia</i>	01.0	01.50		
<i>Scaevola spinescens</i>	01.0	01.50		
<i>Ptilotus obovatus</i>	00.2	00.50		
<i>Eremophila oldfieldii</i>	00.1	02.00		
<i>Pittosporum angustifolium</i>	00.1	01.20		
<i>Stenanthemum stipulosum</i>	00.1	01.20		
<i>Olearia pimeleoides</i>	00.1	01.00		
<i>Prostanthera grylloana</i>	00.1	00.50		
<i>Cheilanthes lasiophylla</i>	00.1	00.15		

Site details			
Site:	CR054	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.768099, 121.186731 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	40	Topography:	hill slope
Tree/shrub cover >2 m (%):	30	Soil colour:	brown,
Shrub cover <2 m (%):	15	Soil:	sandy loam,
Grass cover (%):	0	Rock type:	granite rocks;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Good, EPA (2016)	Disturbance	evidence of feral animals, historic clearing, vehicle tracks,
Land system:			
Vegetation description and type:		Mid <i>Eucalyptus longicornis</i> woodland over mid open <i>Cratystylis conocephala</i> , <i>Santalum acuminatum</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over isolated low <i>Atriplex vesicaria</i> , <i>Rhagodia drummondii</i> and <i>Olearia muelleri</i> shrubs.	



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Eucalyptus longicornis</i>	30.0	15.00		
<i>Cratystylis conocephala</i>	12.0	01.30		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	02.0	01.20		
<i>Atriplex vesicaria</i>	02.0	00.50		
<i>Rhagodia drummondii</i>	01.0	00.60		
<i>Santalum acuminatum</i>	00.1	01.00		
<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	00.1	00.40		
<i>Exocarpos aphyllus</i>	00.1	00.40		
<i>Ptilotus obovatus</i>	00.1	00.40		
<i>Senna</i> sp. Austin (A. Strid 20210)	00.1	00.40		
<i>Scaevola spinescens</i>	00.1	00.30		
<i>Westringia rigida</i>	00.1	00.30		
<i>Acacia xerophila</i> var. <i>brevior</i>	00.1	00.25		
<i>Maireana convexa</i>	00.1	00.25		

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<i>Olearia muelleri</i>	00.1	00.25
<i>Austrostipa nitida</i>	00.1	00.20
<i>Sclerolaena diacantha</i>	00.1	00.15

Site details			
Site:	CR055	Type:	Quadrat (20 m x 20 m)
Date(s):	07 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.768083, 121.185741 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	45	Topography:	hill top
Tree/shrub cover >2 m (%):	20	Soil colour:	red-orange,
Shrub cover <2 m (%):	30	Soil:	sandy clay, clay loam,
Grass cover (%):	0	Rock type:	granite rocks;
Herb cover (%):	0	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Tall open <i>Acacia burkittii</i> shrubland over mid <i>Dodonaea lobulata</i> , <i>Eremophila granitica</i> and <i>Scaevola spinescens</i> shrubland over isolated clumps of low <i>Austrostipa elegantissima</i> grasses.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Acacia burkittii</i>	20.0	02.20		
<i>Eremophila granitica</i>	15.0	01.40		
<i>Dodonaea lobulata</i>	12.0	01.60		
<i>Scaevola spinescens</i>	02.0	01.10		
<i>Eremophila oldfieldii</i>	01.0	01.50		
<i>Rhyncharrhena linearis</i>	00.1	01.00		
<i>Austrostipa elegantissima</i>	00.1	00.30		
<i>Ptilotus obovatus</i>	00.1	00.30		

Site details			
Site:	CR060	Type:	Quadrat (20 m x 20 m)
Date(s):	09 October 2018	Permanent:	Yes
Observer(s):	Grant Wells	Position:	-30.767379, 121.198461 (North-west)
Vegetation		Physical features	
Total vegetation cover (%):	30	Topography:	undulating plain
Tree/shrub cover >2 m (%):	1	Soil colour:	red-orange,
Shrub cover <2 m (%):	28	Soil:	sand,
Grass cover (%):	0	Rock type:	quartz;
Herb cover (%):	2	Fire age:	not evident
Vegetation condition:	Excellent, EPA (2016)	Disturbance	none,
Land system:			
Vegetation description and type:	Isolated tall <i>Melaleuca halmaturorum</i> shrubs over low open <i>Tecticornia doliiformis</i> , <i>T. indica</i> subsp. <i>bidens</i> and <i>T. undulata</i> chenopod shrubland over isolated low <i>Disphyma crassifolium</i> , <i>Calandrinia ?quartzica</i> and <i>Sclerolaena cuneata</i> forbs.		



Species	Cover (%)	Height (m)	Weed	Conservation status
<i>Tecticornia doliiformis</i>	10.0	00.30		
<i>Tecticornia undulata</i>	05.0	00.30		
<i>Tecticornia indica</i> subsp. <i>bidens</i>	05.0	00.25		
<i>Tecticornia pruinosa</i>	03.0	00.30		
<i>Disphyma crassifolium</i>	02.0	00.10		
<i>Melaleuca halmaturorum</i>	01.0	02.00		
<i>Dodonaea viscosa</i>	00.1	01.00		
<i>Atriplex vesicaria</i>	00.1	00.30		
<i>Calandrinia ?quartzitica</i>	00.1	00.30		
<i>Enchylaena tomentosa</i>	00.1	00.30		
<i>Sclerolaena cuneata</i>	00.1	00.25		
<i>Tecticornia</i> sp. (sterile 2)	00.1	00.20		

Appendix 2 Flora species records from desktop review

Family	Species	Conservation status	Introduced	WoNS	Declared pest
Aizoaceae	<i>Aizoon pubescens</i>		*		
Aizoaceae	<i>Disphyma crassifolium</i> subsp. <i>clavellatum</i>				
Aizoaceae	<i>Gunniopsis quadrifida</i>				
Aizoaceae	<i>Mesembryanthemum crystallinum</i>		*		
Aizoaceae	<i>Mesembryanthemum nodiflorum</i>		*		
Aizoaceae	<i>Tetragonia eremaea</i>				
Amaranthaceae	<i>Alternanthera denticulata</i>				
Amaranthaceae	<i>Alternanthera nodiflora</i>				
Amaranthaceae	<i>Amaranthus viridis</i>		*		
Amaranthaceae	<i>Ptilotus aervoides</i>				
Amaranthaceae	<i>Ptilotus carlsonii</i>				
Amaranthaceae	<i>Ptilotus chortophytus</i>	P1 (DBCA list)			
Amaranthaceae	<i>Ptilotus eremita</i>				
Amaranthaceae	<i>Ptilotus exaltatus</i>				
Amaranthaceae	<i>Ptilotus gaudichaudii</i>				
Amaranthaceae	<i>Ptilotus grandiflorus</i>				
Amaranthaceae	<i>Ptilotus helichrysoides</i>				
Amaranthaceae	<i>Ptilotus holosericeus</i>				
Amaranthaceae	<i>Ptilotus nobilis</i>				
Amaranthaceae	<i>Ptilotus obovatus</i>				
Amaranthaceae	<i>Ptilotus procumbens</i>	P1 (DBCA list)			
Amaranthaceae	<i>Surreya diandra</i>				
Anacardiaceae	<i>Schinus molle</i> var. <i>areira</i>		*		
Apiaceae	<i>Daucus glochidiatus</i>				
Apocynaceae	<i>Alyxia buxifolia</i>				
Apocynaceae	<i>Alyxia tetanifolia</i>	P3 (DBCA list)			
Apocynaceae	<i>Asclepias curassavica</i>		*		
Apocynaceae	<i>Marsdenia australis</i>				
Apocynaceae	<i>Orbea variegata</i>		*		
Apocynaceae	<i>Rhyncharrhena linearis</i>				
Araliaceae	<i>Trachymene ornata</i>				
Asparagaceae	<i>Agave americana</i>		*		
Asparagaceae	<i>Chamaexeros fimbriata</i>				
Asparagaceae	<i>Chamaexeros macranthera</i>				
Asparagaceae	<i>Thysanotus manglesianus</i>				
Asparagaceae	<i>Thysanotus patersonii</i>				
Asphodelaceae	<i>Asphodelus fistulosus</i>		*		
Asphodelaceae	<i>Bulbine semibarbata</i>				
Asteraceae	<i>Actinobole uliginosum</i>				
Asteraceae	<i>Angianthus cornutus</i>				
Asteraceae	<i>Angianthus prostratus</i>	P3 (DBCA list)			

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Family	Species	Conservation status	Introduced	WoNS	Declared pest
Asteraceae	<i>Angianthus tomentosus</i>				
Asteraceae	<i>Arctotheca calendula</i>		*		
Asteraceae	<i>Asteridea athrixioides</i>				
Asteraceae	<i>Asteridea chaetopoda</i>				
Asteraceae	<i>Brachyscome ciliaris</i>				
Asteraceae	<i>Brachyscome iberidifolia</i>				
Asteraceae	<i>Brachyscome lineariloba</i>				
Asteraceae	<i>Brachyscome perpusilla</i>				
Asteraceae	<i>Calotis hispidula</i>				
Asteraceae	<i>Calotis multicaulis</i>				
Asteraceae	<i>Carthamus lanatus</i>		*		
Asteraceae	<i>Centaurea melitensis</i>		*		
Asteraceae	<i>Cephalipterum drummondii</i>				
Asteraceae	<i>Ceratogyne obionoides</i>				
Asteraceae	<i>Chrysocephalum apiculatum</i> subsp. <i>norsemanense</i>	P3 (DBCA list)			
Asteraceae	<i>Chrysocephalum puteale</i>				
Asteraceae	<i>Cichorium intybus</i>		*		
Asteraceae	<i>Conyza bonariensis</i>		*		
Asteraceae	<i>Conyza sumatrensis</i>		*		
Asteraceae	<i>Cotula australis</i>				
Asteraceae	<i>Craspedia haplorrhiza</i>				
Asteraceae	<i>Cratystylis conocephala</i>				
Asteraceae	<i>Cratystylis microphylla</i>				
Asteraceae	<i>Cratystylis subspinescens</i>				
Asteraceae	<i>Elachanthus pusillus</i>	P2 (DBCA list)			
Asteraceae	<i>Erymophyllum ramosum</i>				
Asteraceae	<i>Erymophyllum ramosum</i> subsp. <i>ramosum</i>				
Asteraceae	<i>Gazania linearis</i>		*		
Asteraceae	<i>Gilberta tenuifolia</i>				
Asteraceae	<i>Gnephosis brevifolia</i>				
Asteraceae	<i>Gnephosis tenuissima</i>				
Asteraceae	<i>Helianthus annuus</i>		*		
Asteraceae	<i>Helipterum craspedioides</i>				
Asteraceae	<i>Hyalosperma glutinosum</i>				
Asteraceae	<i>Hyalosperma glutinosum</i> subsp. <i>glutinosum</i>				
Asteraceae	<i>Hyalosperma zacchaeus</i>				
Asteraceae	<i>Isoetopsis graminifolia</i>				
Asteraceae	<i>Kippistia suaedifolia</i>				
Asteraceae	<i>Lactuca serriola</i> forma <i>serriola</i>		*		
Asteraceae	<i>Lawrencella rosea</i>				
Asteraceae	<i>Leiocarpa websteri</i>				

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Asteraceae	<i>Lemooria burkittii</i>				
Asteraceae	<i>Millotia myosotidifolia</i>				
Asteraceae	<i>Millotia perpusilla</i>				
Asteraceae	<i>Minuria cunninghamii</i>				
Asteraceae	<i>Minuria gardneri</i>				
Asteraceae	<i>Minuria leptophylla</i>				
Asteraceae	<i>Monoculus monstrosus</i>		*		
Asteraceae	<i>Myriocephalus pygmaeus</i>				
Asteraceae	<i>Notisia intonsa</i>	P3 (DBCA list)			
Asteraceae	<i>Olearia exiguiifolia</i>				
Asteraceae	<i>Olearia homolepis</i>				
Asteraceae	<i>Olearia incana</i>				
Asteraceae	<i>Olearia muelleri</i>				
Asteraceae	<i>Olearia pimeleoides</i>				
Asteraceae	<i>Olearia rudis</i>				
Asteraceae	<i>Olearia</i> sp. Eremicola (Diels & Pritzel s.n. PERTH 00449628)				
Asteraceae	<i>Olearia subspicata</i>				
Asteraceae	<i>Oligocarpus calendulaceus</i>		*		
Asteraceae	<i>Oncosiphon suffruticosum</i>		*		
Asteraceae	<i>Opuntia elata</i>		*	Y	s22(2) (C3 Restricted)
Asteraceae	<i>Ozothamnus cassiope</i>				
Asteraceae	<i>Podolepis aristata</i> subsp. <i>affinis</i>				
Asteraceae	<i>Podolepis capillaris</i>				
Asteraceae	<i>Podolepis lessonii</i>				
Asteraceae	<i>Podolepis rugata</i>				
Asteraceae	<i>Podotricha wilsonii</i>				
Asteraceae	<i>Pogonolepis muelleriana</i>				
Asteraceae	<i>Pogonolepis stricta</i>				
Asteraceae	<i>Rhodanthe battii</i>				
Asteraceae	<i>Rhodanthe charsleyae</i>				
Asteraceae	<i>Rhodanthe chlorocephala</i> subsp. <i>rosea</i>				
Asteraceae	<i>Rhodanthe chlorocephala</i> subsp. <i>splendida</i>				
Asteraceae	<i>Rhodanthe floribunda</i>				
Asteraceae	<i>Rhodanthe haigii</i>				
Asteraceae	<i>Rhodanthe laevis</i>				
Asteraceae	<i>Rhodanthe manglesii</i>				
Asteraceae	<i>Rhodanthe oppositifolia</i> subsp. <i>oppositifolia</i>				
Asteraceae	<i>Rhodanthe pygmaea</i>				
Asteraceae	<i>Rhodanthe rubella</i>				

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Asteraceae	<i>Rhodanthe stricta</i>				
Asteraceae	<i>Rhodanthe uniflora</i>	P1 (DBCA list)			
Asteraceae	<i>Schoenia cassiniana</i>				
Asteraceae	<i>Schoenia filifolia</i> subsp. <i>filifolia</i>				
Asteraceae	<i>Senecio dolichocephalus</i>				
Asteraceae	<i>Senecio glossanthus</i>				
Asteraceae	<i>Senecio lacustrinus</i>				
Asteraceae	<i>Senecio magnificus</i>				
Asteraceae	<i>Senecio pinnatifolius</i>				
Asteraceae	<i>Sonchus oleraceus</i>		*		
Asteraceae	<i>Streptoglossa liatroides</i>				
Asteraceae	<i>Symphotrichum squamatum</i>		*		
Asteraceae	<i>Trichanthodium skirrophorum</i>				
Asteraceae	<i>Triptilodiscus pygmaeus</i>				
Asteraceae	<i>Vittadinia cervicalis</i> var. <i>circularis</i>				
Asteraceae	<i>Vittadinia dissecta</i> var. <i>hirta</i>				
Asteraceae	<i>Vittadinia humerata</i>				
Asteraceae	<i>Vittadinia sulcata</i>				
Asteraceae	<i>Waitzia acuminata</i> var. <i>acuminata</i>				
Asteraceae	<i>Waitzia fitzgibbonii</i>				
Asteraceae	<i>Waitzia nitida</i>				
Boraginaceae	<i>Buglossoides arvensis</i>		*		
Boraginaceae	<i>Echium plantagineum</i>		*		
Boraginaceae	<i>Halgania andromedifolia</i>				
Boraginaceae	<i>Halgania cyanea</i> var. Allambi Stn (B.W. Strong 676)				
Boraginaceae	<i>Halgania cyanea</i> var. Charleville (R.W. Purdie +111)				
Boraginaceae	<i>Halgania integerrima</i>				
Boraginaceae	<i>Heliotropium europaeum</i>		*		
Boraginaceae	<i>Omphalolappula concava</i>				
Boraginaceae	<i>Trichodesma zeylanicum</i>				
Brassicaceae	<i>Alyssum linifolium</i>		*		s22(2) (Exempt)
Brassicaceae	<i>Arabidella chrysodema</i>				
Brassicaceae	<i>Arabidella trisecta</i>				
Brassicaceae	<i>Brassica tournefortii</i>		*		
Brassicaceae	<i>Capsella bursa-pastoris</i>		*		
Brassicaceae	<i>Carrichtera annua</i>		*		

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Brassicaceae	<i>Lepidium fasciculatum</i>	P3 (DBCA list)			
Brassicaceae	<i>Lepidium merrallii</i>	P2 (DBCA list)			
Brassicaceae	<i>Lepidium oxytrichum</i>				
Brassicaceae	<i>Lepidium papillosum</i>				
Brassicaceae	<i>Phlegmatospermum eremaeum</i>	P3 (DBCA list)			
Brassicaceae	<i>Sisymbrium irio</i>		*		
Brassicaceae	<i>Sisymbrium orientale</i>		*		
Brassicaceae	<i>Stenopetalum filifolium</i>				
Brassicaceae	<i>Stenopetalum lineare</i>				
Brassicaceae	<i>Stenopetalum lineare</i> var. <i>lineare</i>				
Brassicaceae	<i>Stenopetalum pedicellare</i>				
Bryaceae	<i>Bryum lanatum</i>				
Bryaceae	<i>Rosulabryum billardieri</i>				
Bryaceae	<i>Rosulabryum capillare</i>				
Cactaceae	<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>		*	Y	
Cactaceae	<i>Cylindropuntia imbricata</i>		*	Y	s22(2) (C3 Restricted)
Cactaceae	<i>Cylindropuntia kleiniae</i>		*	Y	s22(2) (C3 Restricted)
Cactaceae	<i>Cylindropuntia tunicata</i>		*	Y	s22(2) (C3 Restricted)
Cactaceae	<i>Lycium ferocissimum</i>		*	Y	
Cactaceae	<i>Opuntia ficus-indica</i>		*	Y	s22(2) (C3 Restricted)
Campanulaceae	<i>Isotoma petraea</i>				
Campanulaceae	<i>Wahlenbergia gracilentia</i>				
Caryophyllaceae	<i>Spergularia diandra</i>		*		
Caryophyllaceae	<i>Spergularia marina</i>				
Casuarinaceae	<i>Allocasuarina acutivalvis</i> subsp. <i>acutivalvis</i>				
Casuarinaceae	<i>Allocasuarina campestris</i>				
Casuarinaceae	<i>Allocasuarina corniculata</i>				
Casuarinaceae	<i>Allocasuarina eriochlamys</i> subsp. <i>eriochlamys</i>				
Casuarinaceae	<i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i>	P3 (DBCA list)			
Casuarinaceae	<i>Allocasuarina helmsii</i>				
Casuarinaceae	<i>Casuarina obesa</i>				
Casuarinaceae	<i>Casuarina pauper</i>				
Celastraceae	<i>Stackhousia muricata</i>				
Celastraceae	<i>Tripterococcus brunonis</i>				
Chenopodiaceae	<i>Atriplex acutibractea</i> subsp. <i>acutibractea</i>				

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Chenopodiaceae	<i>Atriplex acutibractea</i> subsp. <i>karoniensis</i>				
Chenopodiaceae	<i>Atriplex amnicola</i>				
Chenopodiaceae	<i>Atriplex codonocarpa</i>				
Chenopodiaceae	<i>Atriplex eardleyae</i>				
Chenopodiaceae	<i>Atriplex holocarpa</i>				
Chenopodiaceae	<i>Atriplex lindleyi</i> subsp. <i>inflata</i>				
Chenopodiaceae	<i>Atriplex nummularia</i>				
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>				
Chenopodiaceae	<i>Atriplex pumilio</i>				
Chenopodiaceae	<i>Atriplex quadrivalvata</i> var. <i>quadrivalvata</i>				
Chenopodiaceae	<i>Atriplex semibaccata</i>				
Chenopodiaceae	<i>Atriplex spongiosa</i>				
Chenopodiaceae	<i>Atriplex stipitata</i>				
Chenopodiaceae	<i>Atriplex suberecta</i>				
Chenopodiaceae	<i>Atriplex vesicaria</i>				
Chenopodiaceae	<i>Chenopodium album</i>		*		
Chenopodiaceae	<i>Chenopodium curvispicatum</i>				
Chenopodiaceae	<i>Chenopodium murale</i>		*		
Chenopodiaceae	<i>Didymanthus roei</i>				
Chenopodiaceae	<i>Dissocarpus paradoxus</i>				
Chenopodiaceae	<i>Dysphania cristata</i>				
Chenopodiaceae	<i>Dysphania kalpari</i>				
Chenopodiaceae	<i>Dysphania pumilio</i>				
Chenopodiaceae	<i>Einadia nutans</i> subsp. <i>eremaea</i>				
Chenopodiaceae	<i>Enchylaena lanata</i>				
Chenopodiaceae	<i>Enchylaena tomentosa</i>				
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>				
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>				
Chenopodiaceae	<i>Maireana amoena</i>				
Chenopodiaceae	<i>Maireana appressa</i>				
Chenopodiaceae	<i>Maireana atkinsiana</i>				
Chenopodiaceae	<i>Maireana brevifolia</i>				
Chenopodiaceae	<i>Maireana carnosa</i>				
Chenopodiaceae	<i>Maireana erioclada</i>				
Chenopodiaceae	<i>Maireana eriosphaera</i>				
Chenopodiaceae	<i>Maireana georgei</i>				
Chenopodiaceae	<i>Maireana glomerifolia</i>				
Chenopodiaceae	<i>Maireana pentagona</i>				
Chenopodiaceae	<i>Maireana pentatropis</i>				

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Chenopodiaceae	<i>Maireana pyramidata</i>				
Chenopodiaceae	<i>Maireana radiata</i>				
Chenopodiaceae	<i>Maireana sedifolia</i>				
Chenopodiaceae	<i>Maireana suaedifolia</i>				
Chenopodiaceae	<i>Maireana tomentosa</i>				
Chenopodiaceae	<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>				
Chenopodiaceae	<i>Maireana trichoptera</i>				
Chenopodiaceae	<i>Maireana triptera</i>				
Chenopodiaceae	<i>Maireana turbinata</i>				
Chenopodiaceae	<i>Rhagodia drummondii</i>				
Chenopodiaceae	<i>Rhagodia eremaea</i>				
Chenopodiaceae	<i>Roycea divaricata</i>				
Chenopodiaceae	<i>Salsola australis</i>				
Chenopodiaceae	<i>Sclerolaena cuneata</i>				
Chenopodiaceae	<i>Sclerolaena diacantha</i>				
Chenopodiaceae	<i>Sclerolaena drummondii</i>				
Chenopodiaceae	<i>Sclerolaena eurotioides</i>				
Chenopodiaceae	<i>Sclerolaena fusiformis</i>				
Chenopodiaceae	<i>Sclerolaena gardneri</i>				
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>				
Chenopodiaceae	<i>Sclerolaena parviflora</i>				
Chenopodiaceae	<i>Tecticornia chartacea</i>				
Chenopodiaceae	<i>Tecticornia disarticulata</i>				
Chenopodiaceae	<i>Tecticornia doliiformis</i>				
Chenopodiaceae	<i>Tecticornia halocnemoides</i>				
Chenopodiaceae	<i>Tecticornia indica</i> subsp. <i>bidens</i>				
Chenopodiaceae	<i>Tecticornia pergranulata</i> subsp. <i>elongata</i>				
Chenopodiaceae	<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>				
Chenopodiaceae	<i>Tecticornia pruinosa</i>				
Chenopodiaceae	<i>Tecticornia pterygosperma</i> subsp. <i>pterygosperma</i>				
Chenopodiaceae	<i>Tecticornia</i> sp. Burnerbinmah (D. Edinger et al. 101)				
Chenopodiaceae	<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)				
Chenopodiaceae	<i>Tecticornia triandra</i>				
Chenopodiaceae	<i>Tecticornia undulata</i>				
Colchicaceae	<i>Wurmbea tenella</i>				
Convolvulaceae	<i>Convolvulus clementii</i>				
Convolvulaceae	<i>Convolvulus remotus</i>				

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Convolvulaceae	<i>Ipomoea calobra</i>				
Crassulaceae	<i>Crassula colorata</i> var. <i>acuminata</i>				
Crassulaceae	<i>Crassula colorata</i> var. <i>colorata</i>				
Crassulaceae	<i>Crassula tetramera</i>				
Cucurbitaceae	<i>Cucumis myriocarpus</i>		*		
Cupressaceae	<i>Callitris columellaris</i>				
Cupressaceae	<i>Callitris preissii</i>				
Cyperaceae	<i>Chrysitrix distigmata</i>				
Cyperaceae	<i>Gahnia deusta</i>				
Cyperaceae	<i>Isolepis australiensis</i>	P3 (DBCA list)			
Cyperaceae	<i>Isolepis congrua</i>				
Cyperaceae	<i>Lepidosperma diurnum</i>				
Cyperaceae	<i>Lepidosperma</i> sp. Parker Range (N. Gibson & M. Lyons 2094)	P1 (DBCA list)			
Cyperaceae	<i>Mesomelaena preissii</i>				
Cyperaceae	<i>Schoenus subaphyllus</i>				
Didiereaceae	<i>Portulacaria afra</i>		*		
Droseraceae	<i>Drosera macrantha</i>				
Elaeocarpaceae	<i>Tetratheca efoliata</i>				
Ericaceae	<i>Leucopogon hamulosus</i>				
Ericaceae	<i>Leucopogon</i> sp. Clyde Hill (M.A. Burgman 1207)				
Ericaceae	<i>Melichrus</i> sp. Coolgardie	P1 (DBCA list)			
Ericaceae	<i>Styphelia</i> sp. Bullfinch	P3 (DBCA list)			
Euphorbiaceae	<i>Beyeria lechenaultii</i>				
Euphorbiaceae	<i>Beyeria sulcata</i> var. <i>brevipes</i>				
Euphorbiaceae	<i>Beyeria sulcata</i> var. <i>sulcata</i>				
Euphorbiaceae	<i>Euphorbia philochalix</i>				
Euphorbiaceae	<i>Euphorbia porcata</i>				
Euphorbiaceae	<i>Monotaxis grandiflora</i> var. <i>obtusifolia</i>				
Euphorbiaceae	<i>Monotaxis luteiflora</i>				
Euphorbiaceae	<i>Ricinocarpos stylosus</i>				
Euphorbiaceae	<i>Ricinocarpos velutinus</i>				
Fabaceae	<i>Acacia acuminata</i>				
Fabaceae	<i>Acacia ancistrophylla</i> var. <i>ancistrophylla</i>				
Fabaceae	<i>Acacia andrewsii</i>				
Fabaceae	<i>Acacia beauverdiana</i>				
Fabaceae	<i>Acacia burkittii</i>				
Fabaceae	<i>Acacia calcarata</i>				
Fabaceae	<i>Acacia camptoclada</i>				
Fabaceae	<i>Acacia chrysella</i>				

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Fabaceae	<i>Acacia coatesii</i>	P1 (DBCA list)			
Fabaceae	<i>Acacia collegialis</i>				
Fabaceae	<i>Acacia colletioides</i>				
Fabaceae	<i>Acacia coolgardiensis</i>				
Fabaceae	<i>Acacia crenulata</i>	P3 (DBCA list)			
Fabaceae	<i>Acacia deficiens</i>				
Fabaceae	<i>Acacia desertorum</i> var. <i>desertorum</i>				
Fabaceae	<i>Acacia duriuscula</i>				
Fabaceae	<i>Acacia effusifolia</i>				
Fabaceae	<i>Acacia enervia</i>				
Fabaceae	<i>Acacia enervia</i> subsp. <i>explicata</i>				
Fabaceae	<i>Acacia epedunculata</i>	P1 (DBCA list)			
Fabaceae	<i>Acacia eremophila</i> var. <i>eremophila</i>				
Fabaceae	<i>Acacia erinacea</i>				
Fabaceae	<i>Acacia gibbosa</i>				
Fabaceae	<i>Acacia hemiteles</i>				
Fabaceae	<i>Acacia inaequiloba</i>				
Fabaceae	<i>Acacia inceana</i> subsp. <i>inceana</i>				
Fabaceae	<i>Acacia jennerae</i>				
Fabaceae	<i>Acacia jensenii</i>				
Fabaceae	<i>Acacia jibberdingensis</i>				
Fabaceae	<i>Acacia kalgoorliensis</i>				
Fabaceae	<i>Acacia lasiocalyx</i>				
Fabaceae	<i>Acacia leptopetala</i>				
Fabaceae	<i>Acacia ligulata</i>				
Fabaceae	<i>Acacia longispinea</i>				
Fabaceae	<i>Acacia masliniana</i>				
Fabaceae	<i>Acacia merrallii</i>				
Fabaceae	<i>Acacia multispicata</i>				
Fabaceae	<i>Acacia murrayana</i>				
Fabaceae	<i>Acacia nyssophylla</i>				
Fabaceae	<i>Acacia pachypoda</i>				
Fabaceae	<i>Acacia prainii</i>				
Fabaceae	<i>Acacia pycnantha</i>		*		
Fabaceae	<i>Acacia ramulosa</i> var. <i>ramulosa</i>				
Fabaceae	<i>Acacia rendlei</i>				
Fabaceae	<i>Acacia resinimarginea</i>				
Fabaceae	<i>Acacia resinistipulea</i>				
Fabaceae	<i>Acacia sclerophylla</i> var. <i>teretiuscula</i>	P1 (DBCA list)			

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Fabaceae	<i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i>				
Fabaceae	<i>Acacia sericocarpa</i>				
Fabaceae	<i>Acacia synchronicia</i>				
Fabaceae	<i>Acacia tetragonophylla</i>				
Fabaceae	<i>Acacia websteri</i>	P1 (DBCA list)			
Fabaceae	<i>Acacia xerophila</i> var. <i>brevior</i>				
Fabaceae	<i>Acacia yorkrakinensis</i> subsp. <i>acrita</i>				
Fabaceae	<i>Alhagi maurorum</i>		*		s22(2) (C3)
Fabaceae	<i>Bossiaea cucullata</i>				
Fabaceae	<i>Cullen discolor</i>				
Fabaceae	<i>Cullen leucanthum</i>				
Fabaceae	<i>Daviesia aphylla</i>				
Fabaceae	<i>Daviesia grahamii</i>				
Fabaceae	<i>Daviesia nematophylla</i>				
Fabaceae	<i>Daviesia pachyloma</i>				
Fabaceae	<i>Dillwynia</i> sp. Coolgardie (V.E. Sands 637.3.1)				
Fabaceae	<i>Erythrostemon gilliesii</i>		*		
Fabaceae	<i>Gastrolobium graniticum</i>	EN (EPBC Act); VU (BC Act)			
Fabaceae	<i>Glycyrrhiza acanthocarpa</i>				
Fabaceae	<i>Gompholobium cinereum</i>	P3 (DBCA list)			
Fabaceae	<i>Gompholobium gompholobioides</i>				
Fabaceae	<i>Hovea acanthoclada</i>				
Fabaceae	<i>Jacksonia arida</i>				
Fabaceae	<i>Kennedia prorepens</i>				
Fabaceae	<i>Leptosema daviesioides</i>				
Fabaceae	<i>Lotus cruentus</i>				
Fabaceae	<i>Medicago laciniata</i>		*		
Fabaceae	<i>Medicago minima</i>		*		
Fabaceae	<i>Medicago polymorpha</i>		*		
Fabaceae	<i>Mirbelia depressa</i>				
Fabaceae	<i>Mirbelia microphylla</i>				
Fabaceae	<i>Mirbelia ramulosa</i>				
Fabaceae	<i>Mirbelia seorsifolia</i>				
Fabaceae	<i>Petalostylis cassioides</i>				
Fabaceae	<i>Senna artemisioides</i>				
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>				
Fabaceae	<i>Senna artemisioides</i> subsp. x <i>artemisioides</i>				
Fabaceae	<i>Senna cardiosperma</i>				
Fabaceae	<i>Senna pleurocarpa</i>				

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Fabaceae	<i>Senna pleurocarpa</i> var. <i>angustifolia</i>				
Fabaceae	<i>Senna pleurocarpa</i> var. <i>pleurocarpa</i>				
Fabaceae	<i>Senna</i> sp. Austin (A. Strid 20210)				
Fabaceae	<i>Senna stowardii</i>				
Fabaceae	<i>Swainsona affinis</i>				
Fabaceae	<i>Swainsona beasleyana</i>				
Fabaceae	<i>Swainsona canescens</i>				
Fabaceae	<i>Swainsona colutoides</i>				
Fabaceae	<i>Swainsona gracilis</i>				
Fabaceae	<i>Swainsona halophila</i>				
Fabaceae	<i>Swainsona incei</i>				
Fabaceae	<i>Swainsona kingii</i>				
Fabaceae	<i>Swainsona leeana</i>				
Fabaceae	<i>Swainsona oliveri</i>				
Fabaceae	<i>Swainsona oroboides</i>				
Fabaceae	<i>Swainsona paradoxa</i>				
Fabaceae	<i>Swainsona purpurea</i>				
Fabaceae	<i>Swainsona rostellata</i>				
Fabaceae	<i>Templetonia incrassata</i>				
Fabaceae	<i>Vicia monantha</i> subsp. <i>triflora</i>		*		
Fissidentaceae	<i>Fissidens megalotis</i>				
Frankeniaceae	<i>Frankenia cinerea</i>				
Frankeniaceae	<i>Frankenia desertorum</i>				
Frankeniaceae	<i>Frankenia glomerata</i>	P4 (DBCA list)			
Frankeniaceae	<i>Frankenia interioris</i>				
Frankeniaceae	<i>Frankenia interioris</i> var. <i>interioris</i>				
Frankeniaceae	<i>Frankenia pauciflora</i>				
Frankeniaceae	<i>Frankenia pauciflora</i> var. <i>pauciflora</i>				
Frankeniaceae	<i>Frankenia setosa</i>				
Frankeniaceae	<i>Frankenia tetrapetala</i>				
Gentianaceae	<i>Schenkia clementii</i>				
Geraniaceae	<i>Erodium aureum</i>		*		
Geraniaceae	<i>Erodium botrys</i>		*		
Geraniaceae	<i>Erodium cicutarium</i>		*		
Geraniaceae	<i>Erodium crinitum</i>				
Geraniaceae	<i>Erodium cygnorum</i>				
Goodeniaceae	<i>Brunonia australis</i>				
Goodeniaceae	<i>Brunonia</i> sp. Goldfields (K.R. Newbey 6044)				
Goodeniaceae	<i>Cooperhookia strophiolata</i>				

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Goodeniaceae	<i>Dampiera eriocephala</i>				
Goodeniaceae	<i>Dampiera latealata</i>				
Goodeniaceae	<i>Dampiera lavandulacea</i>				
Goodeniaceae	<i>Dampiera luteiflora</i>				
Goodeniaceae	<i>Dampiera plumosa</i>	P1 (DBCA list)			
Goodeniaceae	<i>Dampiera stenostachya</i>				
Goodeniaceae	<i>Dampiera tenuicaulis</i>				
Goodeniaceae	<i>Dampiera tenuicaulis</i> var. <i>curvula</i>				
Goodeniaceae	<i>Dampiera tenuicaulis</i> var. <i>tenuicaulis</i>				
Goodeniaceae	<i>Goodenia concinna</i>				
Goodeniaceae	<i>Goodenia dyeri</i>				
Goodeniaceae	<i>Goodenia elderi</i>				
Goodeniaceae	<i>Goodenia havilandii</i>				
Goodeniaceae	<i>Goodenia helmsii</i>				
Goodeniaceae	<i>Goodenia mimuloides</i>				
Goodeniaceae	<i>Goodenia occidentalis</i>				
Goodeniaceae	<i>Goodenia pusilliflora</i>				
Goodeniaceae	<i>Goodenia salina</i>	P2 (DBCA list)			
Goodeniaceae	<i>Goodenia xanthosperma</i>				
Goodeniaceae	<i>Lechenaultia brevifolia</i>				
Goodeniaceae	<i>Scaevola spinescens</i>				
Goodeniaceae	<i>Velleia cynopotamica</i>				
Goodeniaceae	<i>Velleia discophora</i>				
Goodeniaceae	<i>Velleia rosea</i>				
Goodeniaceae	<i>Verreauxia dyeri</i>				
Grimmiaceae	<i>Grimmia laevigata</i>				
Gyrostemonaceae	<i>Gyrostemon racemiger</i>				
Haloragaceae	<i>Glischrocaryon angustifolium</i>				
Haloragaceae	<i>Glischrocaryon aureum</i>				
Haloragaceae	<i>Glischrocaryon flavescens</i>				
Haloragaceae	<i>Gonocarpus confertifolius</i> var. <i>helmsii</i>				
Haloragaceae	<i>Haloragis gossei</i>				
Haloragaceae	<i>Haloragis trigonocarpa</i>				
Juncaceae	<i>Juncus subsecundus</i>				
Lamiaceae	<i>Brachysola coerulea</i>				
Lamiaceae	<i>Cyanostegia angustifolia</i>				
Lamiaceae	<i>Cyanostegia microphylla</i>				
Lamiaceae	<i>Dasymalla terminalis</i>				
Lamiaceae	<i>Dicrastylis brunnea</i>				
Lamiaceae	<i>Dicrastylis parvifolia</i>				
Lamiaceae	<i>Hemiphora elderi</i>				

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Lamiaceae	<i>Lachnostachys coolgardiensis</i>				
Lamiaceae	<i>Physopsis viscida</i>				
Lamiaceae	<i>Pityrodia lepidota</i>				
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>				
Lamiaceae	<i>Prostanthera campbellii</i>				
Lamiaceae	<i>Prostanthera grylloana</i>				
Lamiaceae	<i>Prostanthera incurvata</i>				
Lamiaceae	<i>Salvia reflexa</i>		*		
Lamiaceae	<i>Salvia verbenaca</i>		*		
Lamiaceae	<i>Teucrium sessiliflorum</i>				
Lamiaceae	<i>Westringia cephalantha</i>				
Lamiaceae	<i>Westringia cephalantha</i> var. <i>caterva</i>				
Lamiaceae	<i>Westringia rigida</i>				
Loganiaceae	<i>Orianthera flaviflora</i>				
Loganiaceae	<i>Orianthera tortuosa</i>				
Loganiaceae	<i>Phyllangium sulcatum</i>				
Loranthaceae	<i>Amyema benthamii</i>				
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>				
Loranthaceae	<i>Amyema linophylla</i> subsp. <i>linophylla</i>				
Loranthaceae	<i>Amyema miquelii</i>				
Loranthaceae	<i>Amyema preissii</i>				
Loranthaceae	<i>Lysiana casuarinae</i>				
Lythraceae	<i>Lythrum hyssopifolia</i>		*		
Malvaceae	<i>Abutilon cryptopetalum</i>				
Malvaceae	<i>Androcalva aphrix</i>				
Malvaceae	<i>Androcalva luteiflora</i>				
Malvaceae	<i>Brachychiton gregorii</i>				
Malvaceae	<i>Commersonia craurophylla</i>				
Malvaceae	<i>Commersonia magniflora</i> subsp. <i>oblongifolia</i>				
Malvaceae	<i>Hannafordia bissillii</i> subsp. <i>latifolia</i>				
Malvaceae	<i>Hibiscus solanifolius</i>				
Malvaceae	<i>Lawrencia glomerata</i>				
Malvaceae	<i>Lawrencia helmsii</i>				
Malvaceae	<i>Lawrencia repens</i>				
Malvaceae	<i>Lawrencia squamata</i>				
Malvaceae	<i>Malva parviflora</i>		*		
Malvaceae	<i>Malva weinmanniana</i>				
Malvaceae	<i>Radyera farragei</i>				
Malvaceae	<i>Seringia velutina</i>				

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Malvaceae	<i>Sida calyxhymenia</i>				
Malvaceae	<i>Sida fibulifera</i>				
Malvaceae	<i>Sida intricata</i>				
Malvaceae	<i>Sida spodochroma</i>				
Meliaceae	<i>Melia azedarach</i>				
Myrtaceae	<i>Aluta appressa</i>				
Myrtaceae	<i>Aluta aspera</i> subsp. <i>aspera</i>				
Myrtaceae	<i>Astus subroseus</i>				
Myrtaceae	<i>Baeckea elderiana</i>				
Myrtaceae	<i>Baeckea</i> sp. Koonadgin (B.L. Rye & M.E. Trudgen BLR 241137)				
Myrtaceae	<i>Calothamnus gilesii</i>				
Myrtaceae	<i>Calytrix amethystina</i>				
Myrtaceae	<i>Calytrix birdii</i>				
Myrtaceae	<i>Calytrix breviseta</i> subsp. <i>stipulosa</i>				
Myrtaceae	<i>Cyathostemon verrucosus</i>	P3 (DBCA list)			
Myrtaceae	<i>Enekbatus eremaeus</i>				
Myrtaceae	<i>Ericomyrtus serpyllifolia</i>				
Myrtaceae	<i>Eucalyptus campaspe</i>				
Myrtaceae	<i>Eucalyptus capillosa</i>				
Myrtaceae	<i>Eucalyptus celastroides</i>				
Myrtaceae	<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>				
Myrtaceae	<i>Eucalyptus clelandiorum</i>				
Myrtaceae	<i>Eucalyptus comitae-vallis</i>				
Myrtaceae	<i>Eucalyptus concinna</i>				
Myrtaceae	<i>Eucalyptus corrugata</i>				
Myrtaceae	<i>Eucalyptus cylindrocarpa</i>				
Myrtaceae	<i>Eucalyptus distuberosa</i> subsp. <i>distuberosa</i>				
Myrtaceae	<i>Eucalyptus ebbanoensis</i> subsp. <i>ebbanoensis</i>				
Myrtaceae	<i>Eucalyptus ebbanoensis</i> subsp. <i>glauciramula</i>				
Myrtaceae	<i>Eucalyptus eremicola</i>				
Myrtaceae	<i>Eucalyptus eremophila</i>				
Myrtaceae	<i>Eucalyptus eremophila</i> subsp. <i>eremophila</i>				
Myrtaceae	<i>Eucalyptus ewartiana</i>				
Myrtaceae	<i>Eucalyptus flavida</i>				
Myrtaceae	<i>Eucalyptus flocktoniae</i>				
Myrtaceae	<i>Eucalyptus flocktoniae</i> subsp. <i>hebes</i>				

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Myrtaceae	<i>Eucalyptus fraseri</i> subsp. <i>fraseri</i>				
Myrtaceae	<i>Eucalyptus griffithsii</i>				
Myrtaceae	<i>Eucalyptus horistes</i>				
Myrtaceae	<i>Eucalyptus incrassata</i>				
Myrtaceae	<i>Eucalyptus jutsonii</i> subsp. <i>jutsonii</i>	P4 (DBCA list)			
Myrtaceae	<i>Eucalyptus leptophylla</i>				
Myrtaceae	<i>Eucalyptus leptopoda</i> subsp. <i>subluta</i>				
Myrtaceae	<i>Eucalyptus lesouefii</i>				
Myrtaceae	<i>Eucalyptus livida</i>				
Myrtaceae	<i>Eucalyptus longicornis</i>				
Myrtaceae	<i>Eucalyptus longissima</i>				
Myrtaceae	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>				
Myrtaceae	<i>Eucalyptus moderata</i>				
Myrtaceae	<i>Eucalyptus oleosa</i>				
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>				
Myrtaceae	<i>Eucalyptus pileata</i>				
Myrtaceae	<i>Eucalyptus planipes</i>				
Myrtaceae	<i>Eucalyptus platycorys</i>				
Myrtaceae	<i>Eucalyptus prolixa</i>				
Myrtaceae	<i>Eucalyptus ravida</i>				
Myrtaceae	<i>Eucalyptus rigidula</i>				
Myrtaceae	<i>Eucalyptus salicola</i>				
Myrtaceae	<i>Eucalyptus salmonophloia</i>				
Myrtaceae	<i>Eucalyptus salubris</i>				
Myrtaceae	<i>Eucalyptus</i> sp. Mulga Rock (K.D. Hill & L.A.S. Johnson KH 2668)				
Myrtaceae	<i>Eucalyptus stricklandii</i>				
Myrtaceae	<i>Eucalyptus tenera</i>				
Myrtaceae	<i>Eucalyptus torquata</i>				
Myrtaceae	<i>Eucalyptus transcontinentalis</i>				
Myrtaceae	<i>Eucalyptus urna</i>				
Myrtaceae	<i>Eucalyptus vittata</i>				
Myrtaceae	<i>Eucalyptus websteriana</i>				
Myrtaceae	<i>Eucalyptus websteriana</i> subsp. <i>norsemanica</i>	P1 (DBCA list)			
Myrtaceae	<i>Eucalyptus websteriana</i> subsp. <i>websteriana</i>				
Myrtaceae	<i>Eucalyptus</i> x <i>brachyphylla</i>	P4 (DBCA list)			
Myrtaceae	<i>Eucalyptus yilgarnensis</i>				

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Myrtaceae	<i>Euryomyrtus maidenii</i>				
Myrtaceae	<i>Homalocalyx thryptomenoides</i>				
Myrtaceae	<i>Leptospermum fastigiatum</i>				
Myrtaceae	<i>Leptospermum subtenue</i>				
Myrtaceae	<i>Malleostemon peltiger</i>				
Myrtaceae	<i>Malleostemon roseus</i>				
Myrtaceae	<i>Malleostemon tuberculatus</i>				
Myrtaceae	<i>Melaleuca acuminata</i> subsp. <i>acuminata</i>				
Myrtaceae	<i>Melaleuca calyptroides</i>				
Myrtaceae	<i>Melaleuca coccinea</i>	P3 (DBCA list)			
Myrtaceae	<i>Melaleuca cordata</i>				
Myrtaceae	<i>Melaleuca elliptica</i>				
Myrtaceae	<i>Melaleuca fulgens</i> subsp. <i>fulgens</i>				
Myrtaceae	<i>Melaleuca halmaturorum</i>				
Myrtaceae	<i>Melaleuca hamata</i>				
Myrtaceae	<i>Melaleuca lanceolata</i>				
Myrtaceae	<i>Melaleuca lateriflora</i>				
Myrtaceae	<i>Melaleuca leiocarpa</i>				
Myrtaceae	<i>Melaleuca macronychia</i> subsp. <i>macronychia</i>				
Myrtaceae	<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>				
Myrtaceae	<i>Melaleuca sheathiana</i>				
Myrtaceae	<i>Melaleuca zeteticorum</i>				
Myrtaceae	<i>Micromyrtus erichsenii</i>				
Myrtaceae	<i>Micromyrtus monotaxis</i>				
Myrtaceae	<i>Micromyrtus obovata</i>				
Myrtaceae	<i>Micromyrtus stenocalyx</i>				
Myrtaceae	<i>Rinzia carnos</i>				
Myrtaceae	<i>Rinzia triplex</i>	P3 (DBCA list)			
Myrtaceae	<i>Thryptomene australis</i> subsp. <i>brachyandra</i>				
Myrtaceae	<i>Thryptomene kochii</i>				
Myrtaceae	<i>Thryptomene</i> sp. Coolgardie (E. Kelso s.n. 1902)	P1 (DBCA list)			
Myrtaceae	<i>Thryptomene</i> sp. Londonderry (R.H. Kuchel 1763)	P1 (DBCA list)			
Myrtaceae	<i>Thryptomene urceolaris</i>				
Myrtaceae	<i>Verticordia chrysantha</i>				
Myrtaceae	<i>Verticordia picta</i>				
Myrtaceae	<i>Verticordia pritzelii</i>				
Nitrariaceae	<i>Nitraria billardi</i>				

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Nyctaginaceae	<i>Boerhavia coccinea</i>				
Ophioglossaceae	<i>Ophioglossum polyphyllum</i>				
Orchidaceae	<i>Caladenia roei</i>				
Orchidaceae	<i>Caladenia saxicola</i>				
Orchidaceae	<i>Cyanicula amplexans</i>				
Orchidaceae	<i>Pterostylis roensis</i>				
Orchidaceae	<i>Pterostylis</i> sp. inland (A.C. Beaglehole 11880)				
Orchidaceae	<i>Pterostylis tryphera</i>				
Orchidaceae	<i>Thelymitra antennifera</i>				
Orchidaceae	<i>Thelymitra petrophila</i>				
Orchidaceae	<i>Thelymitra stellata</i>	EN (EPBC & BC Acts)			
Oxalidaceae	<i>Oxalis bowiei</i>		*		
Oxalidaceae	<i>Oxalis perennans</i>				
Oxalidaceae	<i>Oxalis pes-caprae</i>		*		
Papaveraceae	<i>Papaver hybridum</i>		*		
Pittosporaceae	<i>Billardiera fusiformis</i>				
Pittosporaceae	<i>Marianthus bicolor</i>				
Pittosporaceae	<i>Pittosporum angustifolium</i>				
Plantaginaceae	<i>Plantago debilis</i>				
Plantaginaceae	<i>Plantago drummondii</i>				
Plantaginaceae	<i>Plantago</i> sp. Mt Magnet (A.S. George 6793)				
Plumbaginaceae	<i>Limonium sinuatum</i>		*		
Poaceae	<i>Amphipogon caricinus</i> var. <i>caricinus</i>				
Poaceae	<i>Aristida contorta</i>				
Poaceae	<i>Aristida holathera</i> var. <i>holathera</i>				
Poaceae	<i>Austrostipa blackii</i>	P3 (DBCA list)			
Poaceae	<i>Austrostipa drummondii</i>				
Poaceae	<i>Austrostipa elegantissima</i>				
Poaceae	<i>Austrostipa eremophila</i>				
Poaceae	<i>Austrostipa hemipogon</i>				
Poaceae	<i>Austrostipa nitida</i>				
Poaceae	<i>Austrostipa platychaeta</i>				
Poaceae	<i>Austrostipa scabra</i>				
Poaceae	<i>Austrostipa</i> sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)	P1 (DBCA list)			
Poaceae	<i>Austrostipa</i> sp. Dowerin (G. Wiehl F 8004)	P2 (DBCA list)			
Poaceae	<i>Austrostipa trichophylla</i>				
Poaceae	<i>Bromus arenarius</i>				
Poaceae	<i>Bromus diandrus</i>		*		

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Poaceae	<i>Cenchrus ciliaris</i>		*		
Poaceae	<i>Chloris truncata</i>				
Poaceae	<i>Dactyloctenium radulans</i>				
Poaceae	<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>				
Poaceae	<i>Digitaria ammophila</i>				
Poaceae	<i>Digitaria brownii</i>				
Poaceae	<i>Ehrharta villosa</i>		*		
Poaceae	<i>Enneapogon avenaceus</i>				
Poaceae	<i>Enneapogon caerulescens</i>				
Poaceae	<i>Enneapogon cylindricus</i>				
Poaceae	<i>Enteropogon ramosus</i>				
Poaceae	<i>Eragrostis dielsii</i>				
Poaceae	<i>Eragrostis falcata</i>				
Poaceae	<i>Eragrostis setifolia</i>				
Poaceae	<i>Eragrostis xerophila</i>				
Poaceae	<i>Eriachne pulchella</i>				
Poaceae	<i>Hordeum glaucum</i>		*		
Poaceae	<i>Hordeum leporinum</i>		*		
Poaceae	<i>Leptochloa digitata</i>				
Poaceae	<i>Monachather paradoxus</i>				
Poaceae	<i>Panicum decompositum</i>				
Poaceae	<i>Paspalidium constrictum</i>				
Poaceae	<i>Paspalidium reflexum</i>				
Poaceae	<i>Pentameris airoides</i> subsp. <i>airoides</i>		*		
Poaceae	<i>Phalaris paradoxa</i>		*		
Poaceae	<i>Rostraria pumila</i>		*		
Poaceae	<i>Rytidosperma caespitosum</i>				
Poaceae	<i>Rytidosperma setaceum</i>				
Poaceae	<i>Schismus arabicus</i>		*		
Poaceae	<i>Schismus barbatus</i>		*		
Poaceae	<i>Setaria dielsii</i>				
Poaceae	<i>Sorghum halepense</i>		*		
Poaceae	<i>Triodia irritans</i>				
Poaceae	<i>Triodia scariosa</i>				
Poaceae	<i>Triodia tomentosa</i>				
Poaceae	<i>Urochloa panicoides</i>		*		
Polygalaceae	<i>Comesperma drummondii</i>				
Polygalaceae	<i>Comesperma scoparium</i>				
Polygonaceae	<i>Persicaria prostrata</i>				
Polygonaceae	<i>Polygonum aviculare</i>		*		
Polygonaceae	<i>Rumex vesicarius</i>		*		
Portulacaceae	<i>Calandrinia calypttrata</i>				
Portulacaceae	<i>Calandrinia eremaea</i>				

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Portulacaceae	<i>Calandrinia polyandra</i>				
Portulacaceae	<i>Calandrinia sculpta</i>				
Portulacaceae	<i>Calandrinia translucens</i>				
Portulacaceae	<i>Portulaca oleracea</i>				
Pottiaceae	<i>Aloina bifrons</i>				
Pottiaceae	<i>Barbula luteola</i>				
Pottiaceae	<i>Crossidium davidai</i>				
Pottiaceae	<i>Didymodon torquatus</i>				
Pottiaceae	<i>Syntrichia pagorum</i>				
Pottiaceae	<i>Tortula muralis</i>				
Proteaceae	<i>Banksia elderiana</i>				
Proteaceae	<i>Conospermum stoechadis</i> subsp. <i>stoechadis</i>				
Proteaceae	<i>Grevillea acacioides</i>				
Proteaceae	<i>Grevillea acuaria</i>				
Proteaceae	<i>Grevillea beardiana</i>				
Proteaceae	<i>Grevillea cagiana</i>				
Proteaceae	<i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i>				
Proteaceae	<i>Grevillea excelsior</i>				
Proteaceae	<i>Grevillea georgeana</i>	P3 (DBCA list)			
Proteaceae	<i>Grevillea haplantha</i> subsp. <i>haplantha</i>				
Proteaceae	<i>Grevillea hookeriana</i> subsp. <i>apiculoba</i>				
Proteaceae	<i>Grevillea huegelii</i>				
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>				
Proteaceae	<i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>				
Proteaceae	<i>Grevillea oligomera</i>				
Proteaceae	<i>Grevillea paniculata</i>				
Proteaceae	<i>Grevillea pterosperma</i>				
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>bicolor</i>				
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>sarissa</i>				
Proteaceae	<i>Grevillea teretifolia</i>				
Proteaceae	<i>Grevillea uncinulata</i>				
Proteaceae	<i>Hakea francisiana</i>				
Proteaceae	<i>Hakea minyma</i>				
Proteaceae	<i>Hakea rigida</i>	P2 (DBCA list)			
Proteaceae	<i>Persoonia saundersiana</i>				
Proteaceae	<i>Petrophile seminuda</i>				
Pteridaceae	<i>Cheilanthes adiantoides</i>				

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Family	Species	Conservation status	Introduced	WoNS	Declared pest
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>				
Ranunculaceae	<i>Myosurus australis</i>				
Restionaceae	<i>Lepidobolus chaetocephalus</i>				
Restionaceae	<i>Lepidobolus deserti</i>				
Rhamnaceae	<i>Cryptandra aridicola</i>				
Rhamnaceae	<i>Cryptandra pungens</i>				
Rhamnaceae	<i>Pomaderris forrestiana</i>				
Rhamnaceae	<i>Trymalium myrtillus</i> subsp. <i>myrtillus</i>				
Ruppiaceae	<i>Ruppia polycarpa</i>				
Rutaceae	<i>Boronia coerulescens</i>				
Rutaceae	<i>Boronia coerulescens</i> subsp. <i>spinescens</i>				
Rutaceae	<i>Boronia ternata</i>				
Rutaceae	<i>Phebalium appressum</i>	P1 (DBCA list)			
Rutaceae	<i>Phebalium canaliculatum</i>				
Rutaceae	<i>Phebalium clavatum</i>	P2 (DBCA list)			
Rutaceae	<i>Phebalium filifolium</i>				
Rutaceae	<i>Phebalium laevigatum</i>				
Rutaceae	<i>Phebalium lepidotum</i>				
Rutaceae	<i>Phebalium tuberculatum</i>				
Rutaceae	<i>Philotheca brucei</i> subsp. <i>brucei</i>				
Rutaceae	<i>Philotheca pachyphylla</i>	P1 (DBCA list)			
Rutaceae	<i>Philotheca tomentella</i>				
Santalaceae	<i>Exocarpos aphyllus</i>				
Santalaceae	<i>Santalum acuminatum</i>				
Santalaceae	<i>Santalum spicatum</i>				
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>				
Sapindaceae	<i>Dodonaea adenophora</i>				
Sapindaceae	<i>Dodonaea amblyophylla</i>				
Sapindaceae	<i>Dodonaea lobulata</i>				
Sapindaceae	<i>Dodonaea microzyga</i>				
Sapindaceae	<i>Dodonaea microzyga</i> var. <i>acrolobata</i>				
Sapindaceae	<i>Dodonaea stenozyga</i>				
Sapindaceae	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>				
Scrophulariaceae	<i>Diocirea acutifolia</i>	P3 (DBCA list)			
Scrophulariaceae	<i>Diocirea microphylla</i>	P3 (DBCA list)			
Scrophulariaceae	<i>Eremophila alternifolia</i>				
Scrophulariaceae	<i>Eremophila caerulea</i> subsp. <i>caerulea</i>				

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Family	Species	Conservation status	Introduced	WoNS	Declared pest
Scrophulariaceae	<i>Eremophila caerulea</i> subsp. <i>merrallii</i>	P4 (DBCA list)			
Scrophulariaceae	<i>Eremophila caperata</i>				
Scrophulariaceae	<i>Eremophila clarkei</i>				
Scrophulariaceae	<i>Eremophila clavata</i>				
Scrophulariaceae	<i>Eremophila decipiens</i>				
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>				
Scrophulariaceae	<i>Eremophila dempsteri</i>				
Scrophulariaceae	<i>Eremophila deserti</i>				
Scrophulariaceae	<i>Eremophila drummondii</i>				
Scrophulariaceae	<i>Eremophila gibbosa</i>				
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>				
Scrophulariaceae	<i>Eremophila granitica</i>				
Scrophulariaceae	<i>Eremophila interstans</i> subsp. <i>interstans</i>				
Scrophulariaceae	<i>Eremophila interstans</i> subsp. <i>virgata</i>				
Scrophulariaceae	<i>Eremophila ionantha</i>				
Scrophulariaceae	<i>Eremophila longifolia</i>				
Scrophulariaceae	<i>Eremophila maculata</i> subsp. <i>brevifolia</i>				
Scrophulariaceae	<i>Eremophila miniata</i>				
Scrophulariaceae	<i>Eremophila oblonga</i>				
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>				
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>oldfieldii</i>				
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>				
Scrophulariaceae	<i>Eremophila pantonii</i>				
Scrophulariaceae	<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>				
Scrophulariaceae	<i>Eremophila praecox</i>	P1 (DBCA list)			
Scrophulariaceae	<i>Eremophila psilocalyx</i>				
Scrophulariaceae	<i>Eremophila pustulata</i>				
Scrophulariaceae	<i>Eremophila rugosa</i>				
Scrophulariaceae	<i>Eremophila saligna</i>				
Scrophulariaceae	<i>Eremophila scoparia</i>				
Scrophulariaceae	<i>Eremophila serrulata</i>				
Scrophulariaceae	<i>Eremophila</i> sp. Mt Jackson (G.J. Keighery 4372)				
Scrophulariaceae	<i>Eremophila subfloccosa</i> subsp. <i>lanata</i>				
Scrophulariaceae	<i>Eremophila veronica</i>	P3 (DBCA list)			

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Family	Species	Conservation status	Introduced	WoNS	Declared pest
Scrophulariaceae	<i>Eremophila weldii</i>				
Scrophulariaceae	<i>Myoporum montanum</i>				
Solanaceae	<i>Anthotroche pannosa</i>				
Solanaceae	<i>Crenidium spinescens</i>				
Solanaceae	<i>Datura inoxia</i>		*		
Solanaceae	<i>Duboisia hopwoodii</i>				
Solanaceae	<i>Lycium australe</i>				
Solanaceae	<i>Nicotiana glauca</i>		*		
Solanaceae	<i>Nicotiana rotundifolia</i>				
Solanaceae	<i>Solanum cleistogamum</i>				
Solanaceae	<i>Solanum esuriale</i>				
Solanaceae	<i>Solanum hoplopetalum</i>				
Solanaceae	<i>Solanum lasiophyllum</i>				
Solanaceae	<i>Solanum nigrum</i>		*		
Solanaceae	<i>Solanum nummularium</i>				
Solanaceae	<i>Solanum petrophilum</i>				
Solanaceae	<i>Solanum plicatile</i>				
Solanaceae	<i>Solanum simile</i>				
Solanaceae	<i>Solanum terraneum</i>				
Solanaceae	<i>Xanthium spinosum</i>		*		s22(2) (C2, C3)
Stylidiaceae	<i>Stylidium arenicola</i>				
Stylidiaceae	<i>Stylidium dielsianum</i>				
Stylidiaceae	<i>Stylidium limbatum</i>				
Thymelaeaceae	<i>Pimelea angustifolia</i>				
Thymelaeaceae	<i>Pimelea microcephala</i> subsp. <i>microcephala</i>				
Thymelaeaceae	<i>Pimelea spiculigera</i> var. <i>thesioides</i>				
Thymelaeaceae	<i>Pimelea suaveolens</i> subsp. <i>flava</i>				
Urticaceae	<i>Urtica urens</i>		*		
Verbenaceae	<i>Glandularia aristigera</i>		*		
Verbenaceae	<i>Phyla canescens</i>		*		
Violaceae	<i>Hybanthus floribundus</i> subsp. <i>curvifolius</i>				
Zygophyllaceae	<i>Roepera apiculata</i>				
Zygophyllaceae	<i>Roepera aurantiaca</i>				
Zygophyllaceae	<i>Roepera aurantiaca</i> subsp. <i>aurantiaca</i>				
Zygophyllaceae	<i>Roepera compressa</i>				
Zygophyllaceae	<i>Roepera eremaea</i>				
Zygophyllaceae	<i>Roepera fruticulosa</i>				
Zygophyllaceae	<i>Roepera glauca</i>				
Zygophyllaceae	<i>Roepera ovata</i>				

Family	Species	Conservation status	Introduced	WoNS	Declared pest
Zygophyllaceae	<i>Roepera reticulata</i>				
Zygophyllaceae	<i>Roepera tetraptera</i>				
Zygophyllaceae	<i>Tribulus terrestris</i>		*		

Appendix 3 Flora species inventory

Family	Species
Aizoaceae	<i>Disphyma crassifolium</i>
Aizoaceae	<i>Gunniopsis quadrifida</i>
Amaranthaceae	<i>Ptilotus exaltatus</i>
Amaranthaceae	<i>Ptilotus helipteroides</i>
Amaranthaceae	<i>Ptilotus holosericeus</i>
Amaranthaceae	<i>Ptilotus obovatus</i>
Amaranthaceae	<i>Surreya diandra</i>
Apocynaceae	<i>Alyxia buxifolia</i>
Apocynaceae	<i>Marsdenia australis</i>
Apocynaceae	<i>Rhyncharrhena linearis</i>
Asparagaceae	<i>Thysanotus ?manglesianus</i>
Asparagaceae	<i>Thysanotus manglesianus</i>
Asparagaceae	<i>Thysanotus patersonii</i>
Asteraceae	<i>Asteridea chaetopoda</i>
Asteraceae	<i>Brachyscome ciliaris</i>
Asteraceae	<i>Brachyscome perpusilla</i>
Asteraceae	<i>Cratystylis conocephala</i>
Asteraceae	<i>Cratystylis microphylla</i>
Asteraceae	<i>Cratystylis subspinescens</i>
Asteraceae	<i>Erymophyllum ramosum</i> subsp. <i>ramosum</i>
Asteraceae	<i>Leiocarpa semicalva</i> subsp. <i>semicalva</i>
Asteraceae	<i>Minuria cunninghamii</i>
Asteraceae	* <i>Monoculus monstrosus</i>
Asteraceae	<i>Olearia ?ciliata</i>
Asteraceae	<i>Olearia muelleri</i>
Asteraceae	<i>Olearia pimeleoides</i>
Asteraceae	<i>Podolepis capillaris</i>
Asteraceae	<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>

Family	Species
Asteraceae	<i>Vittadinia dissecta</i> var. <i>hirta</i>
Asteraceae	<i>Vittadinia humerata</i>
Boraginaceae	<i>Halgania andromedifolia</i>
Boraginaceae	<i>Halgania cyanea</i>
Boraginaceae	<i>Heliotropium curassavicum</i>
Casuarinaceae	<i>Allocasuarina eriochlamys</i> subsp. <i>grossa</i> (P3 DBCA list)
Casuarinaceae	<i>Allocasuarina helmsii</i>
Casuarinaceae	<i>Casuarina obesa</i>
Casuarinaceae	<i>Casuarina pauper</i>
Chenopodiaceae	<i>Atriplex ?nana</i>
Chenopodiaceae	<i>Atriplex ?vesicaria</i>
Chenopodiaceae	<i>Atriplex acutibractea</i> subsp. <i>acutibractea</i>
Chenopodiaceae	<i>Atriplex amnicola</i>
Chenopodiaceae	<i>Atriplex bunburyana</i>
Chenopodiaceae	<i>Atriplex codonocarpa</i>
Chenopodiaceae	<i>Atriplex eardleyae</i>
Chenopodiaceae	<i>Atriplex holocarpa</i>
Chenopodiaceae	<i>Atriplex lindleyi</i> subsp. <i>inflata</i>
Chenopodiaceae	<i>Atriplex nana</i>
Chenopodiaceae	<i>Atriplex nummularia</i>
Chenopodiaceae	<i>Atriplex stipitata</i>
Chenopodiaceae	<i>Atriplex vesicaria</i>
Chenopodiaceae	<i>Chenopodium curvispicatum</i>
Chenopodiaceae	<i>Enchylaena tomentosa</i>
Chenopodiaceae	<i>Maireana ?amoena</i>
Chenopodiaceae	<i>Maireana ?georgei</i>
Chenopodiaceae	<i>Maireana amoena</i>
Chenopodiaceae	<i>Maireana appressa</i>
Chenopodiaceae	<i>Maireana carnosa</i>
Chenopodiaceae	<i>Maireana convexa</i>
Chenopodiaceae	<i>Maireana erioclada</i>
Chenopodiaceae	<i>Maireana eriosphaera</i>
Chenopodiaceae	<i>Maireana georgei</i>
Chenopodiaceae	<i>Maireana glomerifolia</i>
Chenopodiaceae	<i>Maireana pentatropis</i>
Chenopodiaceae	<i>Maireana pyramidata</i>
Chenopodiaceae	<i>Maireana radiata</i>

Family	Species
Chenopodiaceae	<i>Maireana sedifolia</i>
Chenopodiaceae	<i>Maireana</i> sp.
Chenopodiaceae	<i>Maireana thesioides</i>
Chenopodiaceae	<i>Maireana tomentosa</i> ?subsp. <i>tomentosa</i>
Chenopodiaceae	<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>
Chenopodiaceae	<i>Maireana trichoptera</i>
Chenopodiaceae	<i>Maireana triptera</i>
Chenopodiaceae	<i>Maireana turbinata</i>
Chenopodiaceae	<i>Osteocarpum salsuginosum</i>
Chenopodiaceae	<i>Rhagodia drummondii</i>
Chenopodiaceae	<i>Rhagodia spinescens</i>
Chenopodiaceae	<i>Rhagodia ulicina</i>
Chenopodiaceae	<i>Roycea</i> ? <i>divaricata</i>
Chenopodiaceae	<i>Roycea divaricata</i>
Chenopodiaceae	<i>Sclerolaena</i> ? <i>brevifolia</i>
Chenopodiaceae	<i>Sclerolaena brevifolia</i>
Chenopodiaceae	<i>Sclerolaena cuneata</i>
Chenopodiaceae	<i>Sclerolaena diacantha</i>
Chenopodiaceae	<i>Sclerolaena drummondii</i>
Chenopodiaceae	<i>Sclerolaena eurotioides</i>
Chenopodiaceae	<i>Sclerolaena fusiformis</i>
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>
Chenopodiaceae	<i>Sclerolaena recurvuspis</i>
Chenopodiaceae	<i>Tecticornia disarticulata</i>
Chenopodiaceae	<i>Tecticornia doliiformis</i>
Chenopodiaceae	<i>Tecticornia indica</i> subsp. <i>bidens</i>
Chenopodiaceae	<i>Tecticornia indica</i> subsp. <i>leiostrachya</i>
Chenopodiaceae	<i>Tecticornia pergranulata</i> subsp. <i>pergranulata</i>
Chenopodiaceae	<i>Tecticornia pruinosa</i>
Chenopodiaceae	<i>Tecticornia</i> sp. (sterile 1)
Chenopodiaceae	<i>Tecticornia</i> sp. (sterile 2)
Chenopodiaceae	<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)
Chenopodiaceae	<i>Tecticornia undulata</i>
Convolvulaceae	* <i>Cuscuta epithymum</i>
Euphorbiaceae	<i>Euphorbia</i> ? <i>philochalix</i>
Euphorbiaceae	<i>Euphorbia porcata</i>
Fabaceae	<i>Acacia burkittii</i>

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Family	Species
Fabaceae	<i>Acacia colletioides</i>
Fabaceae	<i>Acacia densiflora</i>
Fabaceae	<i>Acacia dissona</i> var. <i>dissona</i>
Fabaceae	<i>Acacia erinacea</i>
Fabaceae	<i>Acacia gibbosa</i>
Fabaceae	<i>Acacia hemiteles</i>
Fabaceae	<i>Acacia jennerae</i>
Fabaceae	<i>Acacia kalgoorliensis</i>
Fabaceae	<i>Acacia merrallii</i>
Fabaceae	<i>Acacia nyssophylla</i>
Fabaceae	<i>Acacia tetragonophylla</i>
Fabaceae	<i>Acacia xerophila</i> var. <i>brevior</i>
Fabaceae	* <i>Medicago minima</i>
Fabaceae	<i>Senna ?stowardii</i>
Fabaceae	<i>Senna artemisioides</i> subsp. <i>artemisioides</i>
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>
Fabaceae	<i>Senna artemisioides</i> subsp. x <i>artemisioides</i>
Fabaceae	<i>Senna cardiosperma</i>
Fabaceae	<i>Senna</i> sp. Austin (A. Strid 20210)
Fabaceae	<i>Senna stowardii</i>
Frankeniaceae	<i>Frankenia ?interioris</i>
Frankeniaceae	<i>Frankenia cinerea</i>
Frankeniaceae	<i>Frankenia interioris</i>
Frankeniaceae	<i>Frankenia irregularis</i>
Frankeniaceae	<i>Frankenia pauciflora</i>
Frankeniaceae	<i>Frankenia setosa</i>
Frankeniaceae	<i>Frankenia tetrapetala</i>
Geraniaceae	* <i>Erodium cicutarium</i>
Goodeniaceae	<i>Goodenia havilandii</i>
Goodeniaceae	<i>Scaevola spinescens</i>
Haloragaceae	<i>Haloragis trigonocarpa</i>
Hemerocallidaceae	<i>Dianella revoluta</i>
Lamiaceae	<i>Prostanthera althoferi</i>
Lamiaceae	<i>Prostanthera grylloana</i>
Lamiaceae	* <i>Salvia verbenaca</i>
Lamiaceae	<i>Westringia rigida</i>
Lauraceae	<i>Cassytha ?nodiflora</i>

Family	Species
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>
Loranthaceae	<i>Amyema miquelii</i>
Loranthaceae	<i>Amyema preissii</i>
Malvaceae	<i>Brachychiton gregorii</i>
Malvaceae	<i>Sida spodochroma</i>
Myrtaceae	<i>Eucalyptus campaspe</i>
Myrtaceae	<i>Eucalyptus celastroides</i> subsp. <i>celastroides</i>
Myrtaceae	<i>Eucalyptus clelandiorum</i>
Myrtaceae	<i>Eucalyptus gracilis</i>
Myrtaceae	<i>Eucalyptus griffithsii</i>
Myrtaceae	<i>Eucalyptus hypolaena</i>
Myrtaceae	<i>Eucalyptus longicornis</i>
Myrtaceae	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>
Myrtaceae	<i>Eucalyptus ovularis</i>
Myrtaceae	<i>Eucalyptus salicola</i>
Myrtaceae	<i>Eucalyptus salmonophloia</i>
Myrtaceae	<i>Eucalyptus salubris</i>
Myrtaceae	<i>Eucalyptus torquata</i>
Myrtaceae	<i>Eucalyptus transcontinentalis</i>
Myrtaceae	<i>Melaleuca halmaturorum</i>
Myrtaceae	<i>Melaleuca lateriflora</i>
Myrtaceae	<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>
Oxalidaceae	* <i>Oxalis corniculata</i>
Pittosporaceae	<i>Pittosporum angustifolium</i>
Poaceae	<i>Aristida contorta</i>
Poaceae	<i>Austrostipa blackii</i> (P3 DBCA list)
Poaceae	<i>Austrostipa elegantissima</i>
Poaceae	<i>Austrostipa nitida</i>
Poaceae	<i>Austrostipa scabra</i>
Poaceae	<i>Enneapogon caeruleus</i>
Poaceae	<i>Enteropogon ramosus</i>
Poaceae	<i>Eragrostis dielsii</i>
Poaceae	<i>Eragrostis pergracilis</i>
Poaceae	<i>Paspalidium gracile</i>
Poaceae	<i>Rytidosperma caespitosum</i>
Poaceae	<i>Triodia scariosa</i>

Family	Species
Portulacaceae	<i>Calandrinia ?quartzitica</i>
Portulacaceae	<i>Calandrinia eremaea</i>
Portulacaceae	<i>Calandrinia</i> sp. Gypsum (F. Obbens & L. Hancock FO 10/14)
Primulaceae	* <i>Lysimachia arvensis</i>
Proteaceae	<i>Grevillea ?oncogyne</i>
Proteaceae	<i>Grevillea acuaria</i>
Proteaceae	<i>Grevillea berryana</i>
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>bicolor</i>
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>sarissa</i>
Pteridaceae	<i>Cheilanthes lasiophylla</i>
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>
Rhamnaceae	<i>Cryptandra aridicola</i>
Rhamnaceae	<i>Pomaderris forrestiana</i>
Rhamnaceae	<i>Stenanthemum stipulosum</i>
Rhamnaceae	<i>Trymalium myrtillus</i> subsp. <i>myrtillus</i>
Rubiaceae	<i>Psyrax suaveolens</i>
Santalaceae	<i>Exocarpos aphyllus</i>
Santalaceae	<i>Santalum acuminatum</i>
Santalaceae	<i>Santalum spicatum</i>
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>
Sapindaceae	<i>Dodonaea lobulata</i>
Sapindaceae	<i>Dodonaea viscosa</i>
Scrophulariaceae	<i>Eremophila alternifolia</i>
Scrophulariaceae	<i>Eremophila caperata</i>
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>
Scrophulariaceae	<i>Eremophila dempsteri</i>
Scrophulariaceae	<i>Eremophila gibbosa</i>
Scrophulariaceae	<i>Eremophila glabra</i>
Scrophulariaceae	<i>Eremophila granitica</i>
Scrophulariaceae	<i>Eremophila interstans</i> subsp. <i>interstans</i>
Scrophulariaceae	<i>Eremophila ionantha</i>
Scrophulariaceae	<i>Eremophila longifolia</i>
Scrophulariaceae	<i>Eremophila miniata</i>
Scrophulariaceae	<i>Eremophila oldfieldii</i>
Scrophulariaceae	<i>Eremophila oppositifolia</i>
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>
Scrophulariaceae	<i>Eremophila parvifolia</i>

Family	Species
Scrophulariaceae	<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>
Scrophulariaceae	<i>Eremophila praecox</i> (P1 DBCA list)
Scrophulariaceae	<i>Eremophila pustulata</i>
Scrophulariaceae	<i>Eremophila scoparia</i>
Solanaceae	<i>Lycium australe</i>
Solanaceae	<i>Solanum hoplopetalum</i>
Solanaceae	<i>Solanum lasiophyllum</i>
Solanaceae	<i>Solanum nummularium</i>
Thymelaeaceae	<i>Pimelea microcephala</i>
Zygophyllaceae	<i>Roepera aurantiaca</i>
Zygophyllaceae	<i>Roepera reticulata</i>
Zygophyllaceae	<i>Roepera similis</i>



Appendix F:
Evolution Mining Targeted Flora Search
Calandrinia lefroyensis/quartzitica



15 November 2019

RE: Evolution Mining Targeted Flora Search *Calandrinia lefroyensis/quartzitica*

Steve Halls
Environmental Advisor
Evolution Mining

Dear Steve,

Two records of a *Calandrinia* species identified as *Calandrinia ?lefroyensis/quartzitica* (both Priority 1) were previously collected in a botanical survey of Evolution Mining's (Evolution) Rayjax Mine Haul Road impact area (Phoenix, Feb 2019). Habitat likely to support either of the Priority *Calandrinia* species is known to occur in the footprint and surrounds of Evolution's Rayjax Mine Haul Road Project.

Evolution engaged Spectrum Ecology to complete a Targeted Flora Survey for the two Priority 1 Flora species, *Calandrinia lefroyensis* and *C. quartzitica*. Botanists Carmel Forrester and Tim Hammer conducted the survey from the 6 to 8 November 2019.

Three main populations of the Priority One species *Calandrinia lefroyensis* were recorded in and around the Rayjax Mine Haul Road Project area. Please see the memo report detailing the results of this assessment.

Please contact me if you require any further information in relation to the above.

Yours sincerely,
Carmel Forrester
Botanist

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INTRODUCTION

Scope of works

Evolution Mining is a gold mining company with multiple projects across Australia. The Rayjax and Castle Hill Project Area is a proposed project situated 20-30 km north and west (respectively) of regional towns Coolgardie and Kalgoorlie, in Western Australia, and approximately 530 km east of Perth. The study area is situated in the Coolgardie IBRA region; a large region which forms an interzone between the Mediterranean climate of the south-west and the arid inland of Western Australia (Thackway & Cresswell, 1995).

Spectrum Ecology was commissioned to undertake a Targeted Flora Survey for Priority 1 Flora species, *Calandrinia lefroyensis* and *C. quartzitica* at the Rayjax and Castle Hill Project Area (the Project). The study targets areas in the vicinity of the proposed Open Pits, Tailings Storage Facility (TSF), Haul Roads, and their associated infrastructure. A previous Flora and vegetation survey suggests the presence of either *Calandrinia lefroyensis* or *C. quartzitica* (Phoenix Environmental Sciences, 2019). There was insufficient material collected to confirm which Priority 1 species was present.

The objectives of the Targeted Flora Survey are:

- To verify the presence of Priority 1 Flora species, *Calandrinia lefroyensis* and *C. quartzitica*;
- If present, explore the extent of the populations; and
- Assess the project's potential impact on this species.

Targeted Species

Database searches and previous surveys for the Rayjax Hill to Castle Mine Project Area indicate that the two Priority 1 Flora species, *Calandrinia lefroyensis* and *C. quartzitica*, are known to occur within 100km of the Project Area (see Figure 1). In February a collection identified as either *Calandrinia lefroyensis* or *C. quartzitica* was recorded in the Haul Road footprint from a Flora and Vegetation survey for the project area (Phoenix Environmental Sciences, 2019). There was insufficient material from the collection to identify the specimen.

Calandrinia quartzitica is known from nine records with scattered to “locally common” distribution. These populations occur in the vicinity of Menzies 80 to 215 km north of the Project area. *Calandrinia lefroyensis* is known from five records with occasional to “locally common” distribution. These populations occur in the vicinity of Lake Lefroy 60 to 90 km south of the Project area.

Prior to the field survey, Spectrum's botanists familiarised themselves with both Priority 1 *Calandrinia* species, including the appearance, size, form, diagnostic features, distribution, habitat, phenology, associated species, and associated geology. The botanists also thoroughly read and discussed the journal article defining these two perennial herb species (Obbens, 2018). This journal article contains a taxonomic description to identify *Calandrinia lefroyensis* and *C. quartzitica* and was consulted throughout the field survey.

METHODOLOGY

Survey Timing

The Targeted Flora Survey was conducted by two botanists from the 6 to 8 November 2019, with a third Graduate Environmental Officer assisting on 6 and 7 November (eight person days). Field survey timing was

selected to coincide with the optimal flowering season of *Calandrinia lefroyensis* and *C. quartzitica* as stipulated in Section 3.1.5 of the Threatened and Priority Flora Report Form – Field Manual (DBCA 2017). The flowering time specific to these species is mid-September to mid-November as outlined in the Nuysia journal article by Frank Obbens (2018):

- *Calandrinia lefroyensis*: flowers and fruits from early October to mid-November, but a longer flowering/fruitletting period is possible;
- *Calandrinia quartzitica*: flowering and fruitletting collections have been made from mid-September to mid-October, but the actual flowering/fruitletting period is likely to be longer.

Peak flowering time is subject to rainfall and seasonal variation.

Project Team

Details on the field team for the Targeted Priority Flora survey are included in Table 1.

Table 1: Project Team

Botanist	Qualification	Experience	Licence
Carmel Forrester	BSc.(Sust Dev)	5 years	FB62000134
Tim Hammer	MSc (PhD)	5 years	FB62000124

Species Distribution Modelling

Species distribution modelling (Modelling) was used prior to mobilisation to direct survey efforts. Maxent (Maximum Entropy) v.3.4.1 is a software package used to model species distributions by utilising a machine-learning approach to predict the probability of species occurrence based on a set of environmental parameters and occurrence records (Phillips, Dudík, & Schapire, 2004).

In this assessment, Maxent models were developed for each species using the same geographic extent for *Calandrinia lefroyensis* and *C. quartzitica*. The species occurrence records, obtained from the DBCA Threatened and Priority Flora, and Western Australian Herbarium databases, and environmental variables, based on land system, soil, surface geology, topography and vegetation maps, were used as input for the models. Environmental variables are detailed in Table 2.

Table 2: Environmental Variables used in Modelling

Environmental Variable	Description
Atlas of Australian Soils	Digitalised soil landscapes from Northcote <i>et al.</i> (1960-1968)
Beard Vegetation	Natural vegetation presumed to have existed prior to European arrival
Depth of Regolith	Metres of <i>in situ</i> and transported material overlying unweathered bedrock (CSIRO)
Digital Elevation Model (1 arc)	Height above sea level (US Geological Survey)
Geology (1:1,000,000)	Surface geology map of Western Australia (CSIRO)
Soil Available Water Capacity	Computed plant-available water capacity of the soil at a depth of 0-5 cm (CSIRO)
Soil Bulk Density	Bulk density of the whole soil (including coarse fragments) in mass per unit volume (CSIRO)
Soil Clay (%)	Percentage of clay content of the soil at a depth of 0-5 cm (CSIRO)

Environmental Variable	Description
Soil Cation Exchange Capacity	Effective cation exchange capacity of the soil at a depth of 0-5 cm (CSIRO)
Soil Organic Carbon	Mass fraction of carbon by weight in the less than 2 mm soil material as determined by dry combustion at 900° C (CSIRO)
Soil pH (CaCl ₂)	pH of 1:5 soil/0.01M calcium chloride extract at a depth of 0-5 cm (CSIRO)
Soil Sand (%)	Percentage of sand content of the soil at a depth of 0-5 cm (CSIRO)
Soil Silt (%)	Percentage of silt content of the soil at a depth of 0-5 cm (CSIRO)
Soil Total Nitrogen	Percentage of nitrogen content of the soil at a depth of 0-5 cm (CSIRO)
Soil Total Phosphorus	Percentage of phosphorus content of the soil at a depth of 0-5 cm (CSIRO)

Requirements for Assessment of Priority Flora Populations

The Department of Biodiversity, Conservation and Attractions require location, sighting or collection information to be submitted on a Threatened and Priority Flora Report Form when a population of Conservation Significant flora is recorded. A population is defined as being less than 500 m between individual plants.

The technical guidance for recording Significant Flora is outlined in the Threatened and Priority Flora Report Form – Field Manual (DBCA 2017) and requires recording the following criteria:

- Comment on species presence/absence;
- Land Access Permission granted;
- Description of location including:
 - Photo;
 - Waypoint co-ordinates;
 - Map;
 - Vegetation Description; and
 - Nearest town and directions to get to location without co-ordinates.
- A boundary polygon of the population, where population boundaries are defined by no more than 500 m between plants and not separated by tenure or abiotic feature;
- Area of population in m²; and
- Records of life stages of plants including dead plants.

The target species were searched and recorded in accordance with the DBCA's requirements for assessment of Priority Flora populations (DBCA 2017). The Threatened and Priority Flora Report Form will be submitted to the DBCA Threatened Species & Communities Branch as soon as practicable.

Survey Effort

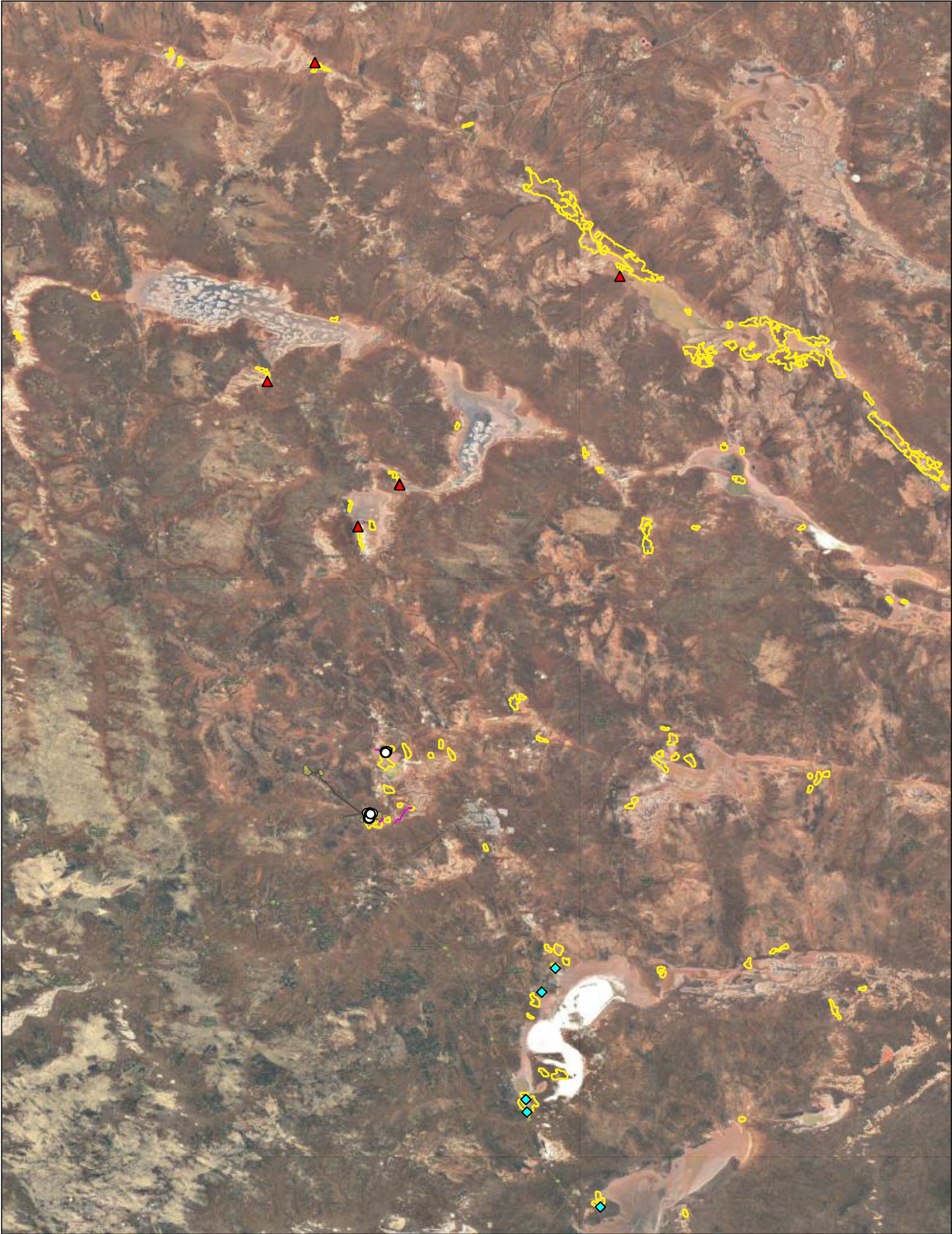
Botanists Carmel Forrester and Tim Hammer with Graduate Environmental Officer, Shannon Wilkes conducted 43 km of transects through habitat likely to contain, *Calandrinia lefroyensis* and *C. quartzitica*, within the vicinity of the project. Existing populations of the target species and the potential habitat are mapped in Figure 1 transects walked are mapped in Figure 1.

Areas defined in the modelling with 0.8 probability of potential habitat occurring were surveyed as the priority and the areas of lesser probability (0.7) were surveyed subsequently. For areas identified as optimal habitat, the botanists walked transects with 50 – 100 m spacing (see Figure 2). Boundaries of selected rocky outcrops or breakaways, adjacent to claypans were traversed.

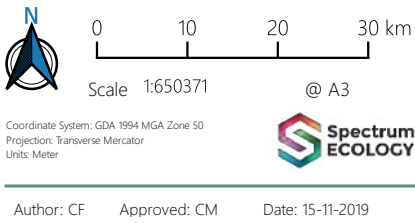
Optimal habitat Areas are defined in Table 3.

Table 3: Habitat Areas Likely to Contain *Calandrinia*

Location	Habitat Comments	Area Traversed	Habitat Probability	Populations Recorded
Area 1	Optimal habitat present. Area traversed.	Yes	0.8	2
Area 2	Area heavily disturbed. Area not traversed.	No	0.8	N/A
Area 3	Sub-optimal habitat. Area not traversed.	No	0.7	N/A
Area 4	Sub-optimal habitat. Area traversed.	Yes	0.7	0
Area 5	Sub-optimal habitat. Area not traversed.	No	0.7	N/A
Area 6	Optimal habitat present. Area traversed.	Yes	0.8	1
Area 7	Optimal habitat present (land access not granted).	No	0.8	N/A



- Legend**
- Potential Habitat (Species Distribution Modelling)
 - Transects Walked (Nov 2019)
 - Calandrinia lefroyensis (From Survey)
- Known Locations (DBCA)**
- Calandrinia lefroyensis
 - Calandrinia quartzitica



Known Locations and Potential Habitat

Calandrinia Targeted Flora Search

Prepared for Evolution Mining



- Legend**
- *Calandrinia lefroyensis* (1-10 plants)
 - Transects Walked (Nov 2019)
 - ▭ Survey Areas (Species Distribution Modelling)



0 0.5 1 1.5 2 km
Scale 1:47500 @ A3

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Author: CF Approved: CM Date: 15-11-2019

**Survey Areas and
Transects Walked**

Calandrinia Targeted Flora Search

Prepared for Evolution Mining

RESULTS & DISCUSSION

Three populations of *Calandrinia lefroyensis* were recorded during the survey totalling 253 individual plants (Figure 4 and Figure 5). No populations of *Calandrinia quartzitica* were recorded.

The showy pink to white flowers highlighted the presence of the plants. Each record of *C. lefroyensis* was found growing up through a low shrub, usually a Samphire or *Frankenia* sp (see Figure 3).

Where the flowers were not present, the basal leaves and stalk of the plant were camouflaged or completely covered by the accompanying shrub, making presence much more difficult to record. For this reason, the recorded numbers in this survey are an estimate of actual population numbers. Seasonal timing is paramount for recording the presence of this species.



Figure 3: *Calandrinia lefroyensis*

The population with the most numbers of individuals (99 plants) was located in Area 1 divided by the Rayjax and Castle Hill Haul Road impact area (**Error! Reference source not found.**). Each population was in good condition with a scattered distribution. These populations are mapped in Figure 4 and Figure 5.



Table 4: Populations of *Calandrinia lefroyensis* Recorded During the Survey

Location	Habitat Comments	Number of Plants	Percentage of Total Found
Area 1 Northern population	1.5 km from Rayjax to Castle Hill Haul Road impact area.	79	31%
Area 1 Southern population	Population boundary 300 m north and south of the Haul Road impact area	99	39%
Area 6	19 km north of Rayjax to Castle Hill Haul Road impact area.	75	30%

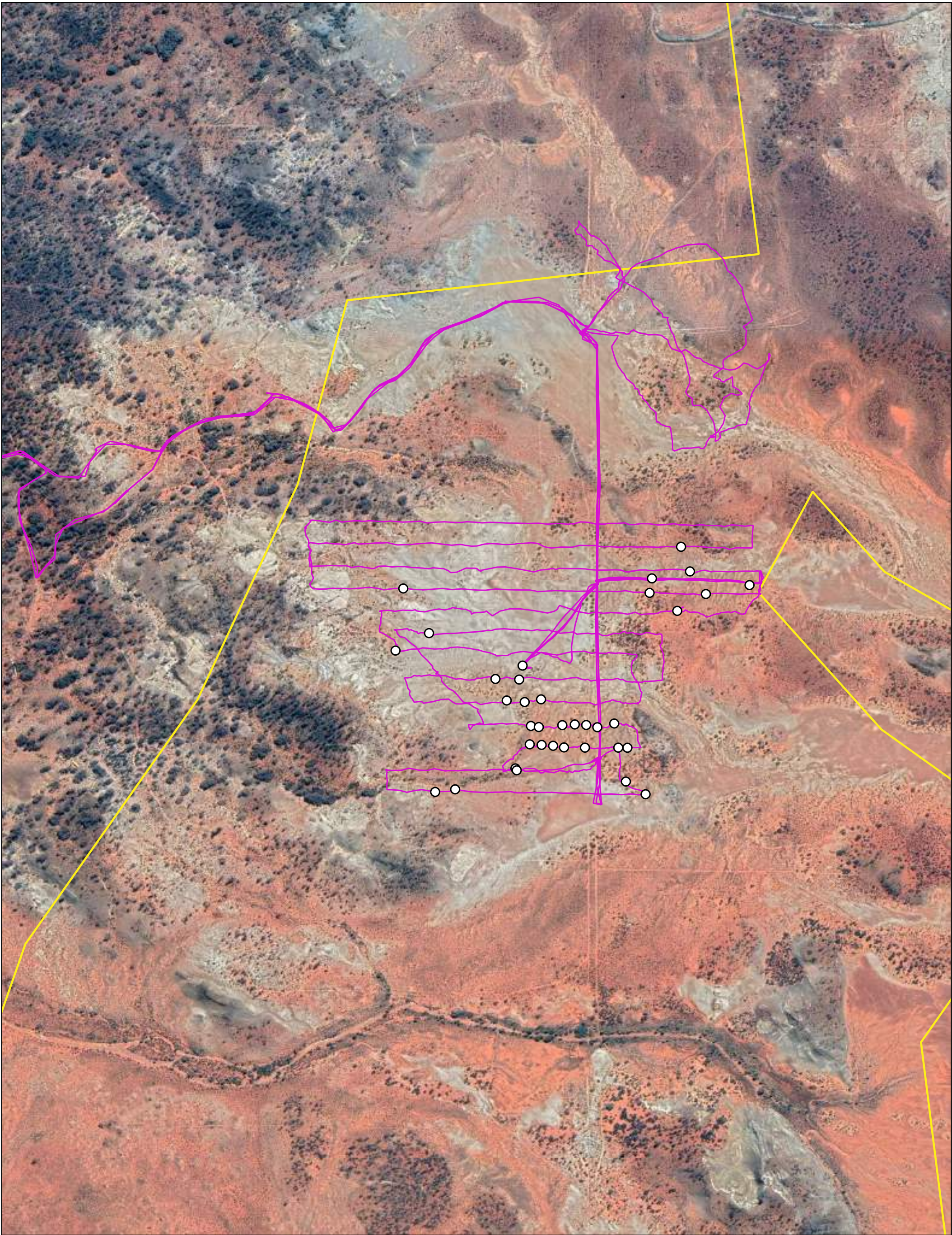
Ten plants from four records were recorded within the Rayjax to Castle Hill Haul Road footprint. This represents 4% of the total number of plants recorded and 10% of the population recorded within 300 m either side of the Haul Road footprint.

The habitat recorded for each area is described in Table 5. This habitat is congruent with habitat described by Obbens (2018) as, "salt-lake flats among samphire communities".

Table 5: Habitat of *Calandrinia lefroyensis*

Location	Rock Type	Soil type	Vegetation description	Photo
Area 1	Foothill slopes. Many Calcrete and Quartz coarse gravel rocks.	Light orange – white sand/clay.	<i>Grevillea sarissa</i> ssp <i>sarissa</i> isolated shrubs over <i>Dodonaea rigida</i> and <i>Frankenia interioris</i> sparse heathland over <i>Tectocornia disarticulate</i> sparse samphire shrubland.	
Area 6	Foothill slopes, saltpan. Many Quartz fine gravel rocks.	White sand/clay	<i>Tecticornia</i> sp. Denny's Crossing sparse samphire shrubland over <i>Maireana glomerifolia</i> and <i>Frankenia setosa</i> isolated clumps of heath shrubs over <i>Disphyma crassifolium</i> subsp. <i>clavellatum</i> herbs.	

Final iterations of Species Distribution Modelling for *C. lefroyensis* including the new locations found during the survey need subsequent reviews and are available upon request. This will indicate potential species habitat for the state and may contextualise the known populations.



- Legend
- Calandrinia lefroyensis (1-10 plants)
 - Transects Walked (Nov 2019)
 - ▭ Survey Areas (Species Distribution Modelling)



0 0.05 0.1 0.15 0.2 km
Scale 1:5000 @ A3

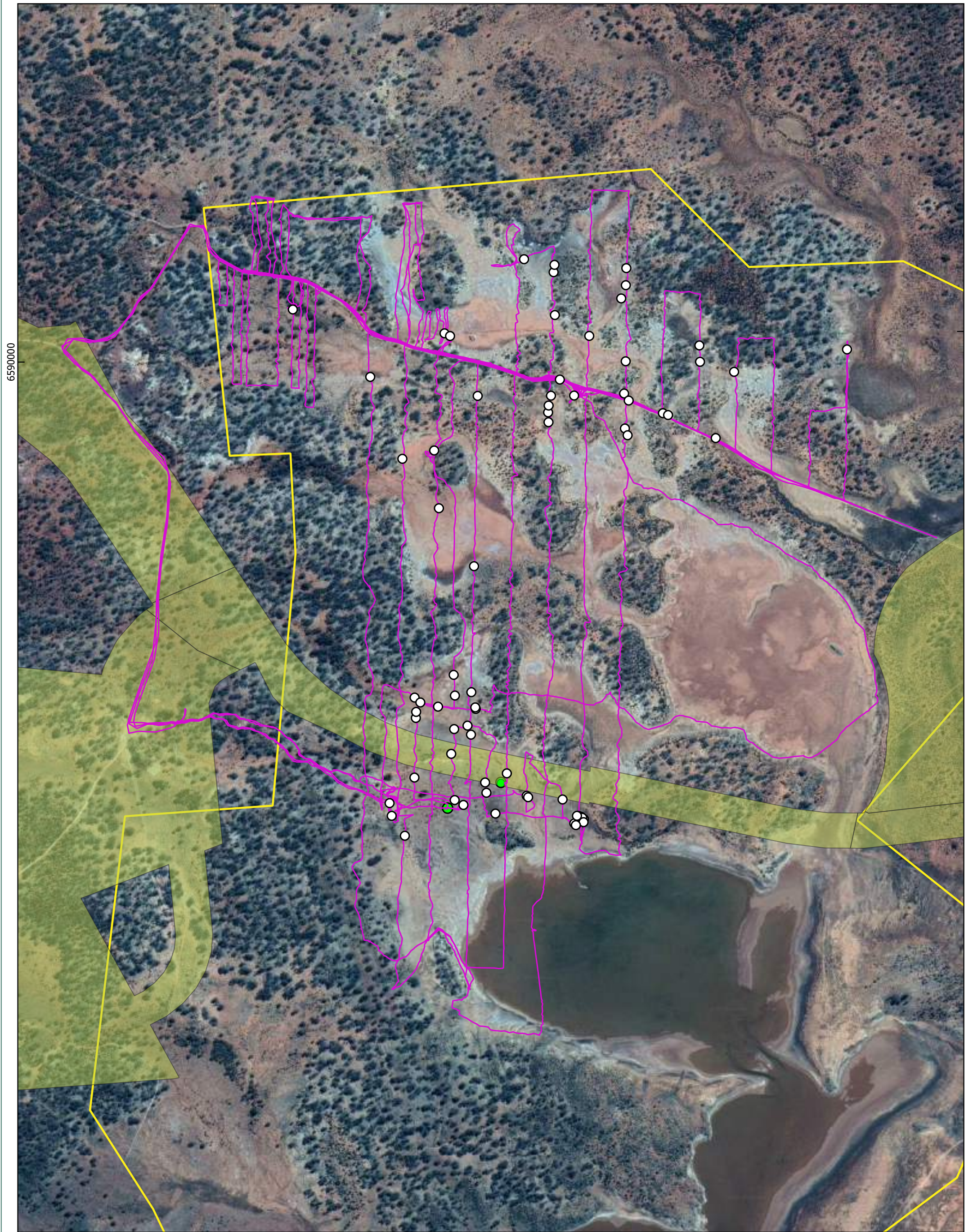
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Author: CF Approved: CM Date: 15-11-2019

Area 6 Calandrinia lefroyensis
Records and Transects

Calandrinia Targeted Flora Search



Prepared for Evolution Mining



Legend

- *Calandrinia lefroyensis* (1-10 plants)
- *Calandrinia* sp? *quartzitica/lefroyensis*
- Transects Walked (Nov 2019)
- Survey Areas (Species Distribution Modelling)
- Rayjax to Castle Hill Haul Road (20190908)




 0 0.1 0.2 0.3 km
 Scale 1:7001 @ A3
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter


Author: CF Approved: CM Date: 15-11-2019

Area 1 *Calandrinia lefroyensis*
Records and Transects

Calandrinia Targeted Flora Search

Prepared for Evolution Mining

LIMITATIONS AND CONSTRAINTS

Table 6: Limitations and Constrains of the Targeted Survey

Limitation	Constraint	Comment
Availability of contextual information at a regional and local scale.	No	Database searches were conducted prior to the survey.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed.	No	The field botanists Carmel Forrester and Tim Hammer have suitable experience conducting botanical surveys in Western Australia.
Proportion of flora recorded and/or collected, any identification issues.	No	Specimens were collected from each of the population locations. All the collections were congruent with <i>Calandrinia lefroyensis</i> and confirmed with <i>Calandrinia</i> expert, Frank Obbens. There were no identification issues for this survey.
Survey effort and extent.	No	Areas of potential habitat were sufficiently searched with transect spacing at either 50 m -100 m. Two new populations of Priority One <i>C. lefroyensis</i> were recorded. The inconclusive Priority flora population of <i>C. lefroyensis/quartzitica</i> was confirmed as <i>C. lefroyensis</i> . Sufficient data for these populations was obtained. The survey effort was optimal.
Access restrictions within the survey area.	No	Habitat Area 5, Area 7 and the southern half of Area 6 were not granted land holder permission to survey. Access granted to the remaining Areas provided sufficient regional data for the survey.
Survey timing, rainfall, season of survey.	No	The field survey was conducted in the first week of November during the optimal flowering time of the targeted species, <i>C. lefroyensis</i> and <i>quartzitica</i> . This is in accordance to the Threatened Priority Flora Report Form – Field Manual and <i>Calandrinia</i> sp. taxonomic journal article (Obbens, 2018). Locating flowering specimens with sufficient material for identification during the survey confirmed accurate seasonal timing.
Disturbance that may have affected the results of survey such as fire, flood or clearing.	No	No disturbances were recorded at the study area that have affected the results of the survey.

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Appendix A: *Calandrinia lefroyensis* Survey Locations



Table 7: *Calandrinia lefroyensis* Locations from November 2019 Survey

Point Name	Plant Count	Latitude	Longitude
Area 1 Records			
CF A101	12	-30.76796402	121.19532
CF A102	1	-30.75471399	121.196869
CF A103	1	-30.75479002	121.197026
CF A104	1	-30.75801797	121.196578
CF A105	5	-30.75964699	121.196712
CF A106	1	-30.75722102	121.199802
CF A107	1	-30.756944	121.199792
CF A108	3	-30.75675096	121.199806
CF A109	1	-30.75647302	121.199872
CF A110	3	-30.754198	121.199982
CF A111	4	-30.75299	121.199947
CF A112	2	-30.75278297	121.199971
CF A113	1	-30.75262397	121.199113
CF A114	1	-30.75739704	121.201957
CF A115	1	-30.75758899	121.202033
CF A116	4	-30.768536	121.20053
CF A117	4	-30.76825898	121.198306
CF A118	1	-30.767672	121.198051
CF A119	1	-30.76738198	121.198015
CF A120	1	-30.76577903	121.197518
CF A121	5	-30.76587601	121.197142
CF A122	3	-30.76657397	121.197059
CF A123	5	-30.76787802	121.197156
CF A124	1	-30.76724301	121.196021
CF A125	1	-30.76556202	121.196061
CF A126	1	-30.76539103	121.19607
CF A127	2	-30.76524301	121.196687
CF A128	2	-30.76530696	121.197751
CF A129	2	-30.7652645	121.1977371

A01 TH01	3	-30.76801599	121.197403
A01 TH02	8	-30.76832302	121.19538
TH A01 03	1	-30.75404202	121.192592
TH A01 04	4	-30.75647897	121.197805
TH A01 05	1	-30.76128197	121.197702
TH A01 06	5	-30.76483497	121.197626
TH A01 07	2	-30.766033	121.197616
TH A01 08	3	-30.76712499	121.198627
TH A01 09	1	-30.75601797	121.200122
TH A01 10	3	-30.756469	121.200525
TH A01 11	3	-30.754787	121.200952
TH A01 12	2	-30.75287601	121.201997
TH A01 13	5	-30.75335696	121.201983
TH A01 14	4	-30.75373004	121.201853
TH A01 15	4	-30.75550298	121.201979
TH A01 16	2	-30.75641099	121.201935
TH A01 17	2	-30.75696697	121.203028
TH A01 18	3	-30.75505598	121.204057
TH A01 19	4	-30.75551698	121.204076
TH A01 20	2	-30.75766903	121.204518
TH A01 21	2	-30.75580004	121.205037
TH A01 22	5	-30.75516804	121.208221
TH A01 23	1	-30.75701902	121.203175
TH A01 24	2	-30.75660998	121.202064
SWA1-14-1	1	-30.76512499	121.196188
SWA1.05-2	2	-30.76833299	121.20067
SWA1.06-1	1	-30.76835001	121.20072
SWA1.06-2	2	-30.76832	121.200629
SWA1.07-1	1	-30.76841497	121.200801
SWA1.07-2	2	-30.768377	121.200755
SWA1.08-1	1	-30.76850097	121.200791
SWA1.09-1	1	-30.76858403	121.200574
SWA1.1-1	1	-30.758253	121.195681

SWA1.10-3	3	-30.76786101	121.200199
SWA1.11-1	1	-30.76775699	121.199187
SWA1.12-1	1	-30.76498702	121.196026
SWA1.12-2	2	-30.76779798	121.199228
Area 6 Records			
CF A601	1	-30.59572304	121.241408
CF A602	2	-30.59462702	121.244503
CF A603	1	-30.59542196	121.238866
CF A604	1	-30.59639904	121.241778
CF A605	1	-30.59645201	121.24145
CF A606	3	-30.596421	121.24109
CF A607	1	-30.59599	121.240865
CF A608	5	-30.59600199	121.24134
CF A609	1	-30.59507302	121.239536
CF A610	1	-30.59693104	121.241575
CF A611	1	-30.596953	121.241733
CF A612	2	-30.59691503	121.242203
CF A613	2	-30.59690103	121.242452
CF A614	1	-30.59691201	121.242681
CF A615	7	-30.59695702	121.242904
CF A616	3	-30.596882	121.243242
CF A617	3	-30.59736698	121.243506
CF A618	5	-30.59736497	121.243323
CF A619	1	-30.59736497	121.242656
CF A620	1	-30.59736103	121.242237
CF A621	1	-30.597328	121.242019
CF A622	3	-30.59730998	121.241789
CF A623	3	-30.597299	121.241551
CF A624	1	-30.59778096	121.241265
TH A06 01	1	-30.593977	121.243996
TH A06 02	3	-30.59383803	121.244757
TH A06 03	2	-30.59334501	121.244579
TH A06 04	3	-30.59417901	121.239021

TH A06 05	5	-30.59426702	121.243949
TH A06 06	2	-30.59428998	121.245076
TH A06 07	1	-30.59411103	121.245949
TH A06 08	1	-30.59804399	121.243475
TH A06 09	1	-30.59829804	121.243869
TH A06 10	1	-30.59819997	121.240059
TH A06 11	2	-30.59825202	121.239659
TH A06 12	2	-30.59781902	121.241291

Appendix G:

Fauna Survey for the Cutters Ridge Project



PHOENIX

ENVIRONMENTAL SCIENCES

Fauna survey for Mungari Gold Operations Cutters Ridge Project

Prepared for Evolution Mining Ltd

February 2019

Draft Report



Fauna survey for the Mungari Operations – Cutters Ridge Project

Prepared for Evolution Mining Ltd

Draft Report

Authors: Ryan Ellis

Reviewer: Karen Crews

Date: 13 February 2019

Submitted to: Kara Postle

Version history			
Name	Task	Version	Date
R. Ellis	Draft for internal review	0.1	6/2/2019
R. Ellis	Draft for client comments	0.2	13/2/2019

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EXECUTIVE SUMMARY

Evolution Mining Ltd (EVO) operates the Mungari Gold Operations (MGO), including the Frog's Leg and White Foil gold projects, located approximately 20 km west of Kalgoorlie. EVO is seeking to develop the Cutters Ridge Project (the Project), located in the vicinity of existing operations.

In September 2018, EVO commissioned Phoenix Environmental Sciences Pty Ltd (Phoenix) to undertake a Level 1 fauna and targeted Malleefowl survey to support environmental approvals for the Project. The study area for the survey was 1,176.5 ha, comprising Cutters Ridge area plus a road corridor between Cutters Ridge and the Mungari Mill (collectively the study area).

The scope of works for the survey was as follows:

- conduct a desktop assessment to define the potential terrestrial fauna values of the study area, including vertebrate fauna and short range endemic (SRE) invertebrate fauna
- complete a combined Level 1 fauna and targeted Malleefowl (*Leipoa ocellata*) field survey
- prepare a comprehensive technical report outlining survey outcomes
- prepare and provide all spatial data collected during the survey.

The desktop assessment for vertebrate fauna identified 22 species of conservation significance potentially occurring in the study area. This included eight species listed as Threatened, Specially Protected or Conservation Dependent under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or State *Biodiversity Conservation Act 2016* (BC Act), 14 listed as Migratory under the EPBC Act and/or BC Act and two listed as Priority fauna by the Department of Biodiversity, Conservation and Attractions (DBCA).

Twelve confirmed and seven potential SRE taxa were identified in the desktop review, and a further 24 taxa of uncertain status (i.e. female or juvenile specimens). Of the 12 confirmed or potential SRE taxa, four are named species (*Austrosuccinea aridicola*, *Jalmenus aridus*, *Missulena harewoodi* and *Ogyris subterrestris petrina*), the remaining are only named to morphospecies codes as applied by the WA Museum until they are formally described. One invertebrate species identified in the desktop review is listed as Threatened under the EPBC and BC Acts (*Ogyris subterrestris petrina*) and one listed as Priority by DBCA (*Jalmenus aridus*).

The field survey was undertaken over nine consecutive days from 2–10 October 2018. The survey included assessment and mapping of broad fauna habitats, active searches for vertebrate and SRE fauna, avifauna surveys, bat echolocation recordings, and litter/soil sieving for SRE fauna and targeted searches for significant taxa, in particular Malleefowl. Thirty-seven terrestrial fauna sites and three bat echolocation call recording sites were surveyed in accordance with relevant Environmental Protection Authority (EPA) guidelines.

Four broad fauna habitats were identified within the study area: open eucalypt woodland, shrubland, chenopod shrubland and salt lake, in addition to a small portion of existing cleared areas. Open eucalypt woodland was the dominant habitat, occupying approximately 80.7% (949.54 ha) of the study area, followed by shrubland habitat (14.3%), with the remaining broad fauna habitats occupying less than 5%. All fauna habitats mapped during the field survey have the potential to support conservation significant species; however, all are well represented within the broader vicinity of the study area and the Coolgardie bioregion.

A total of 75 vertebrate fauna species were recorded during the field survey including 52 birds, 13 reptiles and ten mammals. One conservation significant fauna species was recorded, Malleefowl (*Leipoa ocellata*; Vulnerable EPBC/BC Acts), once from secondary evidence (old disused mound) within

the study area and once from direct observation of an individual within 500 m outside the study area. The open eucalypt woodland and shrubland habitats provide suitable foraging habitat for Malleefowl, but suitable nesting habitat within the study area was sparse and patchy, often occurring in small isolated patches with no connectivity. Suitable nesting habitat was observed in areas outside the study area; nesting is more likely to occur in these areas than in the study area; however, the species may forage in the study area if nesting nearby.

Suitable habitat was recorded for a further 15 conservation significant species within the study area, primarily migratory shorebirds which may utilise the saltlake and chenopod shrubland to forage when inundated following rainfall events.

No SRE invertebrates were collected during the field survey, the lack of which is consistent with the low density of SREs identified in the desktop assessment; however, this may also reflect limited regional collecting effort, or indicate a low likelihood of SREs occurring locally. There is limited presence of suitable SRE habitats in the study area, characterised mainly by open eucalypt woodlands and shrublands which are widespread and homogeneous more broadly outside of the study area. The most potentially prospective SRE habitat within the study area was saltlake habitat and associated chenopod shrubland; however, this habitat represents only a small portion of the study area and sampling of this habitat could not be undertaken during the field survey due to inundation. The hydrological cycle of the saltlake is unknown but it is evidently subject to complete inundation at times, which may render it unfavourable for specialised saltlake SREs, particularly burrowing species.

1 INTRODUCTION

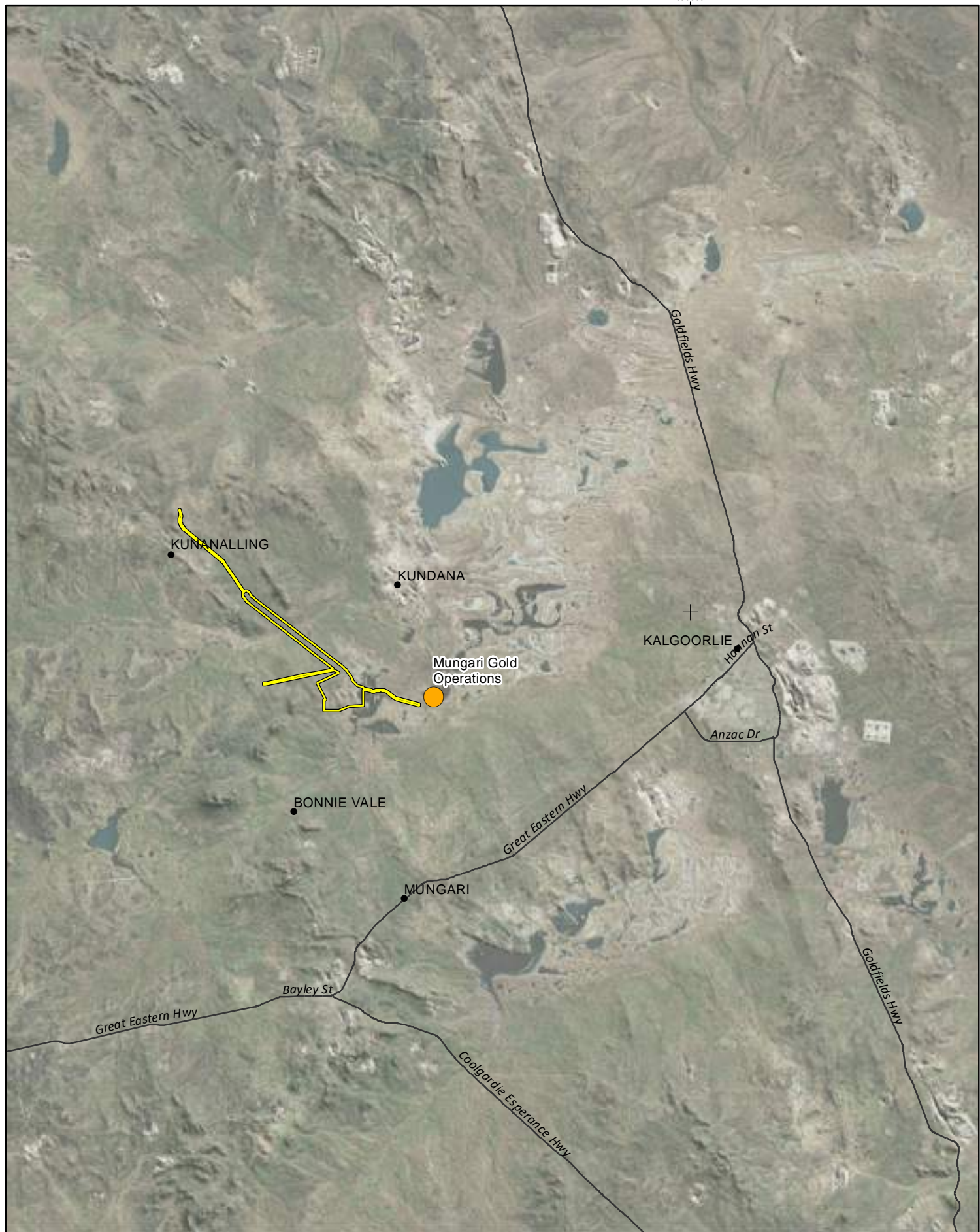
Evolution Mining Ltd (EVO) operates the Mungari Gold Operations (MGO), including the Frog's Leg and White Foil gold projects. MGO is located in the Goldfields region, approximately 20 km west of Kalgoorlie (Figure 1-1).

Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by EVO to undertake a Level 1 fauna survey and targeted Malleefowl survey for the Cutters Ridge Project (the Project), which included the Cutters Ridge mining area and a road corridor between Cutters Ridge and Mungari Mill (near White Foil) covering a total of 1,176.50 ha (collectively the study area), both located within the current MGO area (Figure 1-1).

1.1 SCOPE OF WORK

The scope of works for the Level 1 fauna and targeted Malleefowl survey of the study area was as follows:

- conduct a desktop assessment of relevant existing available fauna information within 40 km of the study area in order to define the key biological values likely to occur and which will require investigation during field surveys
- complete a combined Level 1 fauna and targeted Malleefowl (*Leipoa ocellata*) survey for the study area in accordance with relevant legislation and guidelines
- prepare a comprehensive technical report outlining survey methodologies and outcomes
- prepare and provide all spatial data collected during the survey.



2 LEGISLATIVE CONTEXT

The protection of flora and fauna in Western Australia (WA) is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

The BC Act came into full effect on 1 January 2019 and replaced the functions of the *Wildlife Conservation Act 1950* (WC Act).

2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of the Environment and Energy (DoEE). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a Matter of National Environmental Significance (NES), require approval from the Australian Government Minister for the Environment through a formal referral process. The EPBC Act provides for the listing of Threatened native fauna as matters of NES.

Conservation categories applicable to Threatened Fauna species under the EPBC Act are as follows:

- Extinct (EX)¹ – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent (CD)¹ – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

The EPBC Act is also the enabling legislation for protection of Migratory (Mig.) species as matters of NES under several international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

¹ Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened fauna species in the following categories:

- critically endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future²
- endangered (EN) – species facing a very high risk of extinction in the wild in the near future²
- vulnerable (VU)– species facing a high risk of extinction in the wild in the medium-term future².

Species may also be listed as specially protected under the BC Act in the one or more of the following categories:

- species of special conservation interest – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- migratory species
- cetaceans
- species subject to international agreement
- the category of species otherwise in need of special protection.

The Department of Biodiversity Conservation and Attractions (DBCA) administers the BC Act and also maintains a non-statutory list of Priority fauna. Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority fauna list are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

2.2.1 Critical habitat

Under the BC Act, habitat is eligible for listing as critical habitat if it is critical to the survival of a Threatened species or a Threatened Ecological Community and its listing is otherwise in accordance with the ministerial guidelines. At the time of preparing this report, no listings for critical habitat had been made under the BC Act.

2.2.2 Other significant fauna and fauna habitats

Under the EPA's environmental factor guideline (EPA 2016a), terrestrial fauna may be considered significant for a range of reasons other than listing as a Threatened or Priority species. EPA (2016a) identifies the following attributes that may constitute significant fauna:

- species with restricted distribution

² As determined in accordance with criteria set out in the ministerial guidelines.

- species subject to a degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

Fauna habitats may be significant if they provide habitat important to the life history of a significant species, i.e. breeding, feeding, roosting or congregation areas, or where they are unique or isolated habitats, for example wetlands, in the landscape or region (EPA 2016a).

2.2.3 Short range endemic invertebrates

Short range endemic (SRE) fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km², that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Short range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002), relictual short range endemism – where drying climate has forced range contraction into small pockets with remaining moist conditions (e.g. south-facing rock faces or slopes of mountains or gullies) – and habitat specialist SREs that may have settled in particular isolated habitat types (e.g. rocky or granite outcrops) by means of dispersal and evolved in isolation into distinct species. However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands, mainly in groups with low dispersal capabilities, for example mygalomorph spiders and millipedes. There can be uncertainty in categorising a specimen as SRE due to a number of factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum applies four categories which were adopted in this assessment: confirmed, potential, uncertain and not SRE. Confirmed SREs are taxa for which the distribution is known to be less than 10,000 km², the taxonomy is well known and the group is well represented in collections and/ or via comprehensive sampling (Western Australian Museum 2013). Potential SREs include those taxa for which there is incomplete knowledge of the geographic distribution of the group and its taxonomy, and the group is not well represented in collections.

The EPA’s environmental factor guideline for Terrestrial Fauna (EPA 2016a) identifies species with restricted distributions as being significant fauna in the context of environmental impact assessments (EIA). SRE fauna need to be considered in environmental impact assessments (EIA) as localised, small populations of species that are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa. The likelihood of SRE occurrence therefore needs to be considered early in the environmental scoping stage of any proposal (EPA 2016c).

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The study area is located in the Eastern Goldfields subregion of the Coolgardie bioregion (DSEWPac 2012) which is characterised by (Cowan 2001) as:

- gently undulating plains interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite
- tertiary soils dominated by calcareous earths overlay eroded gneisses and granites
- a series of large playa lakes, including Lake Lefroy, indicate the remnants of an ancient major drainage line in the western half
- vegetation consisting of mallees, *Acacia* thickets and shrub-heaths on sandplains and dwarf shrublands of samphire persisting on salt lakes, surrounded by diverse *Eucalyptus* woodlands, which also occur on ranges and in valleys.
- in the western half, a series of large playa lakes indicate the remnants of ancient major drainage lines
- arid to semi-arid climate with 200–300 mm of mostly summer rainfall.

Rare features within the subregion include highly diverse floristic species and ecosystem diversity, in particular *Eucalyptus* spp., *Acacia* spp. and ephemeral flora communities of the Fraser Range vegetation complex and Woodline Hills and several notable wetlands including freshwater lakes, large salt lakes, claypans, and freshwater swamps such as Rowles Lagoon, Clear and Muddy Lakes and Swan Lake (Cowan 2001).

3.2 LAND SYSTEMS

According to Department of Agriculture and Food Western Australia mapping, three land systems occur in the study area (Figure 3-2):

- **BB5** Rocky ranges and hills of greenstones-basic igneous rocks, representing 218.71 ha (18.53%) of the study area
- **Mx43** Gently undulating valley plains and pediments; some outcrop of basic rock, representing 707.11 ha (59.92%) of the study area
- **SV15** Salt lakes and their associated areas, representing 254.34 ha (21.55%) of the study area.







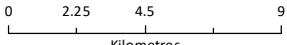

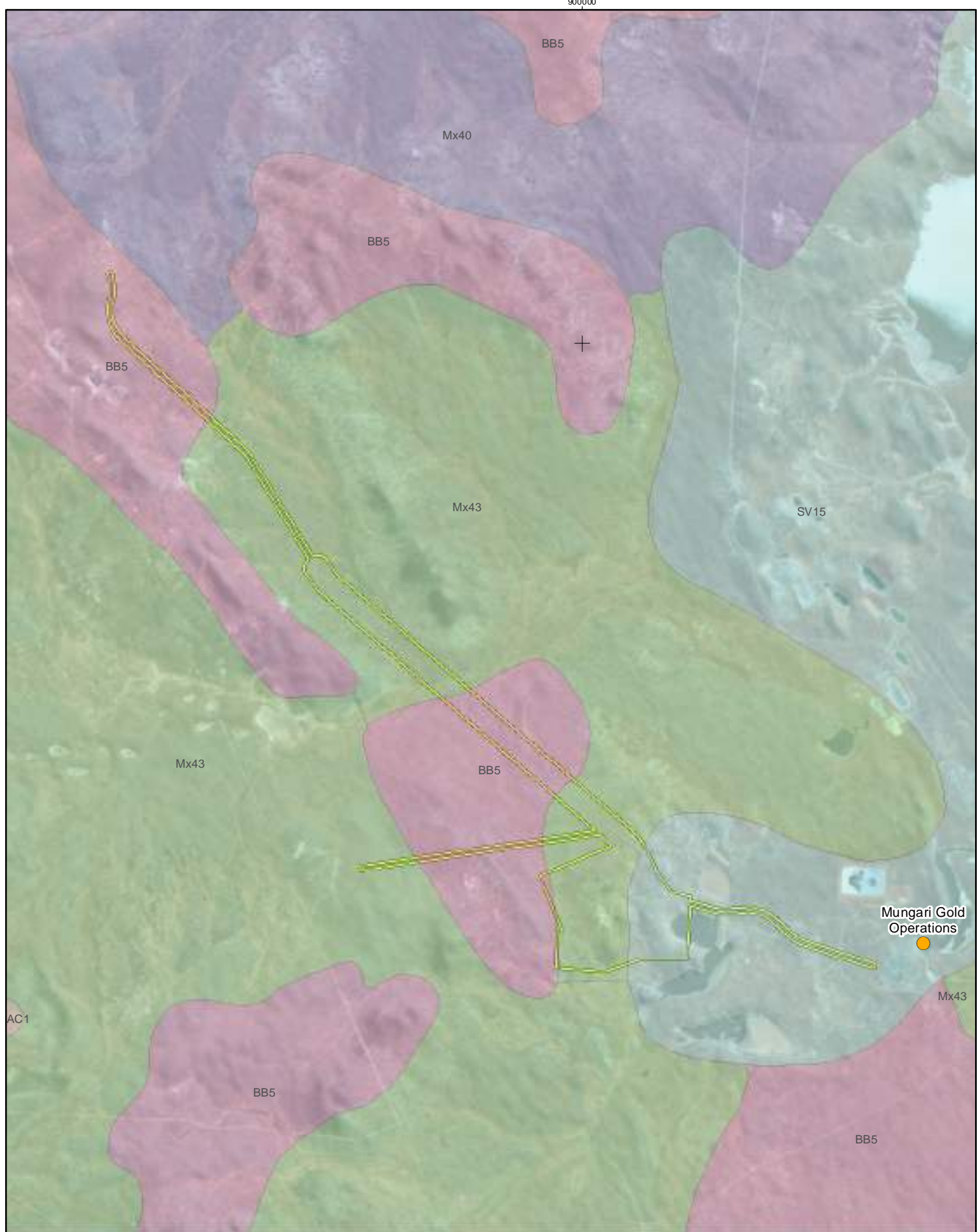
	Evolution Mining Ltd Mungari Operations - Cutters Ridge		
	Project No	1204	
	Date	08-Feb-19	
Drawn by	IH	IBRA bioregion; subregion	 Coolgardie; Eastern Goldfield (COO03)  Murchison; Eastern Murchison (MUR01)
Map author	GW, RE		
			
1:250,000 (at A4)		GDA 1994 MGA Zone 50	
<small>All information within this map is current as of 08-Feb-19. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.</small>			

Figure 3-1
IBRA region of the study area





Evolution Mining Ltd Mungari Operations - Cutters Ridge	
Project No	1204
Date	08-Feb-19
Drawn by	IH
Map author	GW, RE
1:100,000 (at A4) GDA 1994 MGA Zone 50	

	Mungari Gold Operations
	Study area
Land system	
	AC1
	BB5
	Mx40
	Mx43
	SV15

Figure 3-2
Land systems of the study area



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3.3 LAND USE AND CONSERVATION RESERVES

The dominant land use within the Eastern Goldfields subregion is Unallocated Crown Land (UCL) or Crown reserve and grazing-native pasture-leasehold and to a lesser extent conservation reserves and mining tenements (Cowan 2001).

The study area is not situated within any conservation reserves; however, eight reserves or former pastoral leases acquired by the DBCA for conservation occur within 40 km of the study area (Figure 1-1). Of these, the closest is Kurrawang Nature Reserve is, located approximately 12 km southeast of the study area. The former Credo pastoral lease tenement which also encompasses the Rowles Lagoon Conservation Park is located approximately 27 km northwest of the study area. The former pastoral lease was acquired by the DBCA in 2007 and is in the process of being gazetted into the reserves system to be managed for conservation. Several smaller Timber Reserves occur to the east and south of the study area (Figure 1-1).

3.4 CLIMATE AND WEATHER

The Eastern Goldfields subregion has an arid to semi-arid climate with 200–300 mm of annual rainfall which occurs mostly over winter months (Cowan 2001).

The nearest Bureau of Meteorology (BoM) weather station is located at Kalgoorlie-Boulder Airport (Latitude: 30.78°S Longitude: 121.45°E) approximately 20 km east-southeast of the study area. Kalgoorlie-Boulder Airport records the highest maximum mean monthly temperature (33.6°C) in January, the lowest maximum mean annual temperature (16.7°C) in July (BoM 2018) (Figure 3-3). The highest minimum mean monthly temp (18.3°C) is recorded in January with the lowest (5.0°C) recorded in July (BoM 2018) (Figure 3-3). Average annual rainfall is 266.3 mm with January, February and June recording the highest monthly averages (26.8, 30.4 and 27.7 mm respectively) (BoM 2018) (Figure 3-3).

Daily mean temperatures and rainfall for Kalgoorlie-Boulder Airport in the 12 months preceding the survey were comparable to annual long-term averages (Figure 3-3). Mean maximum temperatures were slightly above average for most months, with the exception of April and July – which were considerably higher – and January, February and October which were slightly below average (Figure 3-3). Mean minimum temperatures were slightly above the average in the 12 months preceding the survey (Figure 3-3). Annual rainfall (November 2017 to October 2018) prior to the current survey was above average, with Kalgoorlie-Boulder Airport receiving 274.4 mm of rainfall compared to the long term annual average of 266.9 mm (BoM 2018) (Figure 3-3).

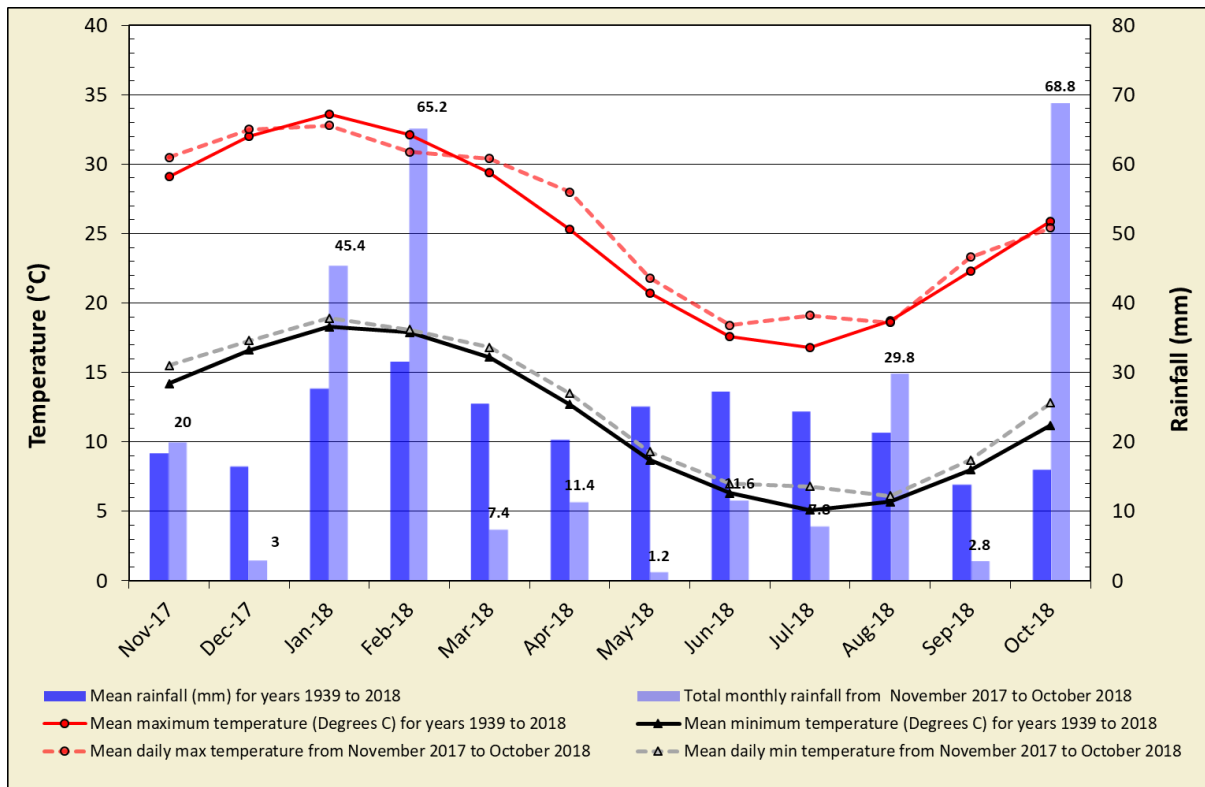


Figure 3-3 Annual climate data and mean monthly data for the 12 months preceding the field survey for Kalgoorlie-Boulder Airport (BoM 2018)

4 METHODS

The biological survey was conducted in accordance with relevant survey guidelines, including:

- *Environmental Factor Guideline: Terrestrial fauna* (EPA 2016a)
- *Technical Guidance: Terrestrial fauna surveys* (EPA 2016d)
- *Technical Guidance: Sampling methods for terrestrial vertebrate fauna* (EPA 2016b)
- *Technical Guidance: Sampling of short range endemic invertebrate fauna* (EPA 2016c).

4.1 DESKTOP ASSESSMENT

Desktop review methods entailed:

- a review of existing environmental information relevant to the biological values of the study area including
 - base environmental datasets to define the physical characteristics of the study area
 - searches of relevant biological databases
 - literature reviews of available technical reports from projects adjacent to the study area, or within the area of the desktop review
- review of existing vegetation mapping
- assessment of 'likelihood of occurrence' of listed species and communities.

Database searches and a literature review were undertaken to identify the significant fauna values that may occur within the study area. The database searches undertaken are detailed in Table 4-1. A literature search was conducted for accessible biological reports of terrestrial fauna surveys conducted within the vicinity of the study area to build on the potential species lists developed from the database searches (

Table 4-2).

Table 4-1 Database searches conducted for the desktop assessment

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (2018a)	EPBC Act Threatened Fauna	Approximate centre point of study area (121.1729°, -30.7654°) with 40 km buffer
DPaW Threatened and Priority Fauna Database (DBCA 2019)	Threatened and Priority fauna	As above.
DPaW NatureMap Database (DBCA 2018a)	Threatened and Priority fauna	As above.
BirdLife Australia BirData Database (Birdlife Australia 2018)	Avifauna	As above.
WA Museum Arachnid and Myriapod Database	Arachnid and Myriapod SREs	100km ² search area encompassing the study area between -30.30°, 120.65° (northwest corner) and -31.30°, 121.65° (southeast corner)
WA Museum Mollusca Database	Mollusc SREs	As above

Table 4-2 Survey reports and datasets incorporated in the desktop assessment

Report author	Survey type	Project
McKenzie & Hall (1992)	Level 2 fauna surveys	Eastern Goldfields Biological Survey
Botanica (2014)	Desktop fauna assessment	Tailings Storage Facility Expansion (KCGM)
Harewood (2015)	Level 2 terrestrial fauna survey	Proposed Tails Storage Facility Expansion (KCGM)
Phoenix (2018a)	Gap analysis, Level 1 terrestrial fauna survey and data consolidation	Fimiston Gold Mine Operations (KCGM)

4.1.1 Likelihood of occurrence assessment

The potential for occurrence in the study area of any significant fauna identified in the database searches was assessed. The assessment was based on reviewed information relating to habitat preference (soils, landforms, elevation and vegetation associations) and locality records from the database searches.

All significant fauna species identified in the database searches were assessed for their potential to occur in the study area based on their known biology and habitat preferences, habitats identified in the study area and records of these species from nearby projects. The likelihood of occurrence for species was then verified during the field survey and re-assessed if required based on field survey data.

The fauna assessments assigned each taxon to one of four ratings:

- recorded – species recorded within the study area by current or previous survey
- likely – study area within known range of species; suitable or optimal habitat occurring within the study area and/or with current and/or previous records in the vicinity of the study area
- possible – within known range of species; suitable habitat present within study area, though not optimal; no records in the vicinity of the study area
- unlikely – outside of the species current known range; no records in the vicinity of the study area and/or no suitable habitat present within the study area. Also includes species considered locally or regionally extinct in relation to the study area due to historic declines.

4.2 FIELD SURVEY

Field work for the terrestrial fauna survey was conducted over nine consecutive days from 2–10 October 2018.

A total of 37 Level 1 sites were surveyed within the study area (Figure 4-1; Table 4-3). Survey methods for terrestrial vertebrates comprised of the following:

- habitat assessment (for details see section 4.2.1)
- active searches (see 4.2.2)
- avifauna surveys (see 4.2.3)

- bat echolocation recordings (see 4.2.4)
- targeted Malleefowl transect surveys (see 4.2.5).

Additional survey methods were employed at each of the Level 1 survey sites targeting SRE invertebrate groups. Collecting methods consisted of two proven, industry-recognised sampling techniques to target SRE taxa consistent with EPA (2016c):

- active foraging (see 4.2.6)
- litter/soil sieving (see 4.2.7).

Dry pitfall trapping is generally used to collect live scorpions by installing a small plastic cup in front of a scorpion burrow. No scorpion burrows were detected during the field survey and therefore this method was not utilised.

Specimens collected were transported to the laboratory and subsequently fixed in absolute ethanol (EtOH) to preserve tissue for future molecular analyses.

4.2.1 Habitat assessment

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Habitats with the potential to support conservation significant terrestrial fauna species were identified based on known habitats of such species within the Coolgardie bioregion. Tentative sites corresponding with flora and vegetation survey quadrats were selected for the terrestrial fauna survey to represent all habitat types. Final survey site selection was conducted after ground-truthing of site characteristics.

At the broadest scale, site selection considered aspect, topography and land systems. At the finer scale, consideration was given to proximity to water bodies (drainage lines and creek), vegetation complexes and condition and soil type. Sites were primarily chosen to represent the best example of distinct habitats within the broader habitat associations of the study area with a focus on species of conservation significance identified in the desktop review. Habitat descriptions and characteristics were recorded at all 37 Level 1 survey sites (Figure 4-1; Appendix 1).

4.2.2 Active searches

Active searches were undertaken at each of the Level 1 survey sites (Figure 4-1; Table 4-3) and primarily targeted diurnal herpetofauna and mammals from direct sightings and secondary evidence. Searches focussed primarily on conservation significant species identified in the desktop review as potentially occurring within the study area.

Searches were undertaken in any observable microhabitats considered likely to support mammals, reptiles and amphibians. Techniques included: raking leaf and bark litter, overturning logs, searching beneath the bark of trees, investigating dead trees and logs, investigating burrows, investigating infrastructure ruins or disused building materials such as tin piles and identifying any secondary evidence including tracks, diggings, scats, fur or sloughs (shed skins), predation or feeding sites, and fauna constructed structures such as pebble mounds or nests. One person hour was spent active searching at each site for a total of 37 hours over the duration of the field survey (Table 4-3).

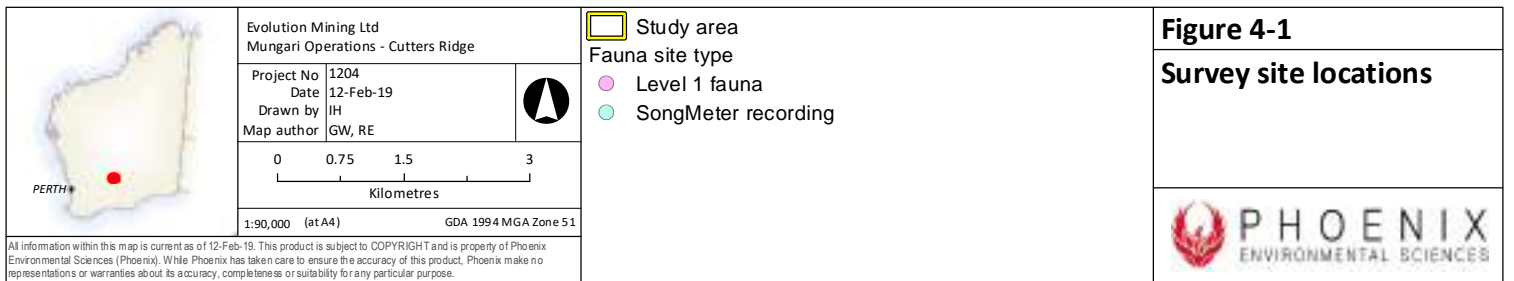
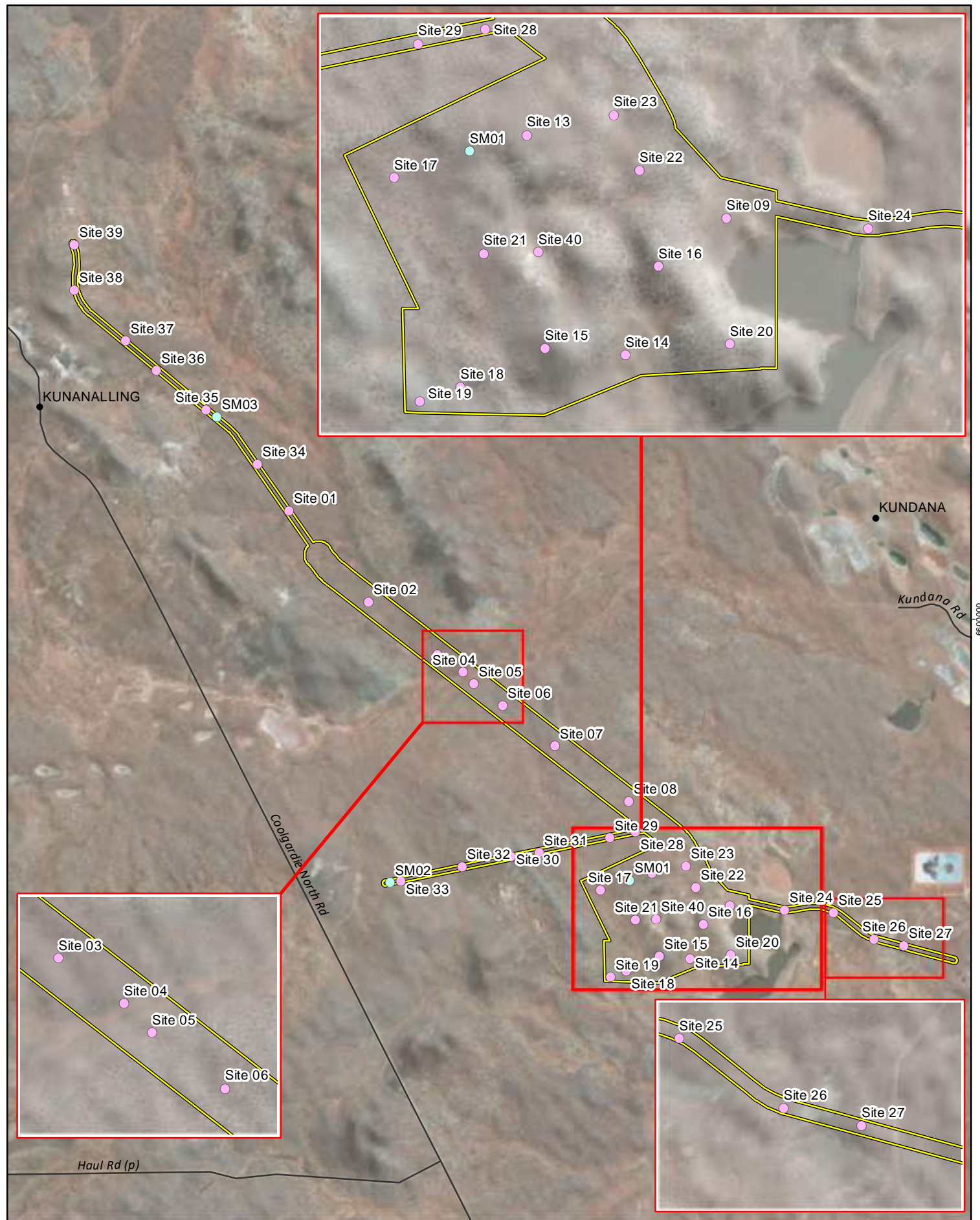


Table 4-3 Terrestrial fauna survey site locations and survey effort

Site	Site type	Latitude	Longitude	Vertebrate fauna			SRE invertebrate fauna	
				Active searches (hr)	Avifauna (min)	SongMeter (night)	Active foraging (hr)	Litter/soil sieves (qty)
Site 01	Level 1 fauna	-30.7012	121.1139	1	20		.5	2
Site 02	Level 1 fauna	-30.7165	121.1288	1	20		.5	3
Site 03	Level 1 fauna	-30.7255	121.1419	1	20		.5	2
Site 04	Level 1 fauna	-30.7285	121.1467	1	20		.5	3
Site 05	Level 1 fauna	-30.7304	121.1488	1	20		.5	2
Site 06	Level 1 fauna	-30.7341	121.1542	1	20		.5	1
Site 07	Level 1 fauna	-30.741	121.1641	1	20		.5	3
Site 08	Level 1 fauna	-30.7504	121.1782	1	20		.5	2
Site 09	Level 1 fauna	-30.768	121.1972	1	20		.5	0
Site 13	Level 1 fauna	-30.7624	121.1824	1	20		.5	3
Site 14	Level 1 fauna	-30.7767	121.1895	1	20		.5	0
Site 15	Level 1 fauna	-30.7762	121.1835	1	20		.5	0
Site 16	Level 1 fauna	-30.771	121.1921	1	20		.5	2
Site 17	Level 1 fauna	-30.765	121.1724	1	20		.5	1
Site 18	Level 1 fauna	-30.7786	121.1771	1	20		.5	0
Site 19	Level 1 fauna	-30.7795	121.1741	1	20		.5	3
Site 20	Level 1 fauna	-30.7761	121.1973	1	20		.5	0
Site 21	Level 1 fauna	-30.77	121.179	1	20		.5	0
Site 22	Level 1 fauna	-30.7648	121.1908	1	20		.5	2
Site 23	Level 1 fauna	-30.7612	121.1889	1	20		.5	0
Site 24	Level 1 fauna	-30.7688	121.2078	1	20		.5	0
Site 25	Level 1 fauna	-30.7693	121.2171	1	20		.5	0
Site 26	Level 1 fauna	-30.7739	121.2248	1	20		.5	0
Site 27	Level 1 fauna	-30.7751	121.2306	1	20		.5	3
Site 28	Level 1 fauna	-30.7555	121.1794	1	20		.5	0
Site 29	Level 1 fauna	-30.7564	121.1744	1	20		.5	3
Site 30	Level 1 fauna	-30.7591	121.1554	1	20		.5	2
Site 31	Level 1 fauna	-30.7587	121.1608	1	20		.5	1
Site 32	Level 1 fauna	-30.7608	121.146	1	20		.5	3
Site 33	Level 1 fauna	-30.763	121.1341	1	20		.5	1
Site 34	Level 1 fauna	-30.6934	121.1079	1	20		.5	3
Site 35	Level 1 fauna	-30.6842	121.0983	1	20		.5	0
Site 36	Level 1 fauna	-30.6776	121.0888	1	20		.5	2
Site 37	Level 1 fauna	-30.6725	121.083	1	20		.5	0
Site 38	Level 1 fauna	-30.664	121.0734	1	20		.5	3
Site 39	Level 1 fauna	-30.6564	121.0735	1	20		.5	2

Site	Site type	Latitude	Longitude	Vertebrate fauna			SRE invertebrate fauna	
				Active searches (hr)	Avifauna (min)	SongMeter (night)	Active foraging (hr)	Litter/soil sieves (qty)
Site 40	Level 1 fauna	-30.77	121.1831	1	20		.5	0
SM01	SongMeter recording	-30.7634	121.1781			1		
SM02	SongMeter recording	-30.7632	121.1321			1		
SM03	SongMeter recording	-30.6855	121.1003			1		
Total				37	740	3	18.5	52

4.2.3 Avifauna surveys

Twenty-minute avifauna surveys were undertaken at each of the Level 1 survey sites (Figure 4-1; Table 4-3). Avifauna surveys were confined to the habitat type (up to 2 ha) represented by each site to collect assemblage data for each habitat. Avifauna surveys were undertaken throughout the day with a focus on periods of higher activity around sunrise and sunset. Surveys consisted of bird recordings from visual sightings and call recognition. A total of approximately 12 person hours of avifauna census was undertaken during the field survey (Table 4-3).

Additional avifauna observations were also recorded at opportunistically while other field work was being completed, including observations made during travel and active searches or during targeted Bilby plot surveys.

4.2.4 Bat echolocation recordings

SongMeter SM2 recording devices were used to record bat echolocation calls at three opportunistic sites during the field survey (Figure 4-1; Table 4-3). Recording devices were deployed at each site for one night of recording for between eight and 12 continuous hours per night. Devices were aimed at a 45° angle to the ground. Areas of habitat likely to have increased insect activity and to attract bats (i.e. likely foraging areas or movement corridors) and potential roosting sites.

4.2.5 Targeted Malleefowl transects

Transect searches for Malleefowl were undertaken throughout the study area. Searches were undertaken across the entire study area to search for any evidence of occurrence including tracks, mounds and/or remains.

Spacing of transects varied depending on suitability of habitat and visibility resulting from changes in the structure and density of vegetation. Broad transect searches were undertaken across the entire study area; where suitable habitat was observed, transect distance was reduced to thoroughly cover areas of suitable habitat. Broad transects ranged between 20–100 m depending on the habitat type and quality for Malleefowl, with broader transects walked in areas of unsuitable or open habitat where visibility was high. Where areas of suitable habitat was observed, narrower transects ranging between 5–25 m were walked depending on visibility of intervening areas. Additional opportunistic searches were also undertaken while moving between sites.

4.2.6 Active foraging for SREs

Active foraging for SRE invertebrate groups comprised inspection of logs, larger plant debris, the underside of bark of larger trees and the underside of rocks. Methodical searches were conducted amongst the leaf litter of shade-bearing tall shrubs and trees, including raking of litter, and spinifex bases were inspected thoroughly. Rocks and rock crevices were inspected, particularly for pseudoscorpions.

A standardised approach was undertaken whereby each site was sampled for 0.5 person hour (concurrently with active searches for vertebrate fauna), a total search effort of approximately 18.5 hours (Table 4-3). Trapdoor spider burrows identified during the searches were excavated if they were considered inhabited. Excavation involved removing soil from around the burrow to carefully expose the burrow chamber and remove the spider.

4.2.7 Litter/soil sieving for SREs

Up to three combined litter/soil sifts were undertaken at each site where sufficient leaf litter was present. At sites with insufficient leaf litter, number of sifts varied from none to three. In total, 52 sifts were undertaken (Table 4-3). The collection of leaf litter samples was standardised volumetrically by the diameter and height (310 mm x 50 mm = 1.55 L) of the sieves which were completely filled with compressed litter and the upper layers of underlying soil. Samples were sieved through three stages of decreasing mesh size over a round tray and invertebrates were picked from the sieves and tray with forceps. These samples particularly targeted small spiders (Araneomorphae), pseudoscorpions, buthid scorpions, millipedes, centipedes (in particular Geophilomorpha and Cryptopidae), smaller species of molluscs (e.g. Pupillidae) and slaters.

4.3 SURVEY PERSONNEL

The personnel involved in the survey are presented (Table 4-4).

Table 4-4 Project team

Name	Qualifications	Role/s
Dr Grant Wells	PhD. (Botany)	Project manager
Mr Ryan Ellis	Dip. (Cons. & Land Mgmt.) BESc. (Wildlife & Cons. Biol.)	Field survey, fauna taxonomy and reporting
Mrs Karen Crews	BSc. (Env. Biol.) (Hons)	Report review
Mr Jarrad Clark	BSc. (Env. Mgmt)	Bat echolocation call analysis
Mr Ian Hay	BAppSc. (Surveying and Mapping)	GIS and spatial data analysis

5 RESULTS

5.1 DESKTOP REVIEW

5.1.1 Vertebrate fauna

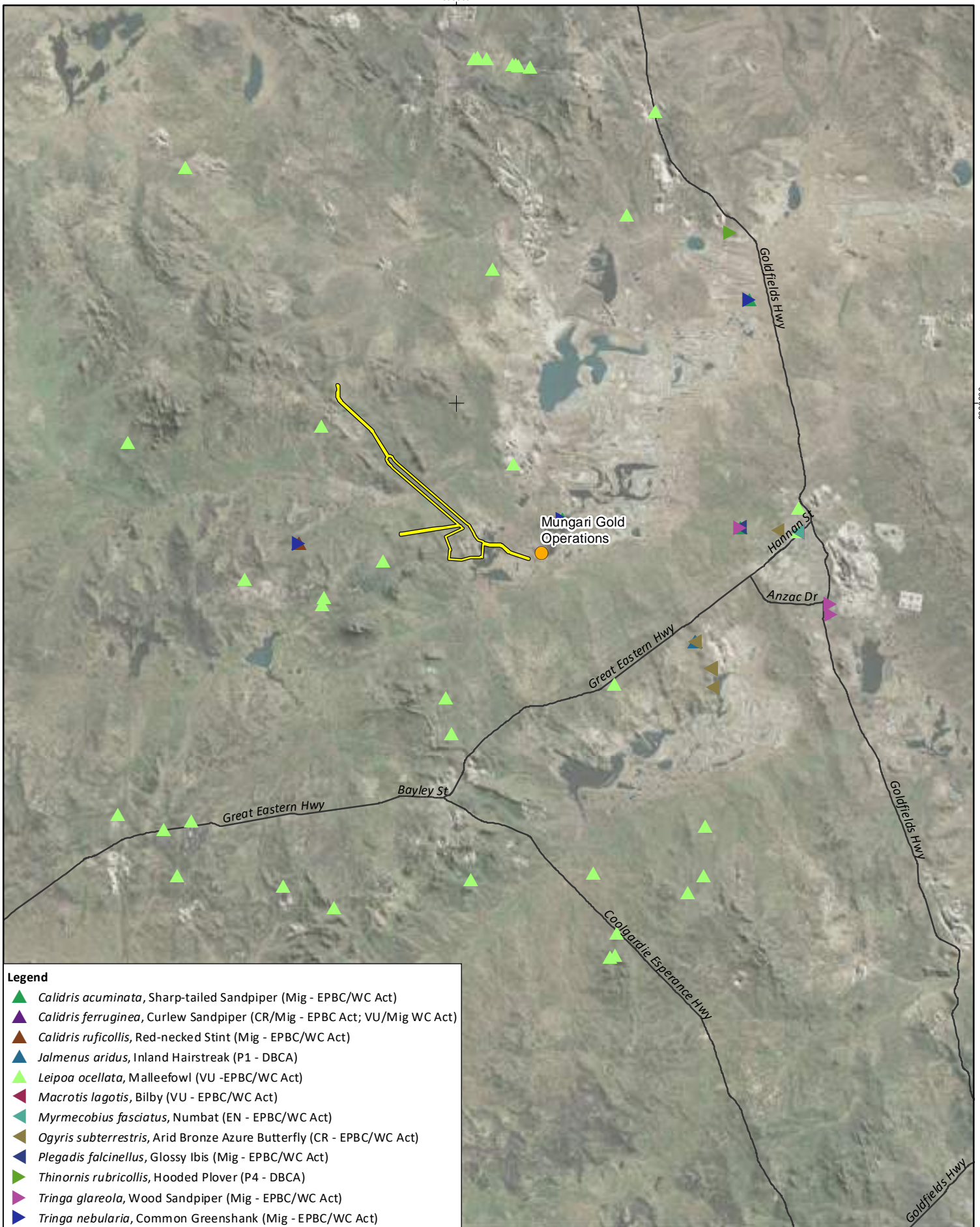
Records for 274 terrestrial vertebrate fauna species and subspecies were identified as potentially occurring within the study area in the desktop review. This comprised six frogs, 72 reptiles (including one introduced species), 158 birds (including three introduced) and 38 mammals (including ten introduced) (Appendix 2).

A total of 22 species of conservation significance were identified in the desktop review, comprising eight species listed under the EPBC Act and/or BC Act as Threatened, Conservation Dependent or Specially Protected (Table 5-1; Figure 5-1). Fourteen species are listed as Migratory under the EPBC Act and BC Act (Table 5-1). A further two species are listed as Priority species by the DBCA (Table 5-1).

Table 5-1 Conservation significant vertebrate fauna species identified in the desktop review

Species	Common name	Conservation status ¹		
		EPBC Act	BC Act	DBCA
Birds				
<i>Apus pacificus</i>	Fork-tailed Swift	Mig.	Mig.	
<i>Thinornis rubricollis</i>	Hooded Plover			P4
<i>Falco peregrinus</i>	Peregrine Falcon		SP	
<i>Glareola maldivarum</i>	Oriental Pratincole	Mig.	Mig.	
<i>Leipoa ocellata</i>	Malleefowl	VU	VU	
<i>Motacilla cinerea</i>	Grey Wagtail	Mig.	Mig.	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	EN	EN	
<i>Pezoporus occidentalis</i>	Night Parrot	EN	CR	
<i>Actitis hypoleucos</i>	Common Sandpiper	Mig.	Mig.	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Mig.	Mig.	
<i>Calidris alba</i>	Sanderling	Mig.	Mig.	
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/Mig.	VU/Mig.	
<i>Calidris melanotos</i>	Pectoral Sandpiper	Mig.	Mig.	
<i>Calidris ruficollis</i>	Red-necked Stint	Mig.	Mig.	
<i>Calidris subminuta</i>	Long-toed Stint	Mig.	Mig.	
<i>Tringa brevipes</i>	Grey-tailed Tattler	Mig.	Mig.	P4
<i>Tringa glareola</i>	Wood Sandpiper	Mig.	Mig.	
<i>Tringa nebularia</i>	Common Greenshank	Mig.	Mig.	
<i>Plegadis falcinellus</i>	Glossy Ibis	Mig.	Mig.	
Mammals				
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU	
<i>Myrmecobius fasciatus</i>	Numbat	EN	EN	
<i>Macrotis lagotis</i>	Bilby	VU	VU	

¹ CR – Critically Endangered; EN – Endangered; VU – Vulnerable; SP – Specially Protected; Mig. – Migratory; P4 – Priority 4.



Evolution Mining Ltd
Mungari Operations - Cutters Ridge

Project No 1204
Date 08-Feb-19
Drawn by JH
Map author GW, RE



0 3.5 7 14
Kilometres

1:400,000 (at A4) GDA 1994 MGA Zone 50

● Mungari Gold Operations
□ Study area

Figure 5-1

**DBCA records of significant
vertebrate fauna**



5.1.2 SRE invertebrate fauna

The desktop review identified records of 12 confirmed SRE taxa and seven potential SRE taxa from the within the SRE desktop search area (Table 5-2; Figure 5-2). A further 24 taxa of uncertain SRE status were identified. None of the records have been collected within the study area and the nearest is a millipede located approximately 12.8 km east-southeast of the study area, *Antichiropus* 'DIP065' (Table 5-2; Figure 5-2).

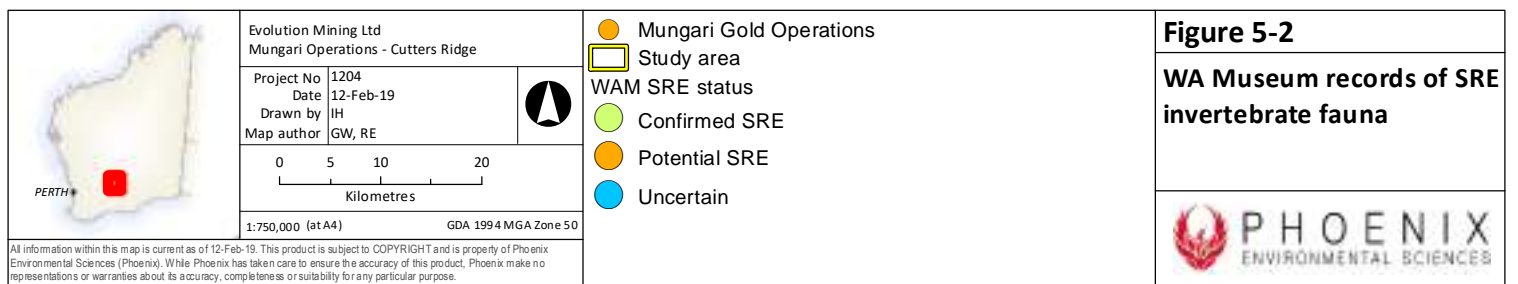
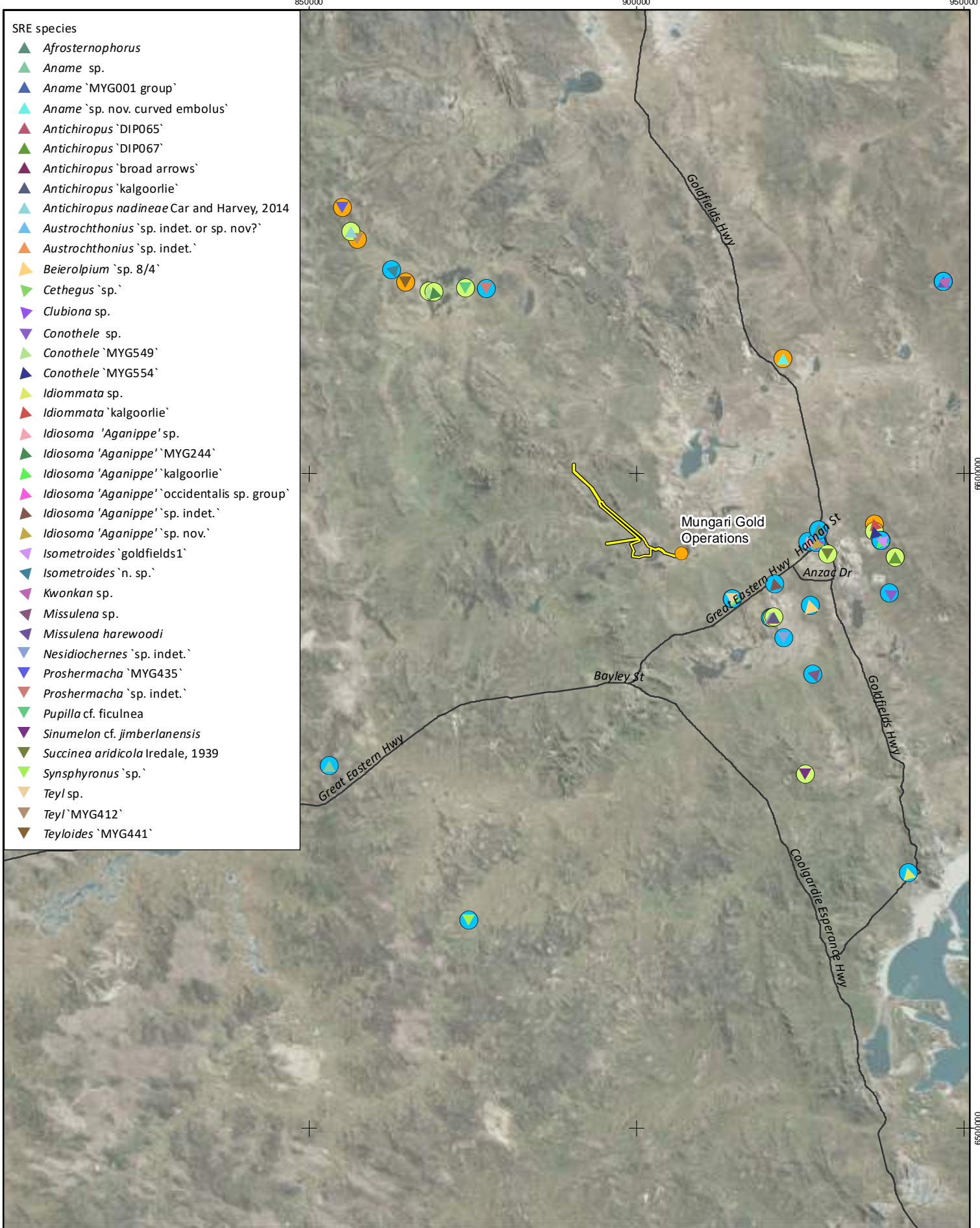
Of the 19 confirmed or potential SRE taxa, only four are named species (*Missulena harewoodi* and *Austrosuccinea aridicola*), while the remaining ten taxa are named only to morphospecies codes as applied by the WA Museum. The majority of taxa records of uncertain SRE status are unidentifiable ("sp. indet.", i.e. female or juvenile specimens) or could not be identified to species or morphospecies, and may represent new species or other species listed in the same genus where records exist (Table 5-2).

Two conservation significant SRE species were returned in the desktop review. The Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*) (EPBC Act, WC Act – CR) has been recorded from around Kalgoorlie until the early 1990s (Field 1999), but is currently only known from Barbalin Nature Reserve in the northern Avon Wheatbelt (Gamblin *et al.* 2009) and therefore a confirmed SRE. The Inland Hairstreak (*Jalmenus aridus*) (DBC – P1), originally described from Lake Douglas, ca. 12 km SW of Kalgoorlie (Graham & Moulds 1988) and is considered a potential SRE. The larvae of *J. aridus* feed on the leaves and flowers of *Senna nemophila* and *Acacia tetragonophylla*. The caterpillars are attended by the ant species *Froggattella kirbii*.

Table 5-2 Confirmed and potential SRE taxa identified in the desktop review from WA Museum records

Family	Species	SRE category
Araneae (spiders)		
Actinopodidae	<i>Missulena harewoodi</i>	Potential
	<i>Missulena</i> sp.	Uncertain
Barychelidae	<i>Idiommatata</i> 'kalgoorlie'	Potential
	<i>Idiommatata</i> sp.	Uncertain
Clubionidae	<i>Clubiona</i> sp.	Uncertain
Ctenizidae	<i>Conothele</i> 'MYG549'	Confirmed
	<i>Conothele</i> 'MYG554'	Confirmed
Dipluridae	<i>Cethegus</i> 'sp.'	Uncertain
Halonoproctidae	<i>Conothele</i> sp.	Uncertain
Idiopidae	<i>Idiosoma</i> 'MYG244'	Confirmed
	<i>Idiosoma</i> 'Aganippe' sp.	Uncertain
	<i>Idiosoma</i> 'Aganippe' 'kalgoorlie'	Uncertain
	<i>Idiosoma</i> 'Aganippe' 'occidentalis sp. group'	Uncertain
	<i>Idiosoma</i> 'Aganippe' 'sp. indet.'	Uncertain
	<i>Idiosoma</i> 'Aganippe' 'sp. nov.'	Uncertain
Nemesiidae	<i>Aname</i> sp.	Uncertain
	<i>Aname</i> 'sp. nov. curved embolus'	Potential
	<i>Aname</i> 'MYG001 group'	Uncertain
	<i>Kwonkan</i> sp.	Uncertain
	<i>Proshermacha</i> 'MYG435'	Potential

Family	Species	SRE category
	<i>Proshermacha</i> `sp. indet.`	Uncertain
	<i>Teyl</i> sp.	Uncertain
	<i>Teyl</i> 'MYG412'	Potential
	<i>Teyloides</i> 'MYG441'	Potential
Diplopoda (millipedes)		
Paradoxosomatidae	<i>Antichiropus</i> 'broad arrows'	Confirmed
	<i>Antichiropus</i> 'DIP065'	Confirmed
	<i>Antichiropus</i> 'DIP067'	Confirmed
	<i>Antichiropus</i> 'kalgoorlie'	Confirmed
	<i>Antichiropus</i> 'sp. indet.'	Uncertain
	<i>Antichiropus nadinae</i> Car & Harvey, 2014	Confirmed
Gastropoda (snails)		
Cameinidae	<i>Sinumelon</i> cf. <i>jimberlanensis</i>	Confirmed
Pupillidae	<i>Pupilla</i> cf. <i>ficulnea</i>	Confirmed
Succineidae	<i>Austrosuccinea aridicola</i> Iredale, 1939	Confirmed
Lepidoptera (butterflies and moths)		
Lycaenidae	<i>Jalmenus aridus</i>	Possible/P1
	<i>Ogyris subterrestris petrina</i>	Confirmed/VU
Pseudoscorpiones (pseudoscorpions)		
Cheliferoidea	<i>Nesidiochernes</i> `sp. indet.`	Uncertain
Chthonioidea	<i>Austrochthonius</i> `sp. indet. or sp. nov?`	Uncertain
	<i>Austrochthonius</i> `sp. indet.`	Uncertain
Garypoidea	<i>Synsphyronus</i> `sp.`	Uncertain
	<i>Beierolpium</i> `sp. 8/4`	Uncertain
Sternophoroidea	<i>Afrosterophorus</i> sp.	Uncertain
Scorpiones (scorpions)		
Buthidae	<i>Isometroides</i> `goldfields1`	Uncertain
	<i>Isometroides</i> `n. sp.`	Uncertain



5.2 FIELD SURVEY

5.2.1 Fauna habitats

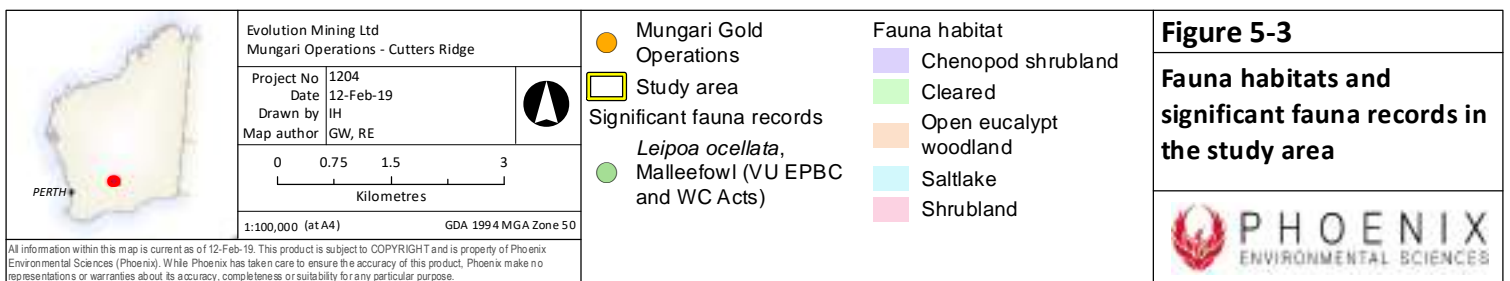
Four broad fauna habitats were identified within the study area, open eucalypt woodland, shrubland, chenopod shrubland and salt lake (Table 5-3; Figure 5-3). Open eucalypt woodland was the dominant habitat, occupying approximately 80.7% (949.54 ha) of the study area, followed by shrubland habitat (14.3 %), with the remaining broad fauna habitats occupying less than 5% of the study area (Table 5-3; Figure 5-3). Distribution of fauna habitats within the study area was variable with scattered larger areas of a single homogeneous habitat type, as well as areas comprising a mosaic of habitats, particularly in the southern and eastern extents (Figure 5-3).

Due to the intermixing of some habitats or gradual transitions from one to the other, fauna habitat boundaries have been mapped broadly, particularly in areas where there was a gradual transition from open eucalypt woodland to shrubland where the intervening area between comprised a mosaic of each.

Table 5-3 Fauna habitat descriptions and extent in the study area

Habitat description	Corresponding vegetation types and mapping units	Fauna sites	Area (ha)	% of study area
Open eucalypt woodland Structure and species diversity often variable, though often comprising of scattered eucalypts to 15 m over mixed large shrubs to 3 m, when present, over mixed small to medium shrubs to 2 m, and occasionally sparse grasses to 0.5 m on clay loam to gravelly clay loam substrate.	EcDIOM, EcEsOm, EgAhOm, ElEaAv, EsEsAb, EtEsOm	01, 02, 04, 06, 07, 08, 13, 16, 17, 18, 19, 20, 21, 22, 23, 27, 28, 29, 30, 32, 34, 35, 36, 37, 38, 39	949.54	80.7%
Shrubland Consisting of a mosaic of differing structures and density, shrubland comprised of mixed shrub species up to 3 m, often dominated by <i>Acacia</i> and/or <i>Casuarina</i> species, with density ranging from open shrubland to scattered sparse areas of dense vegetation with understorey ranging between areas of open to dense medium to tall shrub cover on clay loam to gravelly clay loam substrate.	AbDIPo, CoAtEd, CpEsEd, CsAvDc	03, 05, 15, 25, 26, 31, 33	168.66	14.3%
Chenopod shrubland Dominated by <i>Tecticornia</i> species with height and density variable, though often low (<3 m) and open. Occasionally with scattered isolated individual or small patches of small to medium shrubs on clay loam substrates. Often on low lying plain areas that are inundated following rainfall events. Some areas, particularly close to edges of salt lakes, inundated at time of field survey.	MhTiDc, <i>Tecticornia</i> spp. shrublands (Tp, TuED, Tu, Ts, Ti, Td, TpDcEp, AvDc)	09, 14, 24, 40	35.53	3.3%
Saltlake Salt lake with vegetation largely absent with the exception of individual or small patches of small <i>Tecticornia</i> shrubs, particularly on shorelines where	Lake	—	15.47	1.3%

Habitat description	Corresponding vegetation types and mapping units	Fauna sites	Area (ha)	% of study area
salt lake transitions into chenopod shrubland. Study area intersects only a small portion of the salt lake. Largely inundated following rainfall prior and during the field survey.				
Cleared Existing cleared areas from current and previous operations, i.e. tracks and clearing from previous exploration and mining.	Cleared	–	4.29	0.4%
Total			1,176.50	100%



5.2.2 Vertebrate fauna

A total of 75 terrestrial vertebrate fauna species were recorded during the field survey (Table 5-4; Appendix 2). This represents just over 27% of the species identified as potentially occurring from the desktop review (Table 5-4). Birds were the most diverse class of vertebrates recorded, consistent with the results of the desktop review. Of the 10 mammal species recorded during the field survey, three were introduced species. Three species recorded during the field survey were not returned in the desktop review, one reptile (Marbled Gecko) and two bats (White-striped Free-tailed Bat, South-western Free-tailed Bat).

Table 5-4 Number of vertebrate taxa recorded and potentially occurring in the Project area

Taxa	No. of species recorded during field survey	No. of species potentially occurring from desktop
Amphibians	0	6
Reptiles	13	72 (inc. 1 introduced)
Birds	52	158 (inc. 3 introduced)
Mammals - native	10 (inc. 3 introduced)	38 (inc. 10 introduced)
Total	75	274

The lower number of reptiles and absence of frog records is likely to be attributed to the cooler temperatures experienced during the field survey.

5.2.3 Significant vertebrate fauna

One conservation significant species was recorded during the field survey, Malleefowl (VU). The species was recorded once from secondary evidence (old defunct mound) within the western portion of the study area and once from direct observation of a single individual crossing a track within 500 m of the eastern boundary of the study area (Figure 5-3). Suitable habitat was recorded for a further 15 of the 22 significant species identified in the desktop review, primarily migratory shorebirds that may occur in saltlake and associated fringing samphire shrublands following rainfall events (Table 5-5).

A single Malleefowl mound was recorded within a small and narrow patch of thick tall shrub; however, recent rainfall appeared to have partially flooded the area and washed a large portion of leaf litter out of the patch of thicker shrub vegetation. The mound was in poor condition and showed no apparent signs of recent usage with evidence of disturbance from recent rainfall and surface water movement, and diggings into the mound by other species. The mound also had a large branch that had fallen over it; however, it was not apparent when this may have occurred (i.e. after recent rainfall and storms or naturally from termites) as termites and other signs of decomposition were present in parts of the branch. A number of egg fragments were located in the centre of the mound at a depth of approximately 30–40 cm from the disturbed surface, indicating the mound has been successfully used by the species in the past.

The species was also recorded from a direct observation of an individual crossing a gravel track outside of the study area, between two linear sections of the study area in its western portion. The sighting was in shrubland habitat, approximately 1 km west-northwest of the mound (Figure 5-3).

Suitable foraging habitat for Malleefowl was recorded throughout the majority of the study area, particularly in open woodland and shrubland habitats. Nesting habitat was sparse within the study

area but the species may nest in areas of adjacent suitable habitat, which was observed outside of the study area, and occasionally move into the study area to forage.

Saltlake and associated fringing chenopod shrubland habitat within the study area may provide suitable foraging and possibly roosting habitat for a number of migratory shorebirds and waterbirds identified in the desktop review. Occurrence of these species is most likely to follow rainfall events when habitats are inundated with shallow water which provides foraging habitat for many species.

Peregrine Falcon may occasionally occur to forage within the study area and surrounds due to the species large foraging range. No suitable hollows or other nesting opportunities were observed within the study area during the field survey.

Fork-tailed Swift are likely to forage in the airspace above the study area; however, it is unlikely to land or nest as the species is almost exclusively aerial (DoEE 2018b).

The remaining six significant species identified in the desktop review as potentially occurring in the study area are considered unlikely to occur due to the absence of suitable habitat or, in respect to mammals, are considered regionally extinct in the vicinity of the study area due to historic declines and database records representing historic records (Table 5-5).

5.2.4 SRE invertebrate fauna

No SRE invertebrates were collected during the field survey. Numerous abandoned or damaged mygalomorph spider burrows were located during the field survey; however, only a single burrow excavated contained a specimen, which was identified as a common and widespread species of *Gaius*, *G. villosus*.

Table 5-5 Likelihood of occurrence for conservation significant fauna in the Project area

Species	Common Name	Conservation status			Likelihood of occurrence	Fauna habitats				Summary of records and occurrence	Nearest record (Birdlife Australia 2018; DBCA 2018a, b)
		EPBC Act	WC Act	DBCA		Open eucalypt woodland	Shrubland	Chenopod shrubland	Saltlake		
Birds											
<i>Apus pacificus</i>	Fork-tailed Swift	Mig	Mig		Possible	●	●	●	●	Species forages in variety of habitats including those within the study area; unlikely to land or nest.	>40 km
<i>Thinornis rubricollis</i>	Hooded Plover			P4	Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~32.5 km northeast
<i>Falco peregrinus</i>	Peregrine Falcon		SP		Possible	●	●	●	●	May occasionally occur within study area to forage. Nesting may occur where suitable hollows form or abandoned nests of other raptor species occur.	>40 km
<i>Glareola maldivarum</i>	Oriental Pratincole	Mig	Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km
<i>Leipoa ocellata</i>	Malleefowl	VU	VU		Recorded	●	●			Recorded once from old defunct mound and individual recorded near study area. Likely to occasionally occur to forage throughout the majority of the study area, particularly in shrubland and eucalypt woodland habitats. Nesting may occasionally occur in areas of suitable habitat; however, suitable nesting habitat sparse in the study area	>40 km

Species	Common Name	Conservation status			Likelihood of occurrence	Fauna habitats				Summary of records and occurrence	Nearest record (Birdlife Australia 2018; DBCA 2018a, b)
		EPBC Act	WC Act	DBCA		Open eucalypt woodland	Shrubland	Chenopod shrubland	Saltlake		
										(i.e. rocky substrates or lack of suitable understory cover).	
<i>Motacilla cinerea</i>	Grey Wagtail	Mig	Mig		Unlikely					Suitable habitat not present within study area.	>40 km
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	EN	EN		Unlikely					Study area outside of species current known distribution.	>40 km
<i>Pezoporus occidentalis</i>	Night Parrot	EN	CR		Unlikely					Suitable habitat not present within study area.	>40 km
<i>Actitis hypoleucos</i>	Common Sandpiper	Mig	Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Mig	Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~5 km northeast
<i>Calidris alba</i>	Sanderling	Mig	Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/Mig	VU/Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~9.5 km west
<i>Calidris melanotos</i>	Pectoral Sandpiper	Mig	Mig		Possible			●	●	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km

Species	Common Name	Conservation status			Likelihood of occurrence	Fauna habitats				Summary of records and occurrence	Nearest record (Birdlife Australia 2018; DBCA 2018a, b)
		EPBC Act	WC Act	DBCA		Open eucalypt woodland	Shrubland	Chenopod shrubland	Saltlake		
<i>Calidris ruficollis</i>	Red-necked Stint	Mig	Mig		Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~10 km west
<i>Calidris subminuta</i>	Long-toed Stint	Mig	Mig		Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km
<i>Tringa brevipes</i>	Grey-tailed Tattler	Mig	Mig	P4	Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	>40 km
<i>Tringa glareola</i>	Wood Sandpiper	Mig	Mig		Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~20 km east
<i>Tringa nebularia</i>	Common Greenshank	Mig	Mig		Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~4.8 km northeast
<i>Plegadis falcinellus</i>	Glossy Ibis	Mig	Mig		Possible			•	•	May occur in saltlake and chenopod shrubland to forage, particularly when inundated following rainfall events.	~20 km east
Mammals											
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU		Unlikely					Study area outside of species current known distribution. Considered regionally extinct in the vicinity of the study area (Burbidge 2004; Van Dyck & Strahan 2008).	>40 km

Species	Common Name	Conservation status			Likelihood of occurrence	Fauna habitats				Summary of records and occurrence	Nearest record (Birdlife Australia 2018; DBCA 2018a, b)
		EPBC Act	WC Act	DBCA		Open eucalypt woodland	Shrubland	Chenopod shrubland	Saltlake		
<i>Myrmecobius fasciatus</i>	Numbat	EN	EN		Unlikely					Study area outside of species current known distribution. Considered regionally extinct in the vicinity of the study area (Burbidge 2004; Van Dyck & Strahan 2008)	~2.6 km southeast (historic)
<i>Macrotis lagotis</i>	Bilby	VU	VU		Unlikely					Study area outside of species current known distribution. Considered regionally extinct in the vicinity of the study area (Burbidge 2004; Van Dyck & Strahan 2008).	~25.5 km east (historic)

¹ CR – Critically Endangered; EN – Endangered; VU – Vulnerable; SP – Specially Protected; Mig – Migratory; P2–P4 – Priority 2–4.

5.3 SURVEY LIMITATIONS

The limitations of the survey have been considered (Table 5-6) in accordance with EPA technical guidance (EPA 2016c, d).

Table 5-6 Survey limitations

Limitations	Limitation for this survey?	Comments
Competency/experience of survey personnel, including taxonomy	No	The field personnel and report author have extensive experience in terrestrial fauna surveys within the region and across WA.
Scope and completeness	No	All target groups, significant species and habitats within the study area were surveyed in accordance with the scope of work.
Intensity / effort and extent	No	The survey intensity was appropriate for the areas that were surveyed and significant species targeted.
Proportion of fauna identified, recorded and/or collected	No	All fauna was identified to species level in the field with the exception of analysis of bat echolocation call recordings which were analysed on return to Perth.
Availability of adequate contextual information	No	Numerous surveys have previously been undertaken within the broader vicinity of the study area to provide contextual information for the Project.
Timing, weather, season, cycle	No	Weather preceding and during the survey was comparable to annual averages for previous years. Above average rainfall was recorded in the month preceeding the survey.
Disturbances which affected the results of the survey	Partial	No disturbances occurred during the field survey which are considered to have impacted the overall results for vertebrate fauna. Heavy rainfall prior to and during the survey may have affected the number of taxa recorded and hindered the collection of SRE invertebrate taxa, particularly in saltlake and associated riparian habitats which were inundated.
Remoteness and/or access problems	No	All areas of the study area were accessible by vehicle or on foot.

6 DISCUSSION

In assessing development proposals, the EPA has the objective for the factor Terrestrial Fauna is its protection so that biological diversity and ecological integrity are maintained (EPA 2016a). Considerations for terrestrial fauna in environmental impact assessment (EIA) at the State level include significance of values present, current state of knowledge of those values, potential impacts and the scale at which the impacts are assessed (EPA 2016a). At the Federal level, the Commonwealth publishes guidelines on assessing significance of impacts to matters of NES (Department of the Environment 2013). Accordingly, the aim of this assessment was to determine the conservation significant (i.e. EPBC Act and BC Act listed) terrestrial fauna present or likely to be present within the study area to enable impact assessment, identification of opportunities to apply the EPA mitigation hierarchy (avoidance < minimization < rectification) and management actions to be identified.

6.1 VERTEBRATE FAUNA

Four broad fauna habitats were identified within the study area during the field survey, open eucalypt woodland, shrubland, chenopod shrubland and saltlake, with open eucalypt woodland occupying approximately 80.7% (949.54 ha) of the study area (Table 5-3). All fauna habitats mapped within the study area were considered to be broad habitats well represented in the wider vicinity and more broadly across parts of the the Eastern Goldfields subregion.

In accordance with EPA (2016a), fauna habitats may be significant if they provide habitat important to the life history of a significant species or are unique or isolated habitats in a landscape (see section 2.2.2). All four habitats of the study area have the potential to support significant fauna species to varying extents but do not necessarily meet these significance criteria. Up to 16 significant vertebrate fauna species were considered to have potential to occur in the study area based on habitat suitability, proximity of desktop records and current distributions.

The open eucalypt woodland and shrubland habitats provide foraging habitat value for Malleefowl (VU), the only recorded conservation significant species from the survey. Suitable nesting habitat within the study area was sparse and patchy, often occurring in small isolated patches with no connectivity. Numerous patches of suitable nesting habitat were observed in areas outside the study area; nesting is more likely to occur in these areas than in the study area; however, the species may forage in the study area if nesting nearby. Therefore, the eucalypt woodland and shrubland habitats of the study area may be significant habitat for Malleefowl if the species is found to be nesting in the vicinity and utilising the study area as important foraging habitat.

The saltlake and associated chenopod shrubland habitats may provide feeding habitat for the 12 migratory shorebirds identified in the desktop review (Oriental Pratincole, Common Sandpiper, Sharp-tailed Sandpiper, Sanderling, Curlew Sandpiper, Pectoral Sandpiper, Red-necked Stint, Long-toed Stint, Grey-tailed Tattler, Grey-tailed Tattler, Common Greenshank and Glossy Ibis) and the Hooded Plover (P4) intermittently during inundation events, although none were observed during the survey when the lake and part of the adjacent chenopod shrublands were inundated. Only a small extent of the saltlake is present in the study area and this lake is part of a series of regional saltlakes that include the 33 km² White Flag Lake, 13 km to the north. Similar feeding habitat is likely to be extensive within this lake system during inundation events.

Roosting habitat within the chenopod shrublands bordering the saltlake is limited in the study area and the lake is probably too small to accommodate migratory shorebirds in nationally significant numbers as defined by DEWHA (2009). Taking the extent of the regional lake system into account relative and the limited roosting habitat present in the study area, the saltlake and chenopod

shrublands of the study area are considered unlikely to represent significant habitat for migratory shorebirds but they may utilise these habitats.

The two remaining significant species that were considered to possibly occur within the study area, Peregrine Falcon (SP) and Fork-tailed Swift (Mig), inhabit a broad range of habitats and may occur only occasionally to forage in the study area. No suitable hollows or other nesting opportunities for Peregrine Falcon were observed within the study area during the field survey. Therefore the habitats of the study area are not considered significant habitats for these species.

The remaining six significant species identified in the desktop review were considered unlikely to occur in the study area due to the absence of suitable habitat or, in respect to mammals, are regionally extinct in the vicinity of the study area due to historic declines and database records representing historic records (Table 5-5).

6.2 SRE INVERTEBRATE FAUNA

Only a single mygalomorph burrow containing a specimen was excavated during the field survey, which was identified as a non-SRE species. Numerous abandoned or damaged burrows were observed during the field survey which failed to yield specimens where excavation was attempted.

The lack of SRE invertebrates detected during the survey reflects limited presence of suitable SRE habitats in the study area. Specialist habitats in the Goldfields and neighbouring regions known to harbour SREs include salt lakes including their riparian zone (e.g. Framenau & Hudson 2017; López-López *et al.* 2016; Phoenix 2017), drainage lines (e.g. Phoenix 2012), rocky outcrops and dense woodlands (e.g. Car & Harvey 2014). In contrast, the study area is characterised mainly by open eucalypt woodlands and shrublands which are considered less conducive for the evolution of short range endemism (see section 2.2.3), although diversity and endemism in invertebrates of the Goldfields woodlands has been highlighted in several recent studies on particular groups, e.g. Idiopidae trapdoor spiders, *Antichiropus* millipedes and Bothriembryon snails (several publications in Framenau & Harms 2017).

The most potentially prospective SRE habitat in the study area was the saltlake habitat and associated chenopod shrubland. Several salt lake specialists that burrow into the lake playa or inhabit the fringing riparian vegetation, include species with restricted distributions (e.g. some tiger beetles, wolf spiders in the genus *Tetrallycosa*), in some cases from single salt lakes including Lake Lefroy (Framenau & Hudson 2017; Hudson & Adams 1996; Kamoun & Hogenhout 1996; Pearson & Vogler 2001; Phoenix 2018b).

Widespread sampling of the saltlake habitat was not possible during the survey due to inundation following rainfall preceeding and during the field survey. Significant wet periods may pose a problem for salt lake terrestrial fauna which are in danger of drowning or are pushed to the narrow edge of the lake and subject to predatory pressure (Framenau & Hudson 2017). The hydrological cycle of the saltlake is unknown but it is evidently subject to complete inundation, it may be unfavourable for burrowing SREs. In the event that conditions were favourable for saltlake specialists, the extent of saltlake, as well as the fringing chenopod shrubland habitat in the study area represent only a small portion of this lake, and it is therefore unlikely that any SRE taxa would be restricted to the study area.

The lack of any SRE records from the field survey is consistent with the poor density of SREs from the desktop review, which only returned 12 confirmed SRE taxa and seven potential (Table 5-2). Although this may also reflect an overall low regional collecting effort, it also suggests a low likelihood of SREs to occur locally, most likely due to the widespread and homogeneous habitats such as open eucalypt woodland which largely dominate the study area.

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Appendix 1 Fauna survey site descriptions

Site: 001 (Fauna site) (-30.701213, 121.113942)

Habitat description: Open eucalypt woodland on plain with scattered eucalypts to 10 m and clumps of mallee eucalypts to 6 m over sparse understory with scattered small to medium shrubs to 1.5 m on clay loam substrate with gravelly surface.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), vehicle tracks



Site: 002 (Fauna site) (-30.716537, 121.128832)

Habitat description: Open eucalypt woodland with scattered eucalypts to 12 m and small mallee patches to 8 m over sparse open understory of sparsely scattered medium to large shrubs to 2.5 m over scattered small shrubs to 1.5 m on clay loam substrate with gravelly surface.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: 003 (Fauna site) (-30.725488, 121.141873)

Habitat description: Open shrubland on plain with sparsely scattered eucalypts to 12 m over scattered *Casuarina* to 6 m over mixed open shrub understory with scattered patches of small to medium shrubs to 1.5 m on clay loam substrate with gravelly surface.

Habitat type: shrubland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: 004 (Fauna site) (-30.728455, 121.146702)

Habitat description: Narrow strip eucalypt woodland with tree eucalypts to 10 m and mallee eucalypts to 8 m over patchy open and dense understory of tall shrubs to 3 m over sparse cover of small shrubs to 1 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks



Site: 005 (Fauna site) (-30.730389, 121.14879)

Habitat description: Shrubland on plain with scattered *Casuarina* to 8 m over patchy open and dense understory with tall shrubs to 3 m over medium shrubs to 2 m with sparse small shrub understory on clay loam substrate. Understory patchy with some very dense areas along main track, though largely open throughout the area.

Habitat type: shrubland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: 006 (Fauna site) (-30.734118, 121.154193)

Habitat description: Open woodland with scattered tree eucalypts to 12 m and mallee eucalypts to 8 m over open shrub understory with medium shrubs to 1.5 m over scattered small shrubs to 1 m and hummock grasses to .5 m on sandy clay substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: sandy clay

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: 007 (Fauna site) (-30.740964, 121.164107)

Habitat description: Open eucalypt woodland on plain with scattered eucalypts to 12 m over sparse understory of sparsely scattered medium to large shrubs to 3 m over scattered small shrubs to 1 m on sandy clay substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: sandy clay

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks



Site: 008 (Fauna site) (-30.750417, 121.178174)

Habitat description: Open woodland with scattered mallee eucalypts to 8 m over scattered patches of tall shrubs to 3 m over scattered small shrubs to 1.5 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks



Site: 009 (Fauna site) (-30.767994, 121.197215)

Habitat description: *Tecticornia* shrubland on shore of saltlake with sparsely scattered casuarinas to 6 m over sparsely scattered medium shrubs to 2 m over sparsely scattered low *Tecticornia* shrubs to .5 m on clay loam substrate with gravelly surface.

Habitat type: chenopod shrubland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: quartz;

Fire age: >5 years

Disturbance: none



Site: 010 (Fauna site) (-30.755893, 121.23421)

Habitat description: Open eucalypt woodland on plain with scattered tree and mallee eucalypts to 12 and 8 m over patchy shrub understory with scattered small to medium shrubs to 2.5 m on clay loam substrate. Scattered areas of sparse open shrub understory and dense in patches.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), livestock tracks, vehicle tracks



Site: 011 (Fauna site) (-30.757355, 121.241078)

Habitat description: Open eucalypt woodland with scattered tree and mallee eucalypts to 10 m over open shrub understory with sparsely scattered medium shrubs to 2.5 m over patchy small shrubs to 1.5 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), vehicle tracks



Site: 012 (Fauna site) (-30.761358, 121.244025)

Habitat description: Open eucalypt woodland with large existing and current cleared areas for exploration activities with sparsely scattered eucalypts to 12 m over sparse patchy understory of small regrowth shrubs to 1 m on disturbed clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: current operations, exploration (drill pads and access tracks), vehicle tracks



Site: 013 (Fauna site) (-30.762379, 121.182392)

Habitat description: Open eucalypt woodland with scattered eucalypts to 10 m over sparsely scattered patches of medium to large shrubs to 3 m over scattered small shrubs to 1 m and hummock grasses to .5 m on gravelly clay loam substrate.

Habitat type: open woodland

Topography: undulating plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 014 (Fauna site) (-30.776723, 121.189511)

Habitat description: Low open *Tecticornia* shrubland with sparsely scattered medium shrubs to 2 m over low open *Tecticornia* shrub cover with mixed species to .5 m on clay loam substrate with gravelly surface.

Habitat type: chenopod shrubland

Topography: salt lake (playa)

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: 015 (Fauna site) (-30.776229, 121.183472)

Habitat description: Shrubland on stony hill with scattered medium to large shrubs to 3 m over scattered small shrubs to 1.5 m and herbs to .3 m on stony clay loam substrate. Vegetation patchy with areas of sparse vegetation and scattered clusters of vegetation.

Habitat type: shrubland

Topography: hill slope

Slope: moderate

Soil: clay loam, rocks

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), vehicle tracks



Site: 016 (Fauna site) (-30.771042, 121.192127)

Habitat description: Open eucalypt woodland on stony hill with scattered eucalypts to 10 m on sparsely scattered small to medium shrubs to 2.5 m on rocky substrate.

Habitat type: open woodland

Topography: hill top

Slope: moderate

Soil: rocks

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 017 (Fauna site) (-30.764962, 121.172396)

Habitat description: Open eucalypt woodland on plain with scattered tree and mallee eucalypts to 15 m and 8 m over patchy shrub understory with scattered patches of medium to large shrubs to 3 m over scattered small shrubs to 1.5 m on clay loam substrate. Shrub understory largely open with scattered small patches of denser cover of small to large shrubs.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 018 (Fauna site) (-30.778619, 121.177109)

Habitat description: Open eucalypt woodland with scattered tree eucalypts to 20 m over low open shrub understory with sparsely scattered small to medium shrubs to 1.5 m over low tecticornia shrubs to .75 m on clay loam substrate

Habitat type: open woodland

Topography: undulating plain

Slope: negligible

Soil: clay loam

Soil colour: brown

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 019 (Fauna site) (-30.779455, 121.174069)

Habitat description: Mallee woodland on low hill with scattered mallee eucalypts to 8 m over sparsely scattered medium to large shrubs to 3 m over sparsely scattered small shrubs to 1 m and scattered hummock grasses to .4 m on gravelly clay loam substrate.

Habitat type: mallee woodland

Topography: undulating plain

Slope: gentle

Soil: gravel–alluvial, clay loam

Soil colour: brown

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 020 (Fauna site) (-30.776086, 121.197272)

Habitat description: Open eucalypt woodland on stony hill with scattered eucalypts to 12 m over sparse undretory with sparsely scattered small shrubs to 1.5 m on stony substrate.

Habitat type: open woodland

Topography: hill top

Slope: moderate

Soil: clay loam, rocks

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 021 (Fauna site) (-30.769976, 121.178983)

Habitat description: Open eucalypt woodland on plain with sparsely scattered eucalypts to 15 m over open shrubland understory of sparsely scattered medium to large shrubs to 3 m over scattered small shrubs to 1.5 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: 022 (Fauna site) (-30.764832, 121.190819)

Habitat description: Open eucalypt woodland on low stony hill with scattered eucalypts to 10 m over sparsely scattered medium to large shrubs to 3 m over scattered patchy small shrubs to 1.5 m on stony clay loam substrate.

Habitat type: open woodland

Topography: hill top

Slope: gentle

Soil: clay loam, rocks

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: 023 (Fauna site) (-30.761228, 121.188915)

Habitat description: Open eucalypt woodland on low stony hill with sparsely scattered eucalypts to 10 m over sparsely scattered shrub understory of small shrubs to 1.5 m on stony clay loam substrate.

Habitat type: open woodland

Topography: hill slope

Slope: moderate

Soil: clay loam, rocks

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: historic operations,
vehicle tracks



Site: 024 (Fauna site) (-30.76878, 121.207817)

Habitat description: Low *Tectirocna* shrubland on fringe of seasonally wet shallow lake with even cover of small *Tecticornia* shrubs to .25 m on waterlogged clay loam substrate. Inundated from rainfall during field survey.

Habitat type: chenopod shrubland

Topography: seasonally wet area

Slope: negligible

Soil: clay loam

Soil colour: brown

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: 025 (Fauna site) (-30.769294, 121.217118)

Habitat description: Shrubland on plain with sparsely scattered *Casuarina* to 6 m over patchy shrubland understory with scattered patches of medium shrubs to 2.5 m over scattered small shrubs to 1.5 m on sandy loam substrate.

Habitat type: shrubland

Topography: plain

Slope: negligible

Soil: sandy loam

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 026 (Fauna site) (-30.773905, 121.224832)

Habitat description: Low *Tecticornia* shrubland with even cover of *Tecticornia* shrubs to 1 m and fringing vegetation with sparsely scattered eucalypts to 10 m over narrow thickets of *Melaleuca* to 3 m over sparsely scattered patches of small shrubs to 1 m around *Tecticornia* shrubland on sandy loam substrate.

Habitat type: shrubland

Topography: seasonally wet area

Slope: negligible

Soil: sandy loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), livestock tracks, vehicle tracks



Site: 027 (Fauna site) (-30.77513, 121.230604)

Habitat description: Open eucalypt woodland on plain with sparsely scattered eucalypts to 10 m over sparsely scattered casuarinas to 6 m over scattered and patchy small to medium shrubs to 2 m on sandy loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: sandy loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), livestock tracks, vehicle tracks



Site: 028 (Fauna site) (-30.755523, 121.179369)

Habitat description: Open eucalypt woodland with scattered eucalypts to 12 m over patchy scattered small to medium shrubs to 2.5 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 029 (Fauna site) (-30.756381, 121.174353)

Habitat description: Eucalypt woodland with evenly scattered eucalypts to 10 m over low open shrubland of scattered small shrubs to 1 m on clay loam substrate.

Habitat type: woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 031 (Fauna site) (-30.75874, 121.160812)

Habitat description: Shrubland on plain with scattered casuarinas to 6 m over scattered tall shrubs to 3 m over patchy areas of medium shrubs to 2.5 m and scattered small shrubs to 1.5 m on sandy clay loam substrate. Scattered patches of dense vegetation and areas with sparse vegetation in vegetation corridor across study area corridor.

Habitat type: shrubland

Topography: plain

Slope: negligible

Soil: sandy loam, clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 032 (Fauna site) (-30.760767, 121.146043)

Habitat description: Mallee woodland on plain with scattered mallee and tree eucalypts to 8 m over scattered medium shrubs to 2.5 m over scattered patches of small shrubs to 1.5 m and hummock grasses to .5 m on sandy loam substrate.

Habitat type: woodland

Topography: plain

Slope: negligible

Soil: sandy loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: historic clearing,
vehicle tracks



Site: 033 (Fauna site) (-30.762972, 121.134103)

Habitat description: Shrubland on plain with scattered patches of tall *Casuarina* shrubs to 4 m over patchy shrub understory with scattered small to medium shrubs to 2 m on clay loam substrate.

Habitat type: shrubland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads
and access tracks),
historic clearing,
vehicle tracks



Site: 034 (Fauna site) (-30.693403, 121.107884)

Habitat description: Eucalypt woodland on plain with scattered eucalypts to 12 m over patchy shrub understory with scattered small to medium shrubs to 2.5 m on clay loam substrate.

Habitat type: woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: 035 (Fauna site) (-30.684213, 121.098348)

Habitat description: Open eucalypt woodland with scattered eucalypts to 10 m over patchy shrub understory with scattered small to medium shrubs to 2 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: none



Site: 036 (Fauna site) (-30.677554, 121.088833)

Habitat description: Open eucalypt woodland on plain with scattered tree eucalypts to 12 m and mallee eucalypts to 8 m over scattered patches of small to medium shrubs to 2 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: historic clearing,
livestock tracks, vehicle
tracks



Site: 037 (Fauna site) (-30.672536, 121.08295)

Habitat description: Open eucalypt woodland on low undulating plain with sparsely scattered eucalypts to 12 m over sparse shrub understory with sparsely scattered small to medium shrubs to 2.5 m on clay loam substrate with gravelly surface.

Habitat type: open woodland

Topography: undulating plain

Slope: gentle

Soil: gravel-alluvial, clay
loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: historic clearing



Site: 038 (Fauna site) (-30.663983, 121.073408)

Habitat description: Open eucalypt woodland with scattered tree eucalypts to 12 m over scattered mallee eucalypts to 6 m and sparsely scattered large shrubs to 3 m over scattered small to medium shrubs to 2.5 m on gravelly clay loam substrate. Area heavily disturbed from historic mining activities.

Habitat type: open woodland

Topography: undulating plain

Slope: negligible

Soil: gravel-alluvial, clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years



Disturbance: exploration (drill pads and access tracks), historic operations, livestock tracks, vehicle tracks

Site: 039 (Fauna site) (-30.656449, 121.073534)

Habitat description: Open eucalypt woodland with sparsely scattered tree eucalypts to 12 m over scattered patches of mallee eucalypts to 8 m over scattered small shrubs to 1.5 m on gravelly clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: gravel-alluvial, clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years



Disturbance: historic operations, livestock tracks, vehicle tracks

Site: 040 (Fauna site) (-30.769975, 121.18309)

Habitat description: *Tecticornia* shrubland on low lying floodplain with sparsely scattered patches of tree and mallee eucalypts to 8 m over patchy low *Tecticornia* shrubs to .75 m on clay loam substrate. Area surrounded by open eucalypt woodland on low stony hills.

Habitat type: chenopod shrubland

Topography: floodplain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), livestock tracks, vehicle tracks



Site: SM01 (Audio recording) (-30.763444, 121.17809)

Habitat description: Open eucalypt woodland with scattered eucalypts to 12 m over patchy shrubland understory with scattered medium to large shrubs to 3 m over scattered small shrubs to 1.5 m on clay loam substrate.

Habitat type: open woodland

Topography: undulating plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Site: SM02 (Audio recording) (-30.763156, 121.1321)

Habitat description: Open eucalypt woodland with scattered tree and mallee eucalypts to 8 m over sparsely scattered medium to large shrubs to 2.5 m over scattered small shrubs to 1.5 m on clay loam substrate.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: SM03 (Audio recording) (-30.685494, 121.100267)

Habitat description: Open eucalypt woodland in plain with scattered eucalypts to 12 m over patchy shrub understory of scattered small shrubs to 1.5 m on clay loam substrate. Vehicle track dissects site creating a possible movement corridor with some small pools of water from recent rain.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-orange

Rock type: none

Fire age: >5 years

Disturbance: livestock tracks, vehicle tracks



Appendix 2 Vertebrate fauna species records from the desktop review and field survey

Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCAs Threatened Species Database	NatureMap	BirdData	This survey
Amphibians									
Hylidae	<i>Litoria moorei</i>	Motorbike Frog					•		
Limnodynastidae	<i>Neobatrachus kunapalari</i>	Kunapalari Frog					•		
Limnodynastidae	<i>Neobatrachus pelobatoides</i>	Humming Frog					•		
Limnodynastidae	<i>Neobatrachus sutor</i>	Shoemaker Frog					•		
Limnodynastidae	<i>Neobatrachus wilsmorei</i>	Plonking Frog					•		
Myobatrachidae	<i>Pseudophryne occidentalis</i>	Western Toadlet					•		
Reptiles									
Agamidae	<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon					•		
Agamidae	<i>Ctenophorus cristatus</i>	Bicycle Dragon					•		•
Agamidae	<i>Ctenophorus fordi</i>	Mallee Sand Dragon					•		
Agamidae	<i>Ctenophorus isolepis citrinus</i>						•		
Agamidae	<i>Ctenophorus maculatus</i>	Spotted Military Dragon							•
Agamidae	<i>Ctenophorus nuchalis</i>	Central Netted Dragon					•		
Agamidae	<i>Ctenophorus reticulatus</i>	Western Netted Dragon					•		
Agamidae	<i>Ctenophorus salinarum</i>	Salt Pan Dragon					•		
Agamidae	<i>Ctenophorus scutulatus</i>	Lozenge-marked Dragon					•		
Agamidae	<i>Moloch horridus</i>	Thorny Devil					•		
Agamidae	<i>Pogona minor minor</i>	Dwarf Bearded Dragon					•		
Agamidae	<i>Tympanocryptis cephalus</i>	Pebble Dragon					•		
Agamidae	<i>Tympanocryptis lineata</i>						•		

Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Boidae	<i>Morelia spilota imbricata</i>	Carpet Python					•		
Carphodactylidae	<i>Nephurus vertebralis</i>						•		
Cheluidae	<i>Chelodina colliei</i>						•		
Diplodactylidae	<i>Diplodactylus granariensis granariensis</i>						•		
Diplodactylidae	<i>Diplodactylus pulcher</i>						•		
Diplodactylidae	<i>Hesperoedura reticulata</i>						•		
Diplodactylidae	<i>Lucasium maini</i>						•		
Diplodactylidae	<i>Rhynchoedura ornata</i>	Western Beaked Gecko					•		
Diplodactylidae	<i>Strophurus assimilis</i>	Goldfields Spiny-tailed Gecko					•		
Diplodactylidae	<i>Strophurus elderi</i>						•		
Elapidae	<i>Acanthophis pyrrhus</i>	Desert Death Adder					•		
Elapidae	<i>Brachyuropsis fasciolatus fasciolatus</i>	Narrow-banded Shovel-nosed Snake					•		
Elapidae	<i>Brachyuropsis semifasciatus</i>	Southern Shovel-nosed Snake					•		
Elapidae	<i>Demansia psammophis</i>	Yellow-faced Whipsnake					•		
Elapidae	<i>Furina ornata</i>	Moon Snake					•		
Elapidae	<i>Neelaps bimaculatus</i>	Black-naped Snake					•		
Elapidae	<i>Parasuta gouldii</i>						•		
Elapidae	<i>Parasuta monachus</i>						•		
Elapidae	<i>Pseudechis australis</i>	Mulga Snake					•		
Elapidae	<i>Pseudonaja mengdeni</i>	Western Brown Snake					•		
Elapidae	<i>Pseudonaja modesta</i>	Ringed Brown Snake					•		

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Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Elapidae	<i>Pseudonaja nuchalis</i>	Gwardar					•		
Elapidae	<i>Simoselaps bertholdi</i>	Jan's Banded Snake					•		
Elapidae	<i>Suta fasciata</i>	Rosen's Snake					•		
Gekkonidae	<i>Christinus marmoratus</i>	Marbled Gecko							•
Gekkonidae	<i>Gehyra purpurascens</i>						•		
Gekkonidae	<i>Gehyra variegata</i>						•		
Gekkonidae	<i>Hemidactylus frenatus</i>	Asian House Gecko		*	•		•		
Gekkonidae	<i>Heteronotia binoei</i>	Bynoe's Gecko					•		
Gekkonidae	<i>Underwoodisaurus milii</i>	Barking Gecko					•		
Pygopodidae	<i>Delma australis</i>						•		•
Pygopodidae	<i>Lialis burtonis</i>						•		
Pygopodidae	<i>Pygopus lepidopodus</i>	Common Scaly Foot					•		
Pygopodidae	<i>Pygopus nigriceps</i>						•		
Scincidae	<i>Cryptoblepharus buchananii</i>						•		•
Scincidae	<i>Cryptoblepharus plagiocephalus</i>						•		
Scincidae	<i>Ctenotus atlas</i>						•		
Scincidae	<i>Ctenotus leonhardii</i>						•		
Scincidae	<i>Ctenotus schomburgkii</i>						•		•
Scincidae	<i>Ctenotus uber uber</i>	Spotted Ctenotus					•		•
Scincidae	<i>Cyclodomorphus melanops elongatus</i>	Slender Blue-tongue					•		
Scincidae	<i>Egernia depressa</i>	Southern Pygmy Spiny-tailed Skink					•		

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Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Scincidae	<i>Egernia formosa</i>						•		
Scincidae	<i>Egernia richardi</i>						•		
Scincidae	<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer					•		
Scincidae	<i>Hemiergis initialis initialis</i>						•		
Scincidae	<i>Lerista kingi</i>						•		
Scincidae	<i>Lerista muelleri</i>						•		
Scincidae	<i>Lerista picturata</i>						•		
Scincidae	<i>Lerista stictopleura</i>						•		
Scincidae	<i>Lerista timida</i>						•		
Scincidae	<i>Liopholis inornata</i>	Desert Skink					•		
Scincidae	<i>Menetia greyii</i>						•		•
Scincidae	<i>Morethia adelaidensis</i>						•		
Scincidae	<i>Morethia butleri</i>						•		
Scincidae	<i>Tiliqua occipitalis</i>	Western Bluetongue					•		•
Scincidae	<i>Tiliqua rugosa</i>						•		•
Varanidae	<i>Varanus caudolineatus</i>						•		
Varanidae	<i>Varanus gouldii</i>	Bungarra or Sand Monitor					•		•
Varanidae	<i>Varanus tristis</i>	Racehorse Monitor					•		•
Birds									
Acanthizidae	<i>Acanthiza apicalis</i>	Broad-tailed Thornbill					•	•	
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill					•	•	•
Acanthizidae	<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill					•	•	•

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Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Acanthizidae	<i>Aphelocephala leucopsis</i>	Southern Whiteface					•	•	
Acanthizidae	<i>Gerygone fusca</i>	Western Gerygone					•	•	
Acanthizidae	<i>Hylacola cauta whitlocki</i>	Shy Heathwren					•		•
Acanthizidae	<i>Pyrrholaemus brunneus</i>	Redthroat					•	•	•
Acanthizidae	<i>Smicronis brevirostris</i>	Weebill					•	•	•
Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk					•	•	
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk					•	•	
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle					•	•	•
Accipitridae	<i>Elanus caeruleus</i>	Black-shouldered Kite					•	•	•
Accipitridae	<i>Haliastur spheurnus</i>	Whistling Kite					•	•	
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle					•	•	
Aegothelidae	<i>Aegothales cristatus</i>	Australian Owlet-nightjar					•	•	
Anatidae	<i>Anas gracilis</i>	Grey Teal					•	•	•
Anatidae	<i>Anas platyrhynchos</i>	Mallard					•	•	
Anatidae	<i>Anas rhynchotis</i>	Australasian Shoveler					•	•	
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck					•	•	
Anatidae	<i>Aythya australis</i>	Hardhead					•	•	
Anatidae	<i>Biziura lobata</i>	Musk Duck					•	•	
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck					•	•	
Anatidae	<i>Cygnus atratus</i>	Black Swan					•	•	
Anatidae	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck					•	•	
Anatidae	<i>Stictonetta naevosa</i>	Freckled Duck					•	•	

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Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Anatidae	<i>Tadorna tadornoides</i>	Australian Shelduck					•	•	
Anhingidae	<i>Anhinga novaehollandiae</i>	Australasian Darter					•	•	
Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift	Mig. (EPBC & WC Acts)		•				
Ardeidae	<i>Ardea alba</i>	Great Egret			•			•	
Ardeidae	<i>Ardea modesta</i>	great egret					•		
Ardeidae	<i>Ardea novaehollandiae</i>	White-faced Heron						•	
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron					•	•	
Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow					•	•	
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow					•	•	
Artamidae	<i>Artamus personatus</i>	Masked Woodswallow					•	•	
Campephagidae	<i>Coracina maxima</i>	Ground Cuckoo-shrike					•	•	•
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike					•	•	•
Campephagidae	<i>Lalage tricolor</i>	White-winged Triller					•	•	
Caprimulgidae	<i>Eurostopodus argus</i>	Spotted Nightjar					•	•	
Charadriidae	<i>Charadrius ruficapillus</i>	Red-capped Plover					•	•	•
Charadriidae	<i>Elseornis melanops</i>	Black-fronted Dotterel					•	•	•
Charadriidae	<i>Erythronyx cinctus</i>	Red-kneed Dotterel					•	•	
Charadriidae	<i>Peltohyas australis</i>	Inland Dotterel						•	
Charadriidae	<i>Thinornis rubricollis</i>	Hooded Plover	P4 (DBCA)		•	•	•		
Charadriidae	<i>Vanellus tricolor</i>	Banded Lapwing					•	•	
Cinclosomatidae	<i>Cinclosoma castanotus</i>	Chestnut Quail-thrush						•	•
Climacteridae	<i>Climacteris affinis</i>	White-browed Treecreeper					•	•	

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Prepared for Evolution Mining Ltd

Family	Species	Common name	Conservation status	Naturalised	EPBC Protected Matters Database	DBCA Threatened Species Database	NatureMap	BirdData	This survey
Climacteridae	<i>Climacteris rufus</i>	Black-tailed Treecreeper						•	
Columbidae	<i>Columba livia</i>	Domestic Pigeon		*	•		•	•	
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon					•	•	
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing					•	•	•
Columbidae	<i>Streptopelia chinensis</i>	Spotted Turtle-Dove		*	•				
Columbidae	<i>Streptopelia senegalensis</i>	Laughing Turtle-Dove		*	•		•	•	
Corvidae	<i>Corvus bennetti</i>	Little Crow					•	•	•
Corvidae	<i>Corvus coronoides</i>	Australian Raven					•	•	•
Corvidae	<i>Corvus orru</i>	Torresian Crow					•	•	
Cracticidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird					•	•	•
Cracticidae	<i>Cracticus tibicen</i>	Australian Magpie					•	•	•
Cracticidae	<i>Cracticus torquatus</i>	Grey Butcherbird					•	•	•
Cracticidae	<i>Strepera versicolor</i>	Grey Currawong					•	•	
Cuculidae	<i>Cacomantis pallidus</i>	Pallid Cuckoo					•	•	•
Cuculidae	<i>Chrysococcyx basalis</i>	Horsfield's Bronze Cuckoo					•	•	
Cuculidae	<i>Chrysococcyx osculans</i>	Black-eared Cuckoo			•		•	•	•
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird					•	•	
Dicruridae	<i>Grallina cyanoleuca</i>	Magpie-lark					•	•	•
Dicruridae	<i>Rhipidura albiscapa</i>	Grey Fantail					•	•	
Dicruridae	<i>Rhipidura leucophrys</i>	Willie Wagtail					•	•	•
Dromaiidae	<i>Dromaius novaehollandiae</i>	Emu					•	•	•
Elapidae	<i>Pseudonaja affinis</i>	Dugite			•				•
Estrilidae	<i>Taeniopygia guttata</i>	Zebra Finch					•	•	•

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Falconidae	<i>Falco berigora</i>	Brown Falcon					•	•	
Falconidae	<i>Falco cenchroides</i>	Australian Kestrel					•	•	
Falconidae	<i>Falco longipennis</i>	Australian Hobby					•	•	
Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon	OS (WC Act)					•	
Glareolidae	<i>Glareola maldivarum</i>	Oriental Pratincole	Mig. (EPBC & WC Acts)					•	
Halcyonidae	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher					•	•	
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher					•	•	•
Hirundinidae	<i>Cheramoeca leucosterna</i>	White-backed Swallow					•	•	
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow					•	•	
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin					•	•	
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin					•	•	
Laridae	<i>Larus novaehollandiae</i>	Silver Gull						•	
Maluridae	<i>Malurus leucopterus</i>	White-winged Fairy-wren					•	•	
Maluridae	<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren					•	•	
Maluridae	<i>Malurus splendens</i>	Splendid Fairy-wren					•	•	•
Megapodiidae	<i>Leipoa ocellata</i>	Malleefowl	VU (EPBC & WC Acts)		•	•	•	•	•
Meliphagidae	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater					•	•	•
Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird					•	•	•
Meliphagidae	<i>Certhionyx variegatus</i>	Pied Honeyeater					•		
Meliphagidae	<i>Epthianura albifrons</i>	White-fronted Chat					•	•	•
Meliphagidae	<i>Epthianura tricolor</i>	Crimson Chat					•		•
Meliphagidae	<i>Gavicalis virescens</i>	Singing Honeyeater						•	•

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Meliphagidae	<i>Lichenostomus leucotis</i>	White-eared Honeyeater					•	•	•
Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater					•	•	•
Meliphagidae	<i>Manorina flavigula</i>	Yellow-throated Miner					•	•	•
Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater					•	•	
Meliphagidae	<i>Ptilotula ornata</i>	Yellow-plumed Honeyeater						•	•
Meliphagidae	<i>Ptilotula plumula</i>	Grey-fronted Honeyeater						•	
Meliphagidae	<i>Purnella albifrons</i>	White-fronted Honeyeater					•	•	•
Meliphagidae	<i>Sugomel niger</i>	Black Honeyeater						•	
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater			•		•	•	•
Motacillidae	<i>Anthus australis</i>	Australian Pipit					•	•	
Motacillidae	<i>Motacilla cinerea</i>	Grey Wagtail	Mig. (EPBC & WC Acts)		•				
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella					•	•	
Otididae	<i>Ardeotis australis</i>	Australian Bustard					•	•	
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush					•	•	•
Pachycephalidae	<i>Oreoica gutturalis gutturalis</i>	Crested Bellbird (southern)					•		•
Pachycephalidae	<i>Pachycephala inornata</i>	Gilbert's Whistler					•	•	
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler						•	
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler					•	•	•
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote					•	•	
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote					•	•	•
Petroicidae	<i>Drymodes brunneopygia</i>	Southern Scrub-robin					•	•	
Petroicidae	<i>Eopsaltria griseogularis</i>	Western Yellow Robin					•	•	

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Petroicidae	<i>Microeca fascinans</i>	Jacky Winter					•	•	
Petroicidae	<i>Petroica goodenovii</i>	Red-capped Robin					•	•	•
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant						•	
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant					•	•	
Phasianidae	<i>Coturnix pectoralis</i>	Stubble Quail					•	•	
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth					•	•	•
Podicipedidae	<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe					•	•	
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe					•	•	
Pomatostomidae	<i>Pomatostomus superciliosus</i>	White-browed Babbler					•	•	•
Psittacidae	<i>Cacatua roseicapilla</i>	Galah					•	•	•
Psittacidae	<i>Cacatua sanguinea</i>	Little Corella					•	•	
Psittacidae	<i>Calyptorhynchus latirostris</i>		EN (EPBC & WC Acts)				•	•	
Psittacidae	<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet						•	
Psittacidae	<i>Melopsittacus undulatus</i>	Budgerigar					•	•	
Psittacidae	<i>Nymphicus hollandicus</i>	Cockatiel					•		
Psittacidae	<i>Pezoporus occidentalis</i>	Night Parrot	EN (EPBC Act); CR (WC Act)		•				
Psittacidae	<i>Platycercus varius</i>	Mulga Parrot					•	•	
Psittacidae	<i>Platycercus zonarius</i>	Australian Ringneck					•	•	•
Psittacidae	<i>Polytelis anthopeplus</i>	Regent Parrot					•		•
Rallidae	<i>Fulica atra</i>	Eurasian Coot					•	•	
Rallidae	<i>Porzana fluminea</i>	Australian Spotted Crake					•		
Rallidae	<i>Tribonyx ventralis</i>	Black-tailed Native-hen					•	•	

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Recurvirostridae	<i>Cladorhynchus leucocephalus</i>	Banded Stilt					•		•
Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt					•	•	
Recurvirostridae	<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet					•		
Scolopacidae	<i>Actitis hypoleucos</i>	Common Sandpiper	Mig. (EPBC & WC Acts)		•		•	•	
Scolopacidae	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Mig. (EPBC & WC Acts)		•	•	•	•	
Scolopacidae	<i>Calidris alba</i>	Sanderling	Mig. (EPBC & WC Acts)				•	•	
Scolopacidae	<i>Calidris ferruginea</i>	Curlew Sandpiper	CR/Mig. (EPBC Act); VU/Mig. (WC Act)		•	•	•	•	
Scolopacidae	<i>Calidris melanotos</i>	Pectoral Sandpiper	Mig. (EPBC & WC Acts)		•			•	
Scolopacidae	<i>Calidris ruficollis</i>	Red-necked Stint	Mig. (EPBC & WC Acts)			•	•	•	
Scolopacidae	<i>Calidris subminuta</i>	Long-toed Stint	Mig. (EPBC & WC Acts)					•	
Scolopacidae	<i>Tringa brevipes</i>	Grey-tailed Tattler	Mig. (EPBC); P4/Mig. (DBCA)				•		
Scolopacidae	<i>Tringa glareola</i>	Wood Sandpiper	Mig. (EPBC & WC Acts)			•	•	•	
Scolopacidae	<i>Tringa nebularia</i>	Common Greenshank	Mig. (EPBC & WC Acts)		•	•	•	•	
Strigidae	<i>Ninox boobook</i>	Boobook Owl						•	
Sylviidae	<i>Cincloramphus cruralis</i>	Brown Songlark						•	
Sylviidae	<i>Cincloramphus mathewsi</i>	Rufous Songlark						•	
Threskiornithidae	<i>Platalea flavipes</i>	Yellow-billed Spoonbill					•	•	

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Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis	Mig. (EPBC & WC Acts)			•			
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis					•	•	
Turnicidae	<i>Turnix velox</i>	Little Button-quail					•		
Tytonidae	<i>Tyto alba</i>	Barn Owl					•	•	
Zosteropidae	<i>Zosterops lateralis</i>	Grey-breasted White-eye					•	•	
Mammals									
Bovidae	<i>Bos taurus</i>	European Cattle		*			•		•
Bovidae	<i>Capra hircus</i>	Goat		*	•		•		
Bovidae	<i>Ovis aries</i>	Sheep					•		
Burramyidae	<i>Cercartetus concinnus</i>	Western Pygmy-possum					•		
Canidae	<i>Canis lupus dingo</i>	Dingo		*			•		
Canidae	<i>Canis lupus familiaris</i>	Dog		*	•				•
Canidae	<i>Vulpes vulpes</i>	Red Fox		*	•				
Dasyuridae	<i>Antechinomys laniger</i>	Kultarr					•		
Dasyuridae	<i>Dasyurus geoffroii</i>	Chuditch	VU (EPBC & WC Acts)		•				
Dasyuridae	<i>Ningau ridei</i>	Wongai Ningau					•		
Dasyuridae	<i>Ningau yvonneae</i>	Southern Ningau					•		
Dasyuridae	<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart					•		
Dasyuridae	<i>Sminthopsis dolichura</i>	Little long-tailed Dunnart					•		
Dasyuridae	<i>Sminthopsis gilberti</i>	Gilbert's Dunnart					•		
Dasyuridae	<i>Sminthopsis ooldea</i>	Ooldea Dunnart					•		
Emballonuridae	<i>Taphozous hilli</i>	Hill's Sheathtail-bat					•		

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Equidae	<i>Equus asinus</i>	Donkey		*	●				
Equidae	<i>Equus caballus</i>	Horse		*	●				
Felidae	<i>Felis catus</i>	Cat		*	●		●		
Leporidae	<i>Oryctolagus cuniculus</i>	Rabbit		*	●		●		●
Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo					●		●
Macropodidae	<i>Macropus robustus erubescens</i>	Euro					●		
Macropodidae	<i>Macropus rufus</i>	Red Kangaroo					●		●
Molossidae	<i>Austronomus australis</i>	White-striped Free-tailed Bat							●
Molossidae	<i>Mormopterus kitcheneri</i>	South-western Free-tailed Bat							●
Muridae	<i>Mus musculus</i>	House Mouse		*	●		●		
Muridae	<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse					●		●
Muridae	<i>Pseudomys albocinereus</i>	Ash-grey Mouse					●		
Muridae	<i>Pseudomys bolami</i>	Bolam's Mouse					●		
Muridae	<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse					●		
Myrmecobiidae	<i>Myrmecobius fasciatus</i>	Numbat	EN (EPBC & WC Acts)			●	●		
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna					●		●
Thylacomyidae	<i>Macrotis lagotis</i>	Bilby	VU (EPBC & WC Acts)			●	●		
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat					●		●
Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat					●		
Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat					●		

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Vespertilionidae	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat					•		
Vespertilionidae	<i>Vespadelus baverstocki</i>	Inland Forest Bat					•		•
Vespertilionidae	<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat					•		
Vespertilionidae	<i>Vespadelus regulus</i>	Southern Forest Bat					•		

