DWER Licence Amendment Application
Supporting Information

HORSESHOE PIT DEWATERING

FORTNUM GOLD PROJECT

ARAGON RESOURCES
(ACN 114 714 662)

Prepared by: Westgold Resources
March 2019

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1. PREMISES DETAILS

The Horseshoe Project Area forms part of the Fortnum Gold Project (FGP), which is owned by Aragon Resources Pty Ltd, a wholly owned subsidiary of Westgold Resources Ltd (Westgold). FGP is currently licenced under L8103/1989/03. The Horseshoe Project Area does not form a contiguous boundary with the current licenced premises boundary thus a new and separate licence is required.

2. OWNER OF PREMISES

All compliance and regulatory requirements should be forwarded by post or email to as per contact details listed in Table 1.

Table 1: Contact Details

Rowan Armstrong	**Cheryl Low**	**Tim Cook**
General Manager	Environment Manager	Co-ordinator Titles & Leases
Registered office: Level 6, 197 St Georges Terrace, Perth WA 6000 **Postal:** PO Box 7068 Cloisters Square WA 6850		
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rowan.armstrong@westgold.com.au	Cheryl.low@westgold.com.au	compliance@westgold.com.au

3. NAME AND LOCATION DETAILS OF PREMISES

The Horseshoe Project area is located within the Shire of Meekatharra on vacant crown land on mining lease M52/338; approximately 135 km north of Meekatharra, 26 km northwest of the abandoned Peak Hill townsite and 25 km southeast of the FGP (Figure 1). The mine is located on mining lease M52/338 (Figure 2), with Access from the Shire's Ashburton Downs road via L52/102. The tenements are located on vacant crown land.

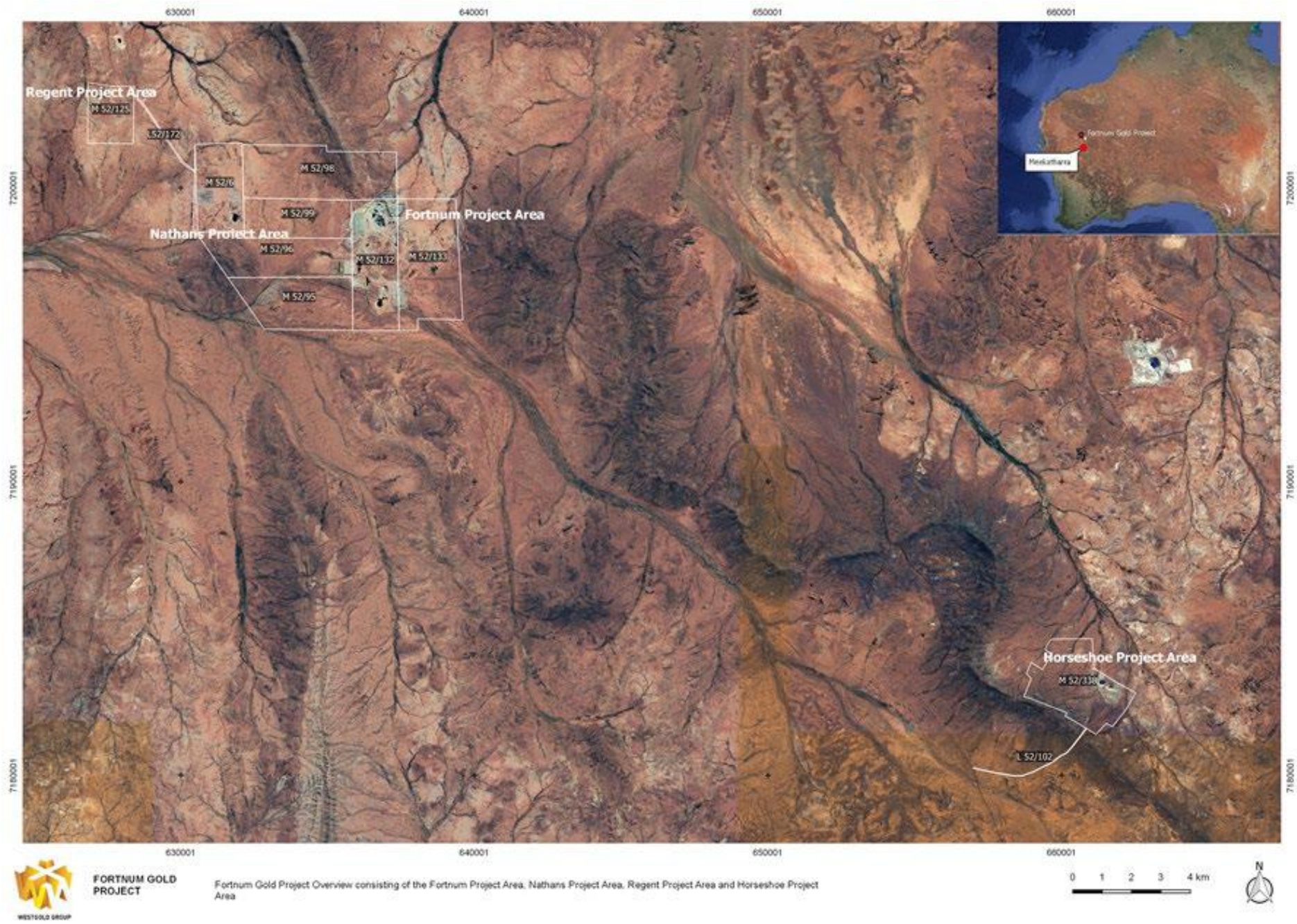

Figure 1: Location Map

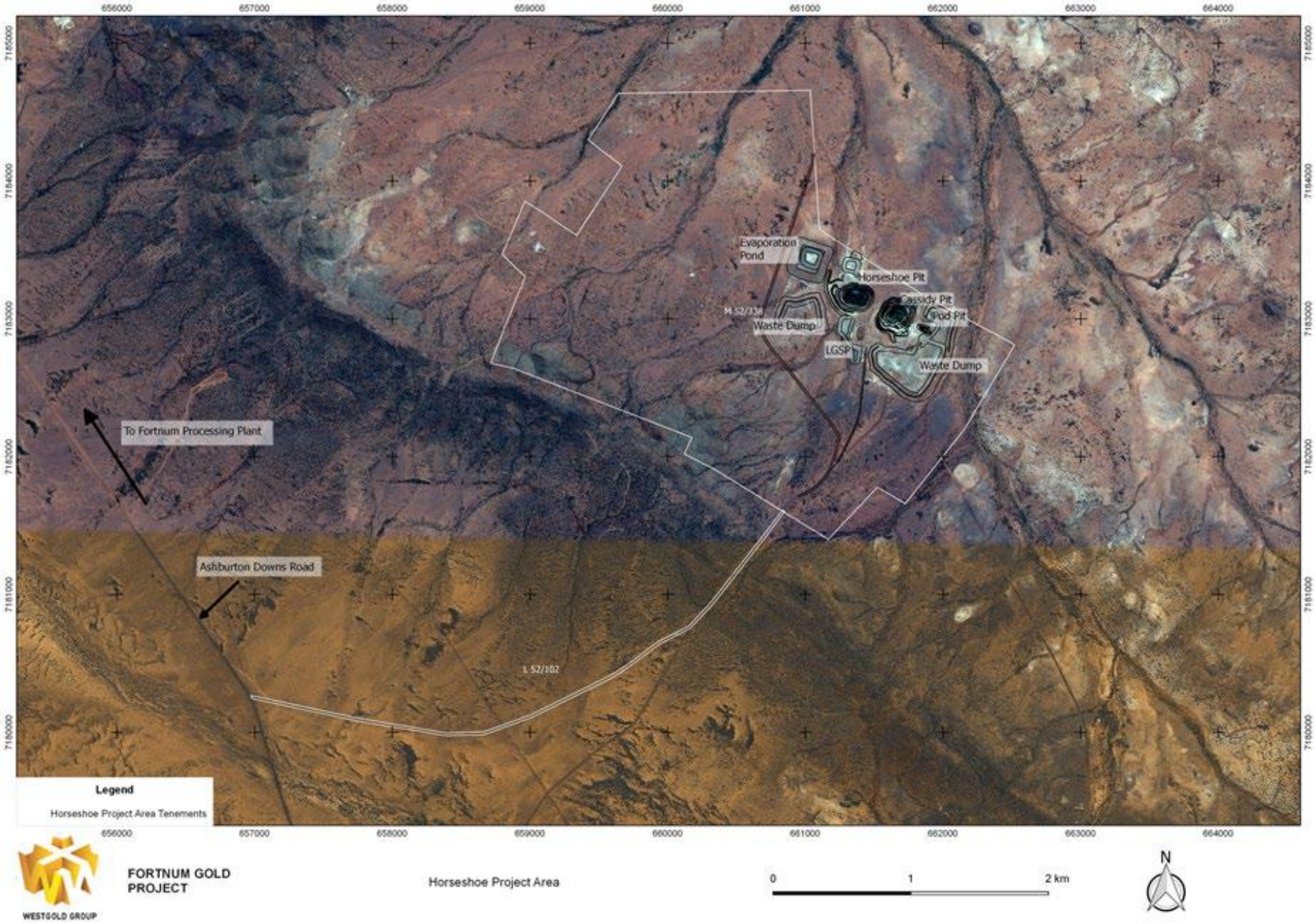

Figure 2: Horseshoe Project Area Tenements and Infrastructure

4. LEGAL LAND DESCRIPTON

The Horseshoe Pits and discharge point are located within Mining Lease 52/338 and owned by Aragon Resources. The addition of this tenement to the current existing prescribed premises licence is not possible due to the tenements between the Fortnum Project Area and the Horseshoe Project Area not being held by Aragon Resources. A new prescribed premises licence will be required to be issued to Aragon Resources to include tenement M52/338 (Table 2). Proof of Aragon Resource's occupier status for M52/338 is provided in Appendix A.

Table 2: Tenement Details

Tenement	Area (ha)	Holder	Granted	Expiry
M52/338	684.35	Aragon Resources Pty Ltd	28/10/1992	27/10/2034

5. PRESCRIBED PREMISES CATEGORY

This application is for the "Prescribed Premises" category number 6 under Schedule 1 of the Environmental Protection Regulations 1987. The FGP currently operates under Department of Water and Environmental Regulation (DWER) Part V (of the EP Act) Prescribed Premises Licence 8103/1989/3 but the boundary for the licence is not contiguous with the Horseshoe Project Area. The facility is prescribed within Schedule 1 of the Environmental Protection Regulations 1987 as outlined in Table 3.

Table 3: Prescribed Premise Categories

Category Number	Category description	Category production
6	Mine dewatering	50,000 tonnes or more per year

6. DESCRIPTION OF ACTIVITY

The primary objective of this proposal is to seek approval to dewater approximately 282,000 kilolitres (kL) from Horseshoe pit into Cassidy pit. Horseshoe consists of three small open pits (Horseshoe, Cassidy and Pod), two Waste Rock Dumps (WRD), an evaporation pond and two low grade stockpiles (Figure 2).

Horseshoe is the deepest of the pits and will be mined to a depth of 120 m using a single cutback. Ore will be hauled approximately 34 km from Horseshoe to the existing FGP processing plant via Meekatharra Shire's Ashburton Downs Road. To access ore below the water table within the

Horseshoe pit, saline groundwater is required to be dewatered. While water will be used for dust suppression, water will also be discharged into Cassidy pit (Figure 3).

Horseshoe pit requires dewatering to enable it to be mined. The entire volume of water in Horseshoe pit is easily able to fit into Cassidy pit (282,000 m^3 of into an available volume of 2,097,000 m^3 of available pit space) (Appendix B) and so the dewatering strategy is to pump the water from Horseshoe pit into the nearby Cassidy pit (approximately 80m distance).

Dewatering of the Horseshoe pit will be achieved through the use of a pontoon pump. The water will be pumped via a pipeline spanning a small distance of approximately 80 m between Horseshoe and Cassidy pit across a heavily disturbed area.

In addition, based on summer dust suppression requirements (9 x 30 kL truckloads during the day and 7 x 30kL truckloads during the evening), an estimated 480kL of water will be used for dust suppression each day. This equates to 260,000 kL for the 18 month (maximum) mine life, which is approximately 75% of the requested total volume of dewater.

It is estimated that the rate of dewatering used will be approximately 24 L per second (62,200 kL per month). At that rate it will take approximately 4 to 5 months for the pit lake level to be reduced to where mining can begin.

The strategy of storing the saline water from Horseshoe pit into the saline water already in Cassidy pit across a very short distance is considered low risk for saline water entering the environment and the most appropriate solution to dewatering the saline water at the Horseshoe Project.

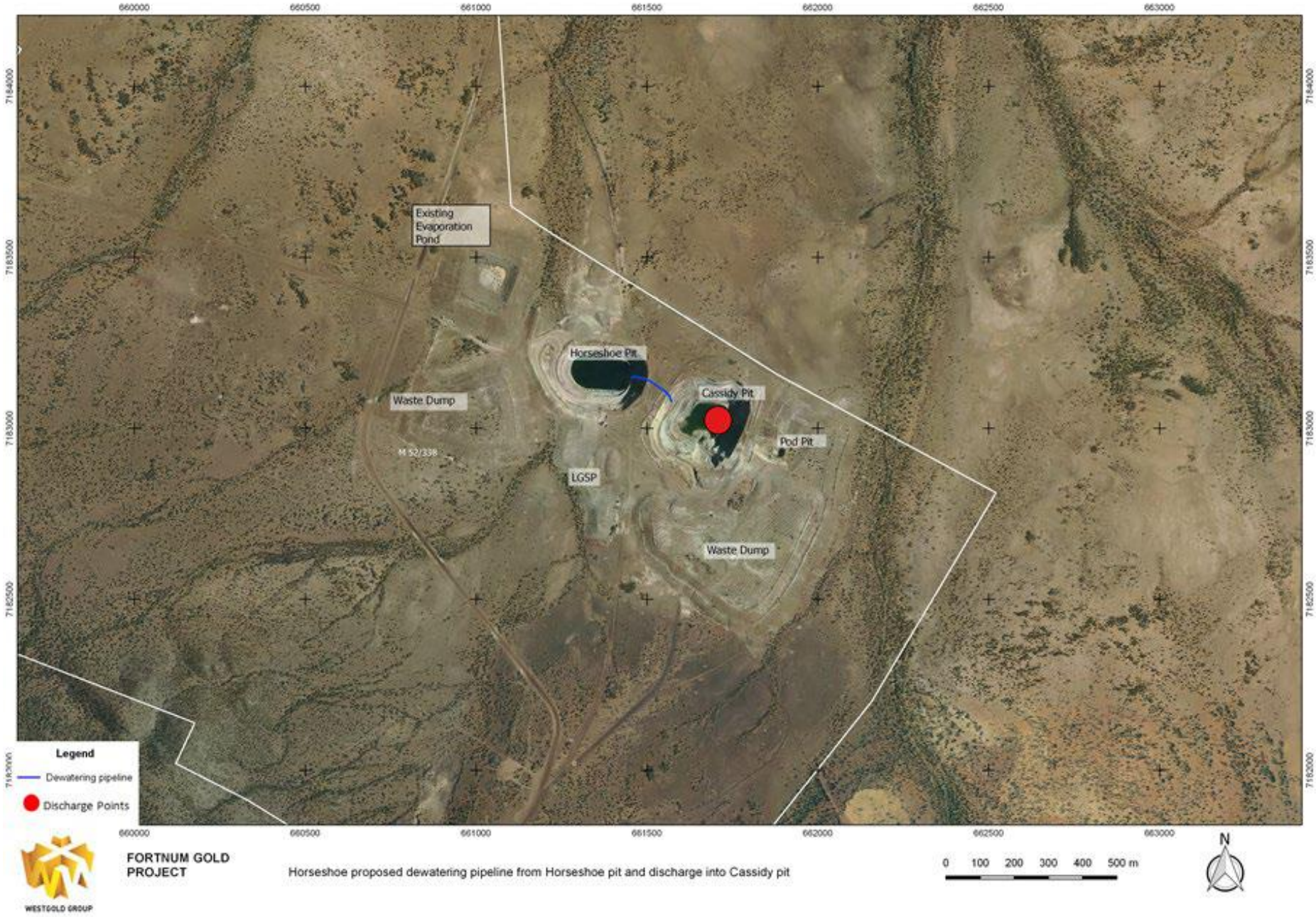

Figure 3: Horseshoe proposed dewatering network and discharge points

7. LEGISLATIVE APPROVALS

7.1. PART IV ENVIRONMENTAL PROTECTION ACT 1986 ENVIRONMENTAL IMPACT ASSESSMENT

No assessment from the Office of Environmental Protection Authority (OEPA) under Part IV of the *Environmental Protection Act 1986* is required for this dewatering operation.

7.2. PART V ENVIRONMENTAL PROTECTION ACT 1986, WORKS APPROVAL AND LICENSING

This Category 6 (Schedule 1) of the *Environmental Protection Regulations 1987* Works Approval/Licence amendment application has been submitted to DWER under the requirements of Part V of the *Environmental Protection Act 1986*.

7.3. OTHER DECISION MAKING AUTHORITIES

Aragon has a current groundwater extraction licence (GWL 159877(8)) for the right to take 3,700,000 kL of groundwater and covers tenement M52/338 upon which Horseshoe and Cassidy pits are located. Horseshoe pit contains approximately 282,000 kL. Based on current extraction estimates of approximately 3,004,765 kL, the inclusion of Horseshoe dewatering will bring total extraction of approximately 3,286,765 kL which is approximately 413,235 kL under the allocated quantity of 3,700,000 kL. Therefore no amendment to the current groundwater extraction licence is required.

An Addendum to the Groundwater Licence Operating Strategy (GLWOS) will be submitted in order to name Horseshoe and Cassidy pits as dewatering pits and that monitoring for parameters as outlined in the GWLOS and on the Fortnum Prescribed Premises licence for existing pits, will be implemented.

Clearing Permit CPS 7329/1 to clear native vegetation at the Horseshoe was approved by the Department of Mines, Industry Regulation and Safety (DMIRS) on 1 December 2016. A Mining Proposal (MP) and supporting Mine Closure Plan (MCP) (REG ID 63891) was approved by DMIRS on 25 August 2017. The proposal included haulage or low grade stockpiles from the Horseshoe to the Fortnum processing plant. An amendment to include mining of the existing Horseshoe and Cassidy pits is currently being drafted and will be submitted to DMIRS in the near future.

7.4. OTHER GUIDANCE MATERIAL AND LEGISLATION

The following guidance and legislation material is specific to this licence amendment:

• *Aboriginal Heritage Act 1972*;	• *Environmental Protection Act 1986*;
• Aboriginal Heritage Regulations 1974;	• Environmental Protection Regulations 1987;
• *Contaminated Sites Act 2003*;	• Environmental Protection (Diesel and Petrol) Regulations 1999;
• Contaminated Sites Regulations 2006;	• Environmental Protection (Unauthorised Discharges) Regulations 2004;
• *Land Drainage Act 1925*;	• *Wildlife Conservation Act 1950*;
• Land Drainage By-Laws 1986;	• Wildlife Conservation Regulations 1970;
• *Mining Act 1978*;	• Department of Water (2000a) Water Quality Protection Guideline 11 Water Quality Management in Mining and Mineral Processing: Mine Dewatering;
• *Rights in Water and Irrigation Act 1914*;	• Department of Water (2000b) Water Quality Protection Guideline 5 Water Quality Management in Mining and Mineral Processing: Minesite Water Quality Monitoring;
• *Soil and Land Conservation Act 1945*;	• *Wildlife Conservation Act 1950*;
• Soil and Land Conservation Regulations 1992;	• Australian and New Zealand Environment and Conservation Council (ANZECC), 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. The National Water Quality Management Strategy. Commonwealth of Australia.

8. EXISTING AND RECEIVING ENVIRONMENT

8.1. BIOGEOGRAPHIC REGION

The Interim Biographic Regionalisation for Australia (IBRA) classification system describes 85 biogeographic regions which cover Australia. The bioregions are defined on the basis of geology, landforms, climate, vegetation and fauna (DSEWPaC, 2013). Horseshoe lies within the Gascoyne Bioregion which is comprised of three subregions: Augustus, Ashburton and Carnegie (DSEWPaC, 2013). Horseshoe lies within the Augustus subregion which is characterised by sedimentary and granite ranges and broad flat valleys (Desmond *et al,* 2001). Most of the drainage of this subregion is provided by the Gascoyne River System. Shallow stony loams on rises contain mulga woodland with *Triodia* and the plains with shallow earthy loams over hardpan are covered by mulga parkland

(Desmond *et al*, 2001).

8.2. CLIMATE

Horseshoe has a semi-arid climate. The nearest Bureau of Meteorology (BoM) station is Milgun (Stn.007050), located 36 km north-north-west of Horseshoe. Rainfall at Milgun (1916 to 2016 records available) averages 221 mm per annum, with on average, 77 % falling in the months January to June, mainly due to thunderstorms or the remnants of cyclones in summer and the passage of frontal systems in winter.

Average dam evaporation at Meekatharra, 126 km to the south (Luke, Burke and O'Brien, 1988) exceeds Milgun's average rainfall in all months of the year (Table 6), and by a factor of 12 overall. Temperatures recorded at Meekatharra airport (BoM station 007045) indicate monthly mean minimum temperatures ranging from 7.4 °C in July to 24.4 °C in January and mean maximum temperatures ranging from 19.1 °C in July to 38.3 °C in January.

Table 4: Average Rainfall (Milgun) and Dam Evaporation (Meekatharra) (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Rainfall (mm)	28.4	39.7	32.2	20.6	23.6	24.4	14.1	8.5	2.3	4.4	7.6	14.2	220.7
Dam Evap. (mm)	380	314	267	190	131	87	92	121	170	259	293	333	2,637

8.3. GEOLOGY

8.3.1 Regional Geology

The regional geology consists of numerous formations including:

Horshoe Formation: A banded iron formation with interbedded quartz and shales metamorphosed

Labouchere Formation: An arenite, quartz wacke, shale and quartz pebble conglomerate lenses

Narracoota Formation: Metabasaltic lavas, locally with pillow structures and dolerite sills

Peak Hill Schist: Rounded fragments of quartz mylonite in quartz-sericite matrix

Ravelstone Formation: Lithic and quartz wacke metamorphosed

Robinson Range: A banded iron formation

Wilthorpe Formation: Sandstone and shale, minor quartz wacke and lenses of conglomerate

8.3.2 Local Geology

Horseshoe lies within a complexly folded and faulted sequence of Lower Proterozoic volcanic and sedimentary units belonging to the Glengarry Group. The geology consists of a unit of mafic and ultrmafic volcanics belonging to the Narracoota Volcanics within the sedimentary sequence of greywacke and argilliteof the Thaduna Greywacke and an upper unit of BIF and manganiferous shale of the Horseshoe Formation.

Host lithologies comprise a sheared westerly thinning sequence of ultramfic schist, mafic tuffaceous rock and jasper of the Narracoota Volcanics wedged between argillaceous sediments of the Thaduna Greywacke. This volcano-sedimentary sequence is at least one kilometre in stike length. The orebody sequence consists of an unaltered argillite footwall overlain by a sheared argillite and pyritic jasper zone. A highly oxidised and sheeted mafic tuffaceous rock with quartz veining is the main host lithology. This unit is overlain by talc-chlorite schist, limonite-sericite schist and a hanging wall argillite. The sequence is intruded by a vertical east-west dolerite dyke and disrupted by several north-south fault zones (Dominion, 1991).

8.4 LANDSYSTEM AND LANDSCAPE

Horseshoe lies partially within two land systems, Beasley and Peak Hill. The Beasley land system is characterised by low ridges and hills above stony footslopes and broad stony lower plains which support scattered mulga and snakewood dominated shrublands (Currey *et al*, 1994). The Peak Hill land system is characterised by ranges and rugged hills with banded ironstone and hematitic shale, supporting stunted mulga and cottonbush shrublands (Currey, *et al*, 1994).

8.5 TOPOGRAPHY AND DRAINAGE

Horseshoe is located immediately north of the Horseshoe Range, a north-westerly trending topographical feature that forms the southern boundary of the lease. Several creeks form part of a drainage network from the Horseshoe Range which eventually terminates in the Gascoyne River, approximately 30 km to the north. The Horseshoe pit and proposed cutback is located adjacent to a small rise between two creeks which drain a small catchment commencing in the adjacent Horseshoe Range. The remainder of the tenement has very low relief and outcrop is very sparse.

The Beasley land system of the Horseshoe Gold Mine contains a series of drainage-related landform

features. Whilst drainage is considered to be sluggish, vegetation has adapted to this constraint (Wilcox and McKinnon, 1974). The presence of halophytic vegetation would suggest the presence of underlying saline water properties and potential waterlogging within the Horseshoe Gold Mine area. Drainage through the site would be driven by overland flows across halophytic and open vegetation into established creeklines, which anastomose to form larger tributaries to the north of the site. This pattern is not unique to the Horseshoe site but is a defining feature of the region.

8.6 HYDROLOGICAL SETTING

The Horseshoe, Cassidy and Pod pits were initially mined by Dominion Mining from January 1992 to early 1993. The natural ground surface is about 535 m AHD and the original water table was about 25 m deep, i.e. about 510 m AHD. The current pit lake levels are 489.35 m (Horseshoe) and 474.49 m (Cassidy) and there is no pit lake in the Pod pit.

Saline lakes have developed in the pits since cessation of mining in the early 1990's. Cassidy pit water is approximately twice the salinity Horseshoe pit water (TDS of 54,000 mg/L versus 22,000 mg/L) and is slightly alkaline ranging from 8.3 to 8.6.

The rocks in and surrounding the pits, in particular the siltstone and wacke country rocks, are generally of low hydraulic conductivity (permeability). The mineralised zones and the jasperoidal pods are likely to be moderately permeable and transition zone rocks (between weathered and fresh) are also likely to be permeable and there may also be fractured rocks along fault zones and the margins of the dolerite dyke (Rockwater 2018).

However, the pods and mineralised zones are not extensive and so long-term dewatering rates are likely to be limited. Geological mapping by Groves (1996) indicates there is no continuity of rock units, particularly those likely to be permeable, between Horseshoe and Cassidy and so there is unlikely to be significant hydraulic connection between the pits. This is supported by the substantial (15 m) difference in pit lake levels. However, there is likely to be hydraulic connection via the mineralised zones between Cassidy and Pod (Rockwater 2018, Appendix B).

Aquifers in the area are either in shallow colluviums or calcrete, or are deeper, within bedrock shear and fault zones (Dominion Mining, 1991). Most groundwater for pastoral purposes is drawn from bedrock shear-fault zones, the closest being Windalah Bore located approximately 11 km east of Horseshoe Pit.

Surface drainages flow northwards and the surface topography also slopes in that direction, so pre-mining groundwater levels would have sloped down from about 510 m AHD at the mine site, to about 480m AHD at the Gascoyne River, 30 km to the north. The Horseshoe and Cassidy pits have become groundwater sinks and so all groundwater at the mine site now flows towards the pits (Rockwater 2018).

8.3.1. Horseshoe Pit Water Quality

Water in the pit was sampled 2012 to 2018. The major ion and metal concentrations are given in Table 5. Results have been compared with the ANZECC (updated 2018) default guideline values (DGV's) for fresh and marine waters, ANZECC (2000) Livestock trigger limits and Department of Health (DoH) 2014 Non Potable groundwater use (NPGU). The threshold levels have been adjusted for extremely hard water in accordance with the guidelines.

Horseshoe pit water exceeds ANZECC Fresh water at the 95% Protection Level DGV's for selenium and boron. Horseshoe does not exceed any ANZECC Marine DGV's. Horseshoe pit water exceeds the DoH NPGU limits for sulphate and chloride and exceeds ANZECC (2000) Livestock triggers for sulphate and TDS.

Figure 4 shows the water from Horseshoe is classified as sodium-chloride type water. The Durov diagram (Figure 5) shows the TDS has increased from 2016 to 2018 and the pH has remained alkaline. The Schoeller diagram (Figure 6) shows 2012 results have higher Cr, Zn and B, the 2016 results have higher HCO_3, Cl, Ca, Mg, Na and K and the 2018 reuslts have the highest Ni, Pb, EC, TDS, Se, NO_2, NO_3 and CO_3.

Trend analysis results provided Table 6. TDS and EC show increasing trends (Figure 7 and Figure 8).

Table 5: Horseshoe Pit Water Quality

Parameter	unit	6/19/2012	9/20/2016	4/25/2017	7/18/2017	3/18/2018	10/14/2018	ANZECC fresh 2018	ANZECC Marine 2018	NPGU	ANZECC 2000 Livestock
Calcium	mg/L		230			160	170				1000
Magnesium	mg/L	770	1100			920	960				
Sodium	mg/L		6200			5600	5700				
Potassium	mg/L		230			200	220				
Bicarbonate	mg/L		390			270	330				
Sulfate	mg/L	2200 2200	4000 4000			4000 4000	4400 4400			1000	1000
Chloride	mg/L	7600	12000			8200	10000			250	
TDS	mg/L	17100	19000	19000	19000	20000	22000				4000
Conductivity	µS/cm	26800	29000	30000	30000	31000	33000				
pH	pH	7.4	8.6	8.5	8.3	8.6	8.5				
Cadmium	mg/L	<0.0001	<0.0001			<0.0005	<0.001	0.02*	0.46*	0.02	0.01
Arsenic	mg/L	<0.01	<0.001			<0.005	<0.01	0.024		0.1	
Chromium	mg/L	0.071	0.046			0.063	0.066	0.19*	1.6*		1
Copper	mg/L	<0.01	<0.001			<0.005	<0.01	0.0014	0.0013	20	1
Mercury	mg/L		<0.0001			<0.00005	<0.00005	0.0006	0.0004	0.01	0.002
Nickel	mg/L	<0.01	0.004			0.007	< 0.01	0.1*	0.07*	0.2	1
Lead	mg/L	<0.01	<0.001			<0.005	0.012	0.41*	2.4*	0.1	0.1
Zinc	mg/L	0.015	<0.005			<0.025	<0.05	0.55*	1	3	20
Aluminum	mg/L	<0.01	<0.01			<0.025		0.055		0.2	
Manganese	mg/L	<0.01	<0.01			0.005		1.9	0.08	5	
Selenium	mg/L		0.002			0.016	0.015	0.011		0.1	0.02
Alkalinity	CaCO3mg/L		390			290	320				
Carbonate	mg/L		<5			41	31				
Hardness	$CaCO_3$mg/L		5100			4200	4400				
Boron	mg/L	10						0.37		40	
Iron	mg/L	<0.05				<0.025	<0.05			0.3	
Nitrate	mg/L	22				110	120			500	400
Nitrite	mg/L	0.33				2.1	1.5			30	30

Parameter	unit	6/19/2012	9/20/2016	4/25/2017	7/18/2017	3/18/2018	10/14/2018	ANZECC fresh 2018	ANZECC Marine 2018	NPGU	ANZECC 2000 Livestock
Silica	mg/L					7.4					
Antimony	mg/L					<0.01	<0.01	0.009		0.03	
Cobalt	mg/L						<0.01		0.001		1

*HMGV

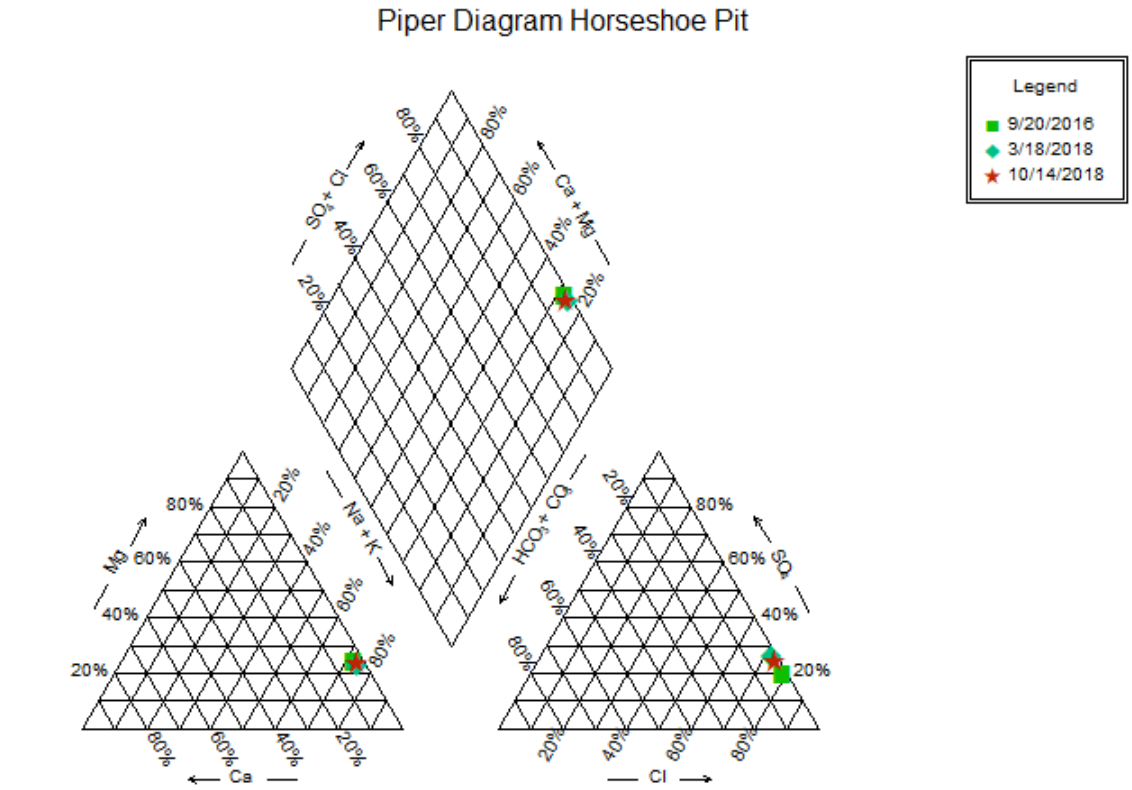

Figure 4: Piper Diagram Horseshoe Pit

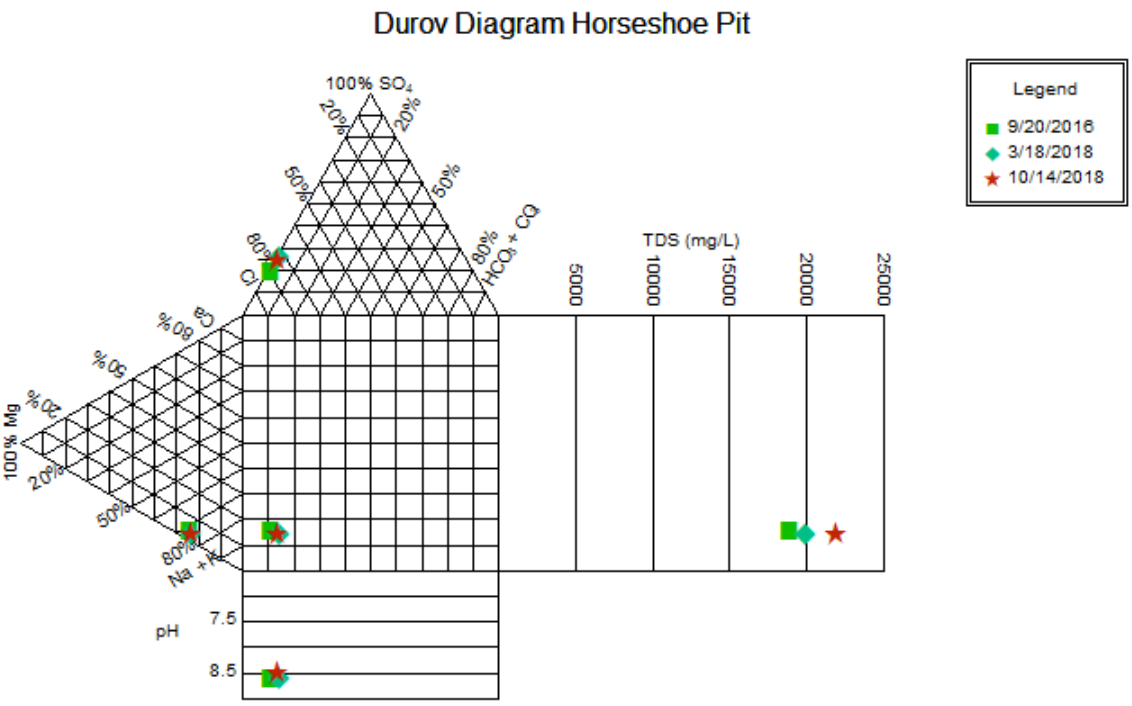

Figure 5: Duov Diagram Horseshoe Pit

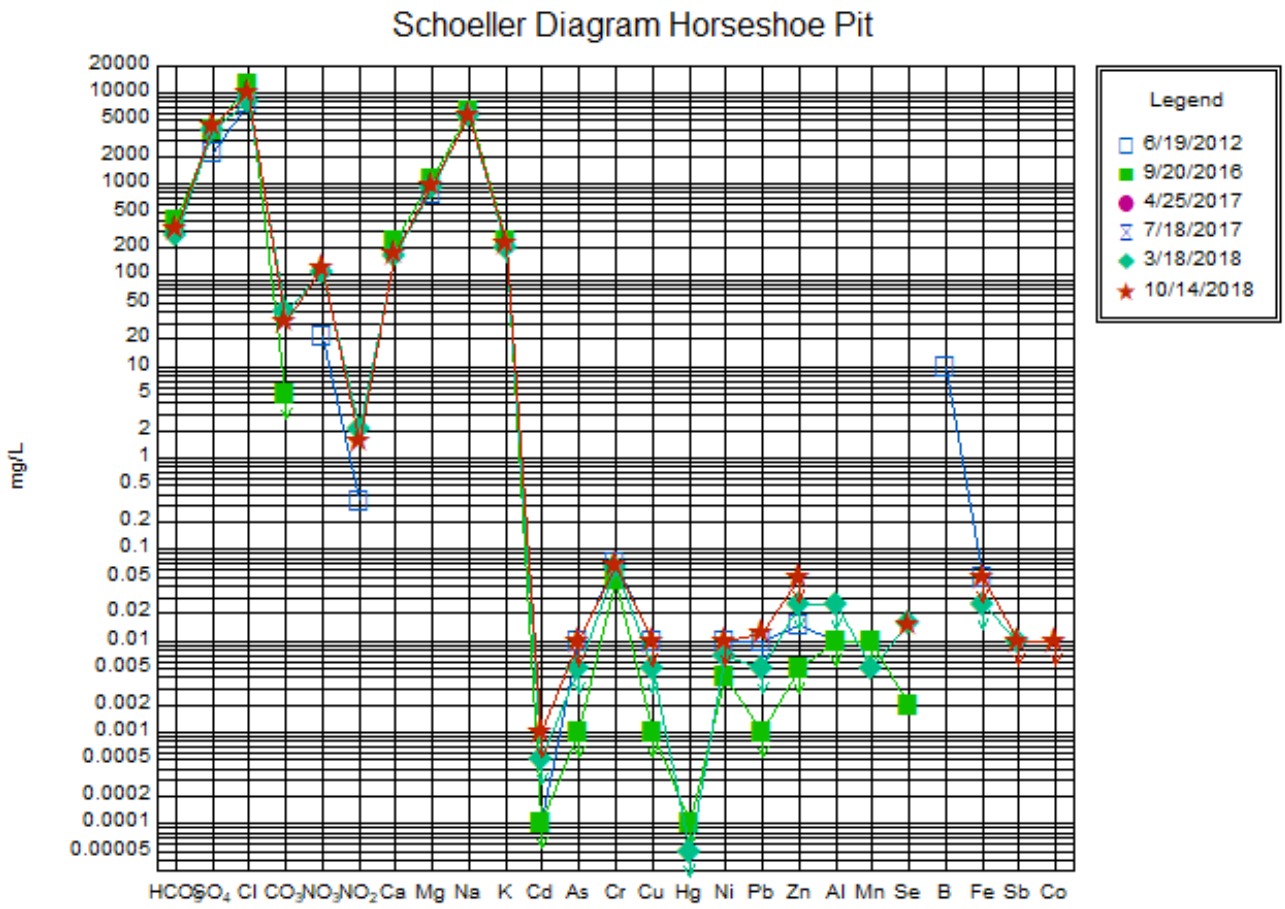

Figure 6: Schoeller Diagram Horseshoe Pit

Table 6: Trend Analysis Results Horseshoe Pit

	Mg	SO_4	Cl	TDS	EC	pH	Cr
Coefficient variation	0.14	0.27	0.21	0.08	0.07	0.06	0.18
MK Statistic	2	5	2	12	14	3	0
Confidence %	62.5	89.6	62.5	98.	99.6	64	37.5
Trend	No trend	No trend	No trend	Increasing	Increasing	No trend	Stable

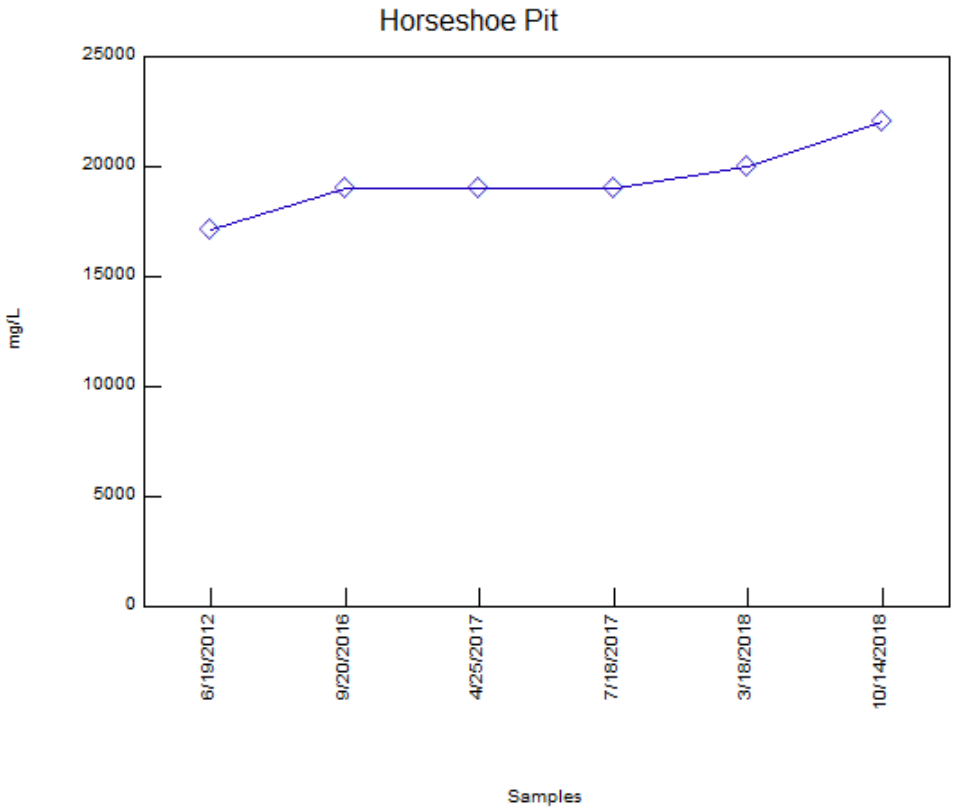

Figure 7: Increasing trend TDS Horseshoe Pit

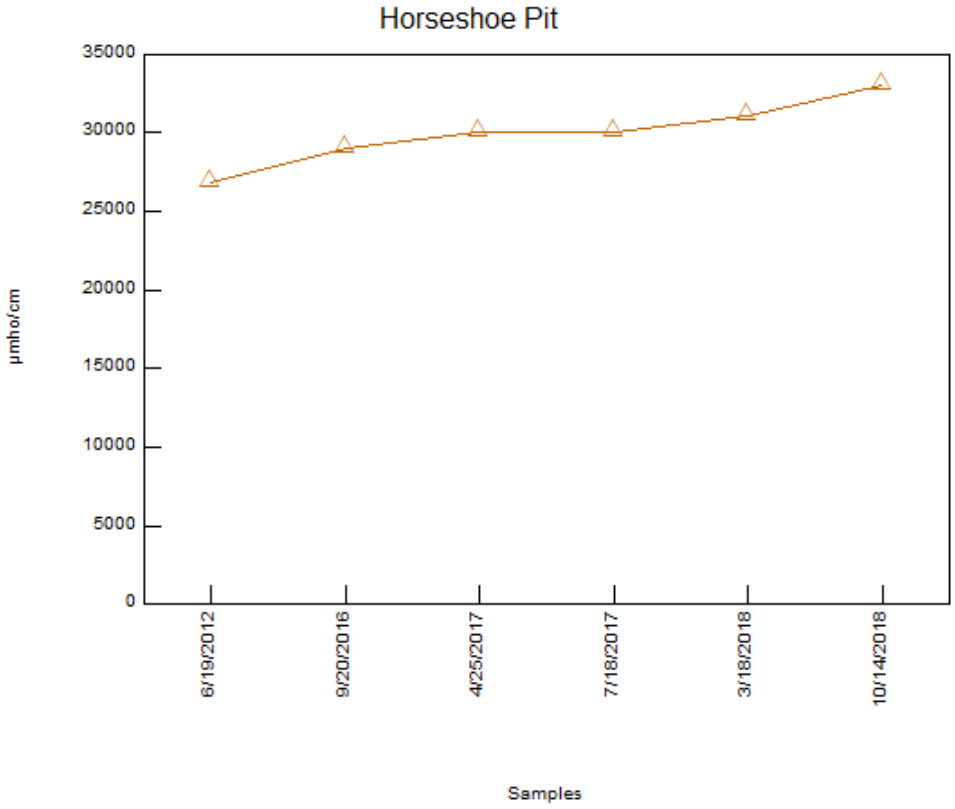

Figure 8: Increasing EC Trend Horseshoe Pit

8.3.2. Cassidy Pit Water Quality

Water in the pit was sampled 2012 to 2018. The major ion and metal concentrations are given in Table 7. Results have been compared with the ANZECC (updated 2018) default guideline values (DGV's) for fresh and marine waters, ANZECC (2000) Livestock trigger limits and Department of Health (DoH) 2014 Non Potable groundwater use (NPGU). The threshold levels have been adjusted for extremely hard water in accordance with the guidelines.

Cassidy pit water exceeds ANZECC Fresh water at the 95% Protection Level DGV's for copper, selenium and boron. Cassidy exceeds copper ANZECC Marine DGV. Cassidy pit water exceeds the DoH NPGU limits for sulphate and chloride and exceeds ANZECC (2000) Livestock triggers for sulphate, selenium and TDS.

Figure 9 shows the water from Cassidy is classified as sodium-chloride type water. The Durov diagram (Figure 10) shows the TDS has increased from 2016 to 2018 and the pH has remained alkaline. The Schoeller diagram (Figure 11) shows 2012 results have higher Cr, Zn and B, the 2016 results have higher HCO_3, Cl, Ca, Mg, Na and K and the 2018 results have the highest Ni, Pb, EC, TDS, Se, NO_2, NO_3 and CO_3. Cd, As, Cu, Hg, Al, Fe, Sb and Co are below the level of reporting (<LoR) denoted by an arrow pointing downwards.

Trend analysis results shown Table 8. No significant trends revealed.

Table 7: Cassidy Pit Water Quality Results

Parameter	Unit	6/19/2012	9/23/2016	4/25/2017	7/18/2017	3/18/2018	10/14/2018	ANZECC fresh 2018	ANZECC Marine 2018	NPGU	2000 ANZECC livestock
Calcium	mg/L		520			390	460				1000
Magnesium	mg/L	1500	2600			2000	2400				
Sodium	mg/L		14000			12000	13000				
Potassium	mg/L		410			350	430				
Bicarbonate	mg/L		350			220	360				
Sulfate	mg/L	7100 7100	11000 11000			8600 8600	11000 11000			1000	1000
Chloride	mg/L	19000	24000			18000	24000			250	
TDS	mg/L	33500	50000	38000	44000	43000	54000				4000
EC	µS/cm	52400	61000	53000		57000	69000				
pH	pH	8.3	8.5	8.6	8.5	8.5	8.3				
Alkalinity	mg/L		350			240	300				
Carbonate	mg/L		< 5			36	7				
Nitrate	mg/L		19			74	68			500	400
Nitrite	mg/L		0.035			4.9	4.8			30	30
Hardness	mg/L		12000			9100	11000				
Antimony	mg/L						<0.02	0.009		0.03	
Arsenic	mg/L	< 0.02	<0.001			<0.01	<0.02	0.024		0.1	0.5
Cadmium	mg/L	<0.002	0.004			<0.001	<0.002	0.03*	1*	0.02	0.01
Chromium	mg/L	<0.02	0.029			0.014	<0.02	0.4*	4.1*	0.5	1
Cobalt	mg/L						<0.02		0.001		1
Copper	mg/L	<0.02	0.003 0.003			<0.01	<0.02	0.0014	0.0013	20	1
Iron	mg/L	<0.1				<0.05	<0.1			0.3	
Lead	mg/L	<0.02	<0.001			<0.01	<0.02	6.1*	7*	0.1	0.1
Nickel	mg/L	<0.02	0.01			0.017	<0.02	1.6*	10*	0.2	1
Selenium	mg/L		0.003			0.024 0.024	0.021 0.021	0.011		0.1	0.02
Zinc	mg/L	<0.02	0.005			<0.05	< 0.1	1.2*	2.2*	3	20

Parameter	Unit	6/19/2012	9/23/2016	4/25/2017	7/18/2017	3/18/2018	10/14/2018	ANZECC fresh 2018	ANZECC Marine 2018	NPGU	2000 ANZECC livestock
Silica	mg/L					5.7					
Aluminum	mg/L	<0.02	<0.01			<0.05		0.055		0.2	5
Manganese	mg/L	<0.02	<0.01			0.037		1.9	0.08	5	
Mercury	mg/L		<100E-6			<50E-6		0.0006	0.0004	0.01	0.002
Boron	mg/L	18						0.37		40	5

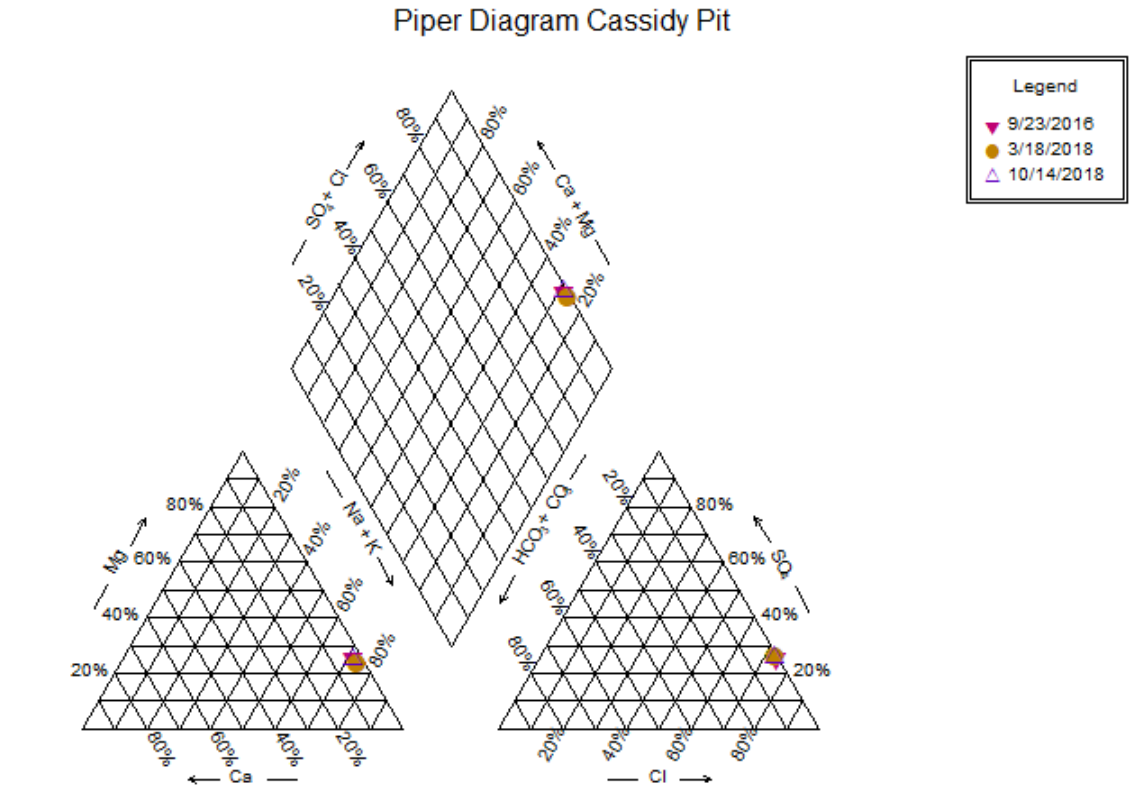

Figure 9: Piper Diagram Cassidy Pit

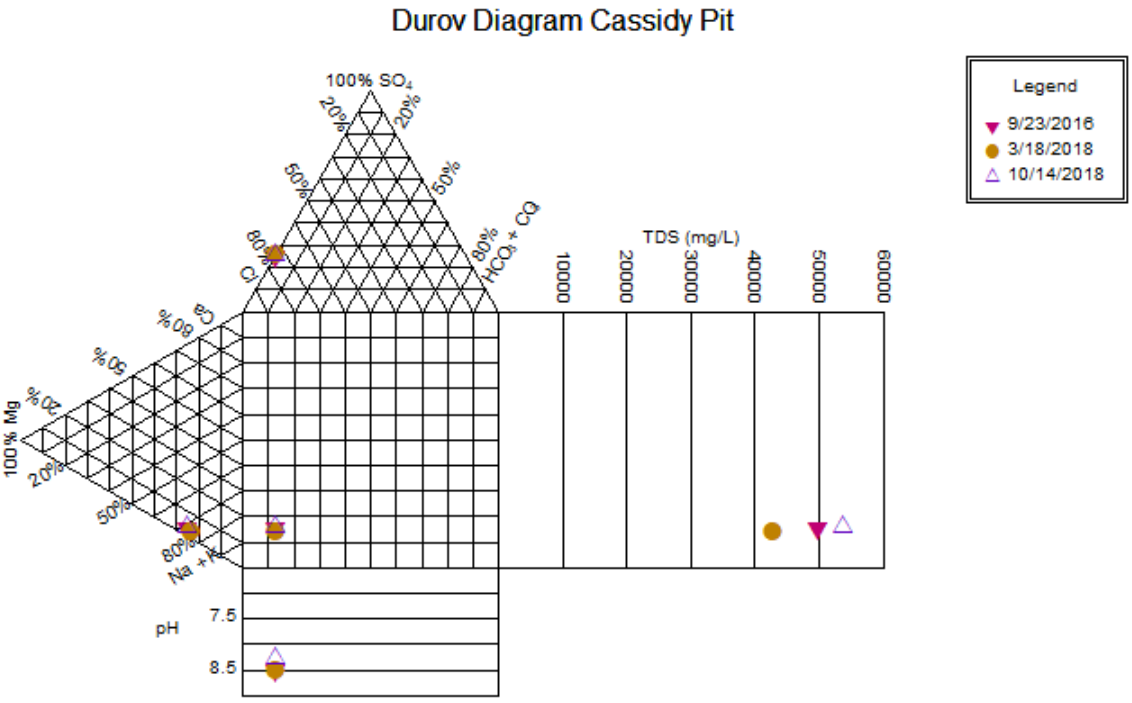

Figure 10: Durov Diagram Cassidy Pit

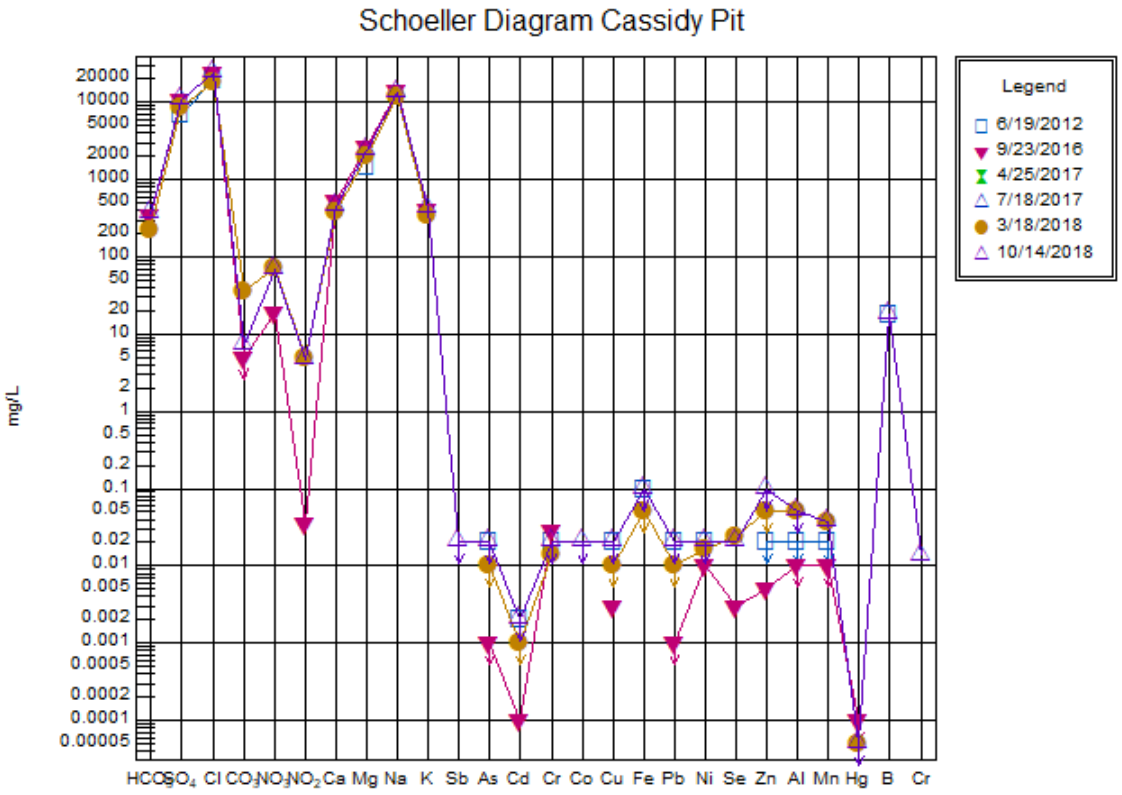

Figure 11: Schoeller Diagram Cassidy Pit

Table 8: Trend Analysis Results Cassidy Pit

	Mg	SO_4	Cl	TDS	EC	pH
Coefficient variation	0.23	0.20	0.15	0.17	0.17	0.01
MK Statistic	2	3	1	7	7	-1
Confidence %	62.5	72.9	50	86.4	86.4	50
Trend	No trend	No trend	No trend	No trend	No trend	Stable

8.3.3. Modelled Mixed Horseshoe and Cassidy Pits

The AqQa (RockWare, 2006) program was used to calculate the composition of the mixture of the Horse shoe pit water with the receiving environment Cassidy Pit (Table 9). The mixed composition contains each analyte which is conservative during mixing. Ion compositions such as sodium and sulphate, for example, are conservative, but pH is not. For example, as pH is based on a logarithmic scale, mixing pH 5 water with pH 7 water does not yield a mixture of pH 6.

The modelled mixed water exceeds the ANZECC 2018 Fresh water for Se and B. No parameters exceed ANZEC 2018 Marine waters. Sulphate and chloride exceed NPGU and sulphate a, TDS and B exceed ANZECC 2000 Livestock triggers.

Table 9: Modelled Mixed Pit Water Results

Parameter	Unit	Cassidy	Horseshoe	Mixed	ANZECC Fresh 2018	ANZECC Marine 2018	NPGU	ANZECC 2000 Livestock
Calcium	mg/L	460	170	315				1000
Magnesium	mg/L	2400	960	1680				
Sodium	mg/L	13000	5700	9350				
Potassium	mg/L	430	220	325				
Bicarbonate	mg/L	360	330	345				
Sulfate	mg/L	11000 11000	4400 4400	7700 7700			1000	1000
Chloride	mg/L	24000	10000	17000			250	
TDS	mg/L	54000	22000	38000				4000
EC	µS/cm	69000	33000					
pH	pH	8.3	8.5					
Alkalinity	mg/L	300	320					
Carbonate	mg/L	7	31	19				
Nitrate	mg/L	68	120	94			500	400
Nitrite	mg/L	4.8	1.5	3.15			30	30
Hardness	mg/L	11000	4400	7700				
Antimony	mg/L	<0.02	<0.01	<0.02	0.009		0.003	
Arsenic	mg/L	<0.02	<0.01	<0.01	0.024		0.1	0.5
Cadmium	mg/L	<0.002	<0.001	<0.002	0.02*	0.76*	0.02	0.01
Chromium	mg/L	<0.02	0.066	0.066	0.31*	2.59*	0.5	1
Cobalt	mg/L	<0.02	< 0.01	<0.02		0.001		1
Copper	mg/L	<0.02	<0.01	<0.02	0.0014	0.0013	20	1
Iron	mg/L	<0.1	<0.05	<0.05			0.3	
Lead	mg/L	<0.02	0.012	0.012	3.9*	5*	0.1	0.1
Nickel	mg/L	<0.02	<0.01	<0.02	1.2*	7.8*	0.2	1
Selenium	mg/L	0.021 0.021	0.015	0.018	0.011		0.1	0.02
Zinc	mg/L	<0.1	<0.05	<0.1	0.89*	1.6*	3	20
Silica	mg/L	5.7	7.4	6.55				
Aluminum	mg/L	<0.05	<0.025	<0.05	0.055		0.2	5
Manganese	mg/L	0.037	0.005	0.021	1.9	0.08	5	
Mercury	mg/L	<50E-6	<50E-6	<0.00005	0.0006	0.0004	0.01	0.002
Boron	mg/L	18 18	10 10	14 14	0.37		40	5

8.7 FLORA, FAUNA AND VEGETATION

The Murchison Region is located within the Eremaean Botanical Province and the Austin Botanical District. The vegetation of the Austin Botanical District is dominated by mulga (*Acacia aneura*) communities (Beard, 1990). A Geographical Information System (GIS) dataset of pre-European

vegetation in WA (Shepherd, 2003) is compiled largely from published and unpublished mapping by J.S. Beard (1:250,000 scale). The data set indicates three vegetation associations at Horseshoe (Table 10).

Umwelt (2013) undertook a Level 1 Flora and Vegetation survey (Level 1 Flora survey) and a Level 1 Fauna Survey and targeted fauna habitat survey for species of conservation significance (Level 1 Fauna survey) (Appendix C). The flora and fauna surveys were conducted in accordance with the Environmental Protection Authorities (EPA) relevant Position and Guidance Statements.

Results from the database searches recorded on Priority Ecological Community (PEC) that could occur within the area in addition to one Threatened Flora and 23 Priotity Flora (PF) which potentially occur within the area. 80 flora taxa (species, subspecies and varieties) were recorded within 24 families and 43 genera. Fabaceae, chenopodiaceae Malvvaceae, Poaceae and Scrophulariaceae were the most common families containing most taxa. The presence of halophytic vegetation would suggest the presence of underlying saline water properties within the local area.

No Declared rare Flora (DRF) pursuant to Section 23F (2) of the *Wildlife Conservation Act 1950* (WC Act) or Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the area. No PF were recorded in the area. Only one introduced flora species was recorded, *Portulaca oleracea* Purslane.

11 vegetation communities were identified with low open Acacia woodland considered the dominant vegetation. The area is located within the boundary of the PEC Robinson Range vegetation complexes (banded ironstone formation) (Priority 1). Two communities identified during the survey (X1 and X2) may express similarities with the PEC. However, the location of these communities are not in close proximity to existing mine site infrastructure and are unlikely to be impacted by any future works at horseshoe Gold Mine.

The condition of the vegetation communities across the survey ranged from ‘Excellent’ to ‘Completely Degraded’ in accordance with Keighery’s (1994) condition scale. Vegetation varied within vegetation communities across the area. Various causes of disturbance were recorded throughout the survey area including mineral exploration, vehicle tracks and cattle grazing. Results of the Level 1 Flora surveys of the area conclude no significant impacts to the flora and vegetation will occur as a result of the recommencement of mining on M52/338, M52/521 and L52/102 at horseshoe Gold Mine.

From a fauna perspective, four fauna habitats can be broadly described with Acacia woodland/shrubland (plains) representing up to 71% of the total area (979.22 ha) and the remainder comprises creekline vegetation (8.7%), Acacia woodland (hills) (6%) and Mulga (<1%). The desktop

study identified 285 fauna species that potentially could occur in the local area. This includes two fish species, six species of amphibians, 69 species of reptiles, 31 species of native mammals, ten species of non-native mammals, 100 native bird species and one exotic species of bird. Of these species, 16 are considered to be of fauna conservation significance.

64 species of vertebrate fauna were recorded during the on-site reconnaissance survey, with three species of conservation significance:

- Abandoned burrows of *Pseudomys chapmani Westtern pebble mound Mouse;*
- *Burhinus grallarius* Bush Stone-curlew; and
- *Oreoica gutturalis* Crested Bellbird.

A further three species of conservation significance are considered likely to occur in the area:

- *Sminthopsis longicaudata* Long-tailed Dunnart;
- *Ardeotis australis* Australian Bustard; and
- *Merops ornatus* Rainbow Bee-eater.

The saline nature of the groundwater precludes the presence of local groundwater dependent ecosystems.

Table 10: Vegetation Associations within Horseshoe

Vegetation Association	Description
18	Low woodland, mulga (*Acacia aneura)*
29	Sparse low woodland, mulga, discontinuous in scattered groups
39	Shrublands, mulga scrub

9 ABORIGINAL HERITAGE SITES

Horseshoe lies within the Nharnuwangga Wajarri and Ngarlawangga native title determination area (WCD 2000/001). A site avoidance heritage survey was conducted over Horseshoe in 2017 (Appendix D). No registered Aboriginal sites were found to exist at Horseshoe. During the survey a newly identified heritage place (ARA 17-01) was determined (Figure 12). The heritage place is located at the north eastern corner of the tenement (M52/338) on a small creekline and has been classified as a large medium density scatter.

The creekline, and thus the heritage place, will not be affected by any proposed mining operations and is further protected by its location behind existing waste dumps which prevent inadvertent accidental

access to the site. Furthermore, the boundary of the heritage place will be pegged and flagged and staff informed during the site induction.

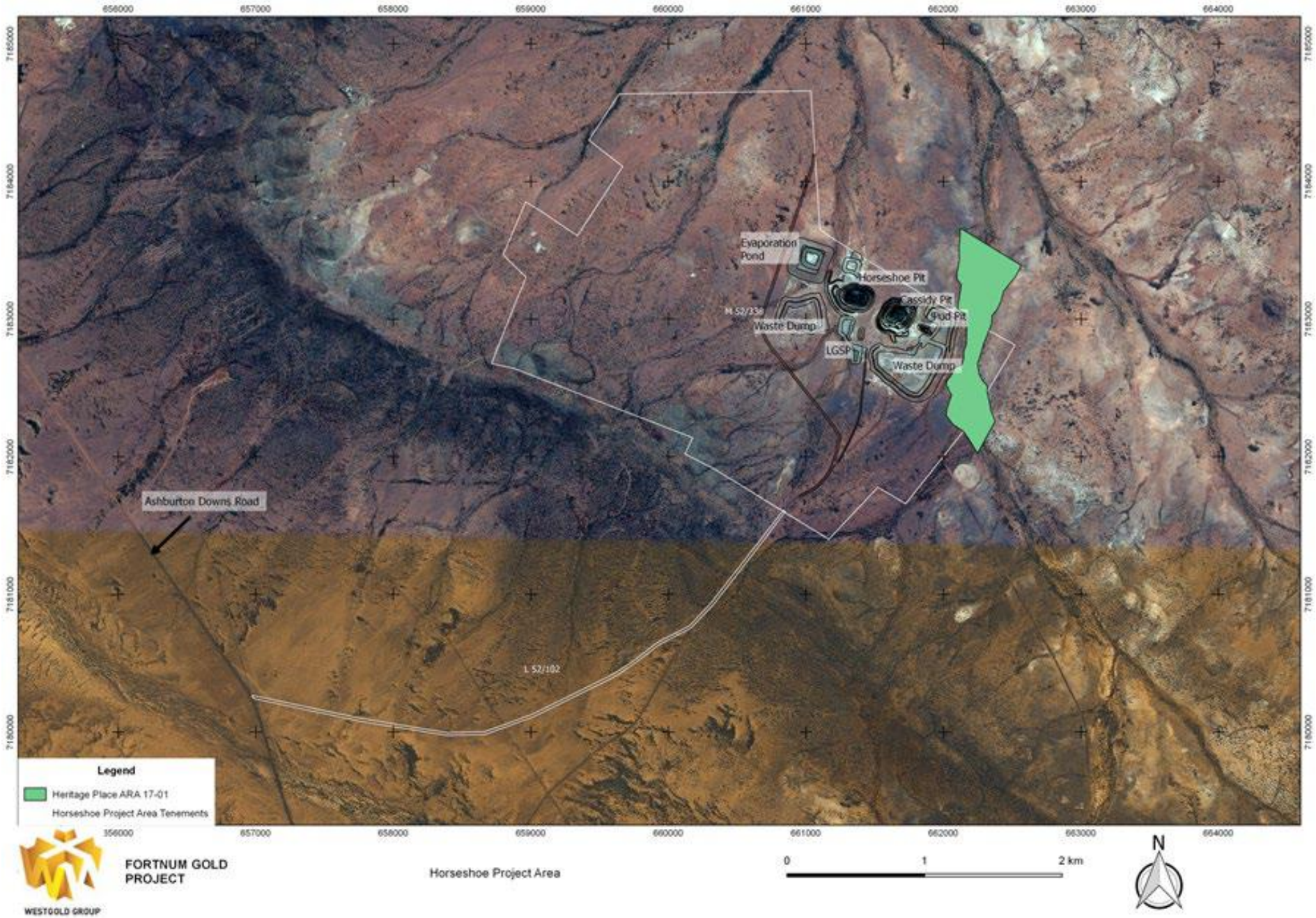

Figure 12: Horseshoe Aboriginal Heritage Place – ARA 17-01

10 SENSITIVE RECEPTORS

No Environmentally Sensitive Areas (ESAs) are known to occur within or adjacent to Horseshoe. ESAs generally include areas within 50 metres of protected wetlands, within 50 metres of declared rare flora, Bush Forever sites and those areas containing a threatened ecological community. In addition to this, there are no Specified Ecosystems listed in Appendix 1 of the 2016 Environmental Siting Guidance Statement, that occur within or adjacent to the premises.

The Yulga Jinna community is located approximately 20 km south of Horseshoe and consists of approximately 14 households (Figure 13)

An environmental survey (flora and fauna) was completed over the project area (Appendix C) and results have been summarised in Section 8.7

The nearest groundwater sources used for pastoral purposes, shown on the geological maps are Windalah Bore, 11 km to the east, Gullgogo Bore 12 km east-north-east, Grain Bore 8 km to the north, and Dandy Well 10 km to the north-west.

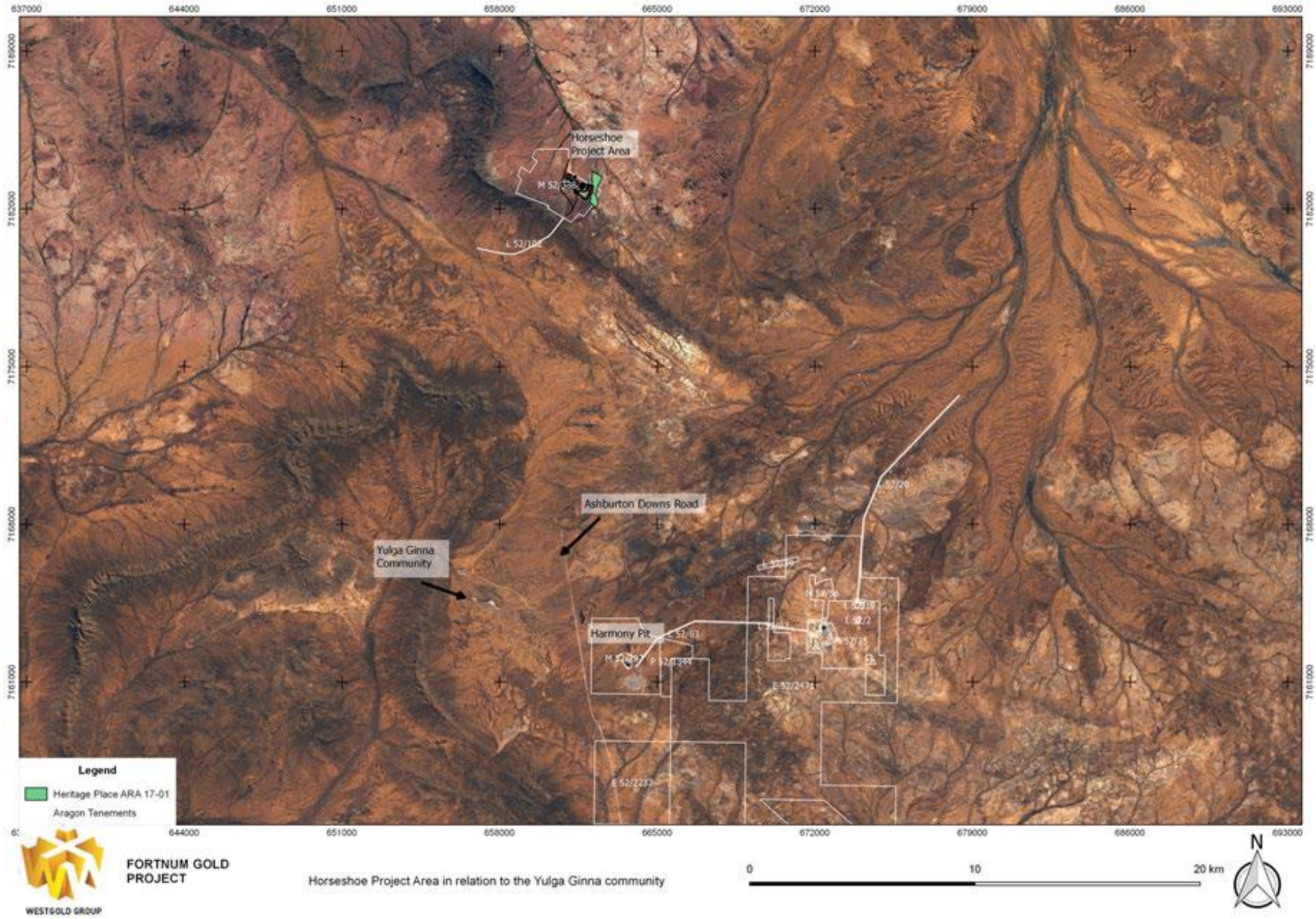

Figure 13: Horseshoe Project Area in relation to Yulga Ginna community

11 POTENTIAL IMPACTS AND MANAGEMENT MEASURES

11.3 AIR QUALITY/GASEOUS EMISSIONS

Operational activities associated with dewatering of the Horseshoe pit will generate low levels of greenhouse gas emissions from light vehicle and diesel generator fuel consumption. A small scale vehicle fleet will be used for the project. Greenhouse gas emissions from the dewatering project are unlikely to cause any significant environmental impacts. The project is a small scale operation with a relatively short duration of approximately one year. The uninhabited nature of the local area, small scale and short duration of the project will ensure that emissions will not directly impact any populated area.

11.4 DUST EMISSION

During dewatering at Horseshoe, minor fugitive dust is likely to be generated from light vehicle movements, refuelling activities and infrastructure inspections. Fugitive dust emissions can impact on sensitive receptors, the health of vegetation and fauna and surface water quality. Visual amenity and nuisance effects could result from dust generated during project operational activities including traffic movements. These are considered very low risk. Standard dust suppression measures (i.e. use of water cart) will be adequate in controlling dust emission.

11.5 NOISE AND VIBRATION

No sensitive receptors such as residential areas are within 20 km of the proposed dewatering activity and therefore noise and vibration are considered not to be a major issue. The potential impact in regard to noise is considered minimal based on lack of sensitive receptors. However, during operations a diesel generator will be used. Noise and vibration may be caused by the following activities:

- Diesel generator; and
- Light vehicles.

Westgold will ensure that noise levels meet the requirements of the Environmental Protection (Noise) Regulations 1997.

11.6 STORED CHEMICAL AND FUELS

No chemicals will be stored on site. A pontoon mounted electric powered pump will be powered by a generator located at the top of Horseshoe pit. The generator will use diesel from a self bunded 4,500L

steel fuel tank that will be located immediately adjacent to a generator on a secure flat level pad. There is minimal risk of significant land contamination as a result of accidental spillage of fuels during operations. Spill kits will be strategically located and internal spill management procedures will be implemented and followed.

11.7 LIGHT EMISSION

The proposed dewatering project will be run on a continuous 24/7 basis but will not require artificial lighting. Refuelling activities will take place during daylight hours. There is no risk to fauna or the environment from light emissions.

11.8 DISCHARGE TO LAND

The saline groundwater dewatered from Horseshoe pit will be stored in Cassidy pit thereby reducing the discharge to land.

The pipeline carrying the water will be located in an area that is very disturbed mine area from previous operations and with no vegetation. The distance the pipeline will cross between the two pits is approximately 80m.

Potential impacts from pit water and dewatering activities include:

- Death or decline in vegetation health:
- Impact to local fauna species:
- increased metal, salt, nutrient and solid loads into the environment;
- inundation/drawdown impacts (altered hydrological conditions and potentially soil salinities), which may impact on nearby receptors; and
- erosion/scouring effects associated with flow.

Potential Impacts will be minimised by implementation of recommended modes of disposal for pit water and via the implementation of management strategies listed in the risk assessment (Table 16). While unlikely, any seepage or leakage will be restricted locally to mine areas.

In addition, a monitoring program will be undertaken that:

- Records the amount of water drawn and discharged monthly;
- Assesses discharge water quality through sampling of field pH and electrical conductivity (EC),
- Sampling for laboratory analysis of major components (quarterly),

- Pipeline situated in a bunded corridor, and
- Daily inspections of pipeline.

Provided the above measures are implemented, the risk associated with the proposed dewatering and discharge from the pits is considered low.

11.9 FLORA AND VEGETATON

The area where the dewatering infrastructure is to be installed is a small area located between two near pits and very disturbed from previous mining. There is no flora within 100m of the pipeline. No threatened flora exists in the area affected by dewatering infrastructure and existing vegetation is very sparse and degraded therefore unlikely to be affected by any potential salinity.

A clearing permit (CPS 7429/1) has been granted over M52/338. The assessment completed by the Department of Mines, Industry Regulation and Safety (DMIRS), found that the proposed clearing of native vegetation was 'not at variance' or 'not likely to be at variance 'to any of the listed clearing principles.

Impacts to flora and vegetation will be managed via implementation of management measures listed in the risk assessment (Table 16).

11.10 TERRESTIAL FAUNA

Two species of conservation significance recorded at Horseshoe are birds. Two other bird species have the potential to occur in the area. The high mobility of birds in conjunction with the relatively low disturbance of this project reduces the potential impact on these species.

The Long-tailed Dunnart has the potential to occur in the area, however they are known to prefer stony slope habitat, of which there is not in the immediate highly disturbed area.

A clearing permit (CPS 7429/1) has been granted over M52/338. The assessment completed by the Department of Mines, Industry Regulation and Safety (DMIRS), found that the proposed clearing of native vegetation was 'not at variance' or 'not likely to be at variance 'to any of the listed clearing principles.

In addition to this, the habitats found within the mining area do not represent significance habitat for local fauna species, including species of conservation significance. The risk presented to local fauna species from dewatering and dust suppression activities are considered low.

Impacts to local fauna species will be managed via implementation of management measures listed in the risk assessment (Table 16).

12 SUMMARY OF IMPACTS AND MITIGATION MEASURES

Table 11 presents a summary of impacts and mitigation measures, including monitoring (discussed further below). Section thirteen presents risk assessment results.

Table 11 Summary of Impacts and Mitigation Measures

Environmental Factor	Potential Impact	Management measures	Monitoring
Air Quality, Gaseous Emissions	Low levels of greenhouse gas emissions due to fuel consumption from light vehicles and equipment including diesel generators	Only low levels of greenhouse gas emissions will be produced from light vehicle and equipment fuel consumption. The uninhabited nature of the region, small scale and short duration of the project will ensure that emissions will not directly impact any populated area.	Fuel consumption data will be recorded and reported to the National Pollutant Inventory and National Greenhouse and Energy Reporting.
Dust Emissions	Dust will be generated predominantly from natural occurrences. Minor fugitive dust is likely to be generated as a result of the proposed pit dewatering project due to the light vehicle movements from refuelling activities and infrastructure inspections.	Only minor fugitive dust is likely to be generated from light vehicle movements during refuelling activities and infrastructure inspections. Limit activities to minimise dust generation on cleared areas. Delay activities if weather conditions are likely to produce excessive dust. Utilise the water truck for dust suppression as required.	Visual monitoring for dust during construction and maintenance activities.
Noise Emissions	No sensitive receptors such as residential areas are within 20km of the proposed dewatering activity and therefore noise and vibration are considered not to be a major issue.	The potential impact from noise and vibration is considered minimal. Ensure that noise levels meet the requirements of the Environmental Protection (Noise) Regulations 1997.	N/A
Light Emissions	Excessive light emissions causing alteration in the behaviour of local fauna.	There is no risk to fauna or the environment from light emissions as the dewatering project will not require artificial lighting. Refuelling activities will take place during daylight hours only.	N/A
Hydrocarbons Management	Localised contamination of soil and groundwater.	There is minimal risk of significant land contamination as the only fuel stored at the site will be at the self bunded diesel powered generator and associated self bunded fuel	At a minimum, generator will be inspected once per 12 hour shift and undergo regular maintenance and servicing to ensure efficient operation

Environmental Factor	Potential Impact	Management measures	Monitoring
		pod.	
Dewatering	Increased salinity in the aquifer (groundwater) Overflow or discharge of saline water to drainage lines (surface water) and soil, increasing salinity	Discharge outlet located 10 m below Cassidy pit crest; Monitor and inspect pipeline daily.	Water quality monitoring. Pipeline inspections.
Dewatering	Reduced groundwater availability for dependent ecosystems and other users Pipeline leaks and spills	Commission assessment of dewatering requirements and implement recommended modes of disposal; Monitor and inspect pipeline daily.	Undertake monitoring activities to: 1) Record the amount of water drawn and discharged monthly; 2) Assess discharge water quality through sampling of field pH, Total Dissolved Solids (TDS) and electrical conductivity (EC), 3) Quarterly sampling for laboratory analysis of major components. 4)Visual monitoring of any impacts to vegetation will be undertaken following identification of any spills or leaks 5) Photo monitoring of creekline vegetation
Waste	Contamination of the project area with domestic and industrial waste	All waste from pipeline and infrastructure installation and maintenance activities will be disposed at a licensed landfill facility.	Monthly environmental inspections
Native Vegetation	Loss of biological diversity and reduced regional representation of flora and vegetation communities. Loss of conservation significant flora Increased weed distribution Loss or degradation of flora and vegetation due to dust deposition Increased movement of people and vehicles (damage to native flora via off road travel)	Develop and undertake weed management procedures; Restriction of vehicle movements to designated roads; Implement dust management practices.	Monthly environmental inspections
Flora	Potential impacts to vegetation surrounding areas undergoing dewatering	While it is considered that the dewatering phase will pose minimal risk to the environment, if any degradation to vegetation occurs an investigation will be commissioned to determine the actual cause.	Monthly environmental inspections
Fauna	Alteration in behaviour of fauna	There are no significant	Daily (once per 12 hour

Environmental Factor	Potential Impact	Management measures	Monitoring
	due to dust, noise, vibration and light emissions. Fauna access to project infrastructure including the discharge point causing entrapment	dust, noise, vibration and light emissions from dewatering activities. Installation of measures to reduce fauna access (such as fencing and fauna egress matting) where deemed necessary.	shift) monitoring of the dewatering pump, pipeline and evaporation pond.
Discharges to Land	Contaminate surface water, groundwater and soil; and Impact on flora and fauna	Hydrocarbon spill kits will be stored in close vicinity to all diesel powered pumps and generators and refuelling areas Pit water will be discharged into neighbouring saline pit located approximately 80m from each other. Pipeline will be monitored and inspected daily.	Monitoring will include visual inspection of pipes, other infrastructure and the vegetation near to the proposed pipeline route once per 12 hour shift

13 ASSESSMENT OF ENVIRONMENTAL RISKS

The methodology used in this risk assessment was rating likelihood on a scale Rare (1) to Almost Certain (5) (Table 12) and consequence on a scale of Insignificant (A) to Severe (E) (Table 13). The risk rating matrix (Table 14) is used to determine a single score for the environmental risk for each factor. The Risk Assessment (Table 14) considers the combination of the likelihood and the consequences for potential environmental impacts and provides a risk analysis for environmental factors before and after controls are implemented.

Table 12: Likelihood Categories

Level	Descriptor	Expected Frequency		Probability
1	Rare	Once in 15 years	Highly unlikely, but it may occur in exceptional circumstances	0 – 10%
2	Unlikely	At least once in 10 years	Not expected, but there's a slight possibility it may occur at some time	11 – 40%
3	Possible	At least once in 3 years	The event might occur at some time as there is a history of infrequent occurrences of similar issues with similar projects/ activities	41 – 60%
4	Likely	At least once per year	There is a strong possibility the event will occur as there is a history of frequent occurrence with similar projects/activities	61 – 90%
5	Almost certain	More than once per year	The event is expected to occur at some time as there is a history of continuous occurrence with similar projects / activities	91 – 100%

Table 13: Consequence Categories

Environmental factor	Insignificant (A)	Minor (B)	Moderate (C)	Major (D)	Severe (E)
Biodiversity / Flora/ Fauna/ Ecosystem	None or insignificant impact to ecosystem component (physical, chemical or biological) expected with no effect on ecosystem function	Moderate to minor impact to ecosystem component (physical, chemical or biological) Minor off-site impacts at a local scale	Minor and short-term impact to high value or sensitive ecosystem expected Off-site impacts at a local scale	Long-term impact to significant high value or sensitive ecosystem expected Long-term impact on a wide scale Adverse impact to a listed species expected	Irreversible impact to significant high value or sensitive ecosystem expected Irreversible and significant impact on a wide scale Total loss of a threatened species expected
Water Resources	Low impact to isolated area without affecting any use of the water.	Contained low impact with negligible effect on the use of the water.	Uncontained impact that will materially affect the use of the water, but able to be rectified in short-term.	Extensive hazardous impact requiring long-term rectification	Uncontained hazardous impact with residual effect
Land Degradation	Negligible impact to isolated area.	Contained low impact, not impacting on any environmental value.	Uncontained impact, able to be rectified in short-term without causing pollution or contamination	Extensive hazardous impact requiring long-term rectification	Uncontained hazardous impact with residual effect
Air Quality	No detectable impact	Contained low impact not impacting on any environmental value.	Uncontained impact that will materially affect an environmental value, but able to be rectified in short-term.	Extensive hazardous impact on an environmental value requiring long-term rectification	Uncontained hazardous impact with residual effect
Mine Closure	Site is safe, stable a non-polluting and post mining land use is not adversely affected	The site is safe, all major landforms are stable and any stability or pollution issues are contained and require no residual management. Post-mining land use is not adversely affected.	The site is safe, and any stability or pollution issues require minor, ongoing maintenance by end land-user	The site cannot be considered safe, stable or non-polluting without long-term management or intervention. Agreed end land-use cannot proceed without ongoing management.	The site is unsafe, unstable and/ or causing pollution or contamination that will cause an ongoing residual affect. The post mining land use cannot be achieved.

Table 14 Risk Rating Matrix

	Insignificant (A)	Minor (B)	Moderate (C)	Major (D)	Severe (E)
Rare (1)	Low	Low	Low	Moderate	Moderate
Unlikely (2)	Low	Low	Moderate	Moderate	High
Possible (3)	Low	Moderate	Moderate	High	High
Likely (4)	Low	Moderate	High	Extreme	Extreme
Almost certain (5)	Low	High	High	Extreme	Extreme

Table 15: Risk Assessment

Environmental factor	Potential environmental impact	Inherent risk			Control	Residual risk		
		L	C	RR		L	C	RR
Water Resources	Increased salinity in the aquifer	2	B	L	Disposal into non mining pit that has greater salinity therefore diluting the salinity. Geology of both pits is of low permeability and no connectivity between the pits despite the close proximity to each other. The pits are ground water sinks. Scheduled quarterly pit water quality monitoring.	2	B	L
Water Resources	Increased salinity of nearby creek	3	B	M	Existing bunding surrounding the pits contains any saline water from possible burst pipe within pit area. Short distance of pipeline carrying saline water (approx. 80m). Daily inspections of pipeline. Install pipeline in a bunded corridor. Photo point monitoring of site at nearby creek	2	B	L
Biodiversity / Flora / Fauna / Ecosystem	Vegetation death at nearby creek. Vegetation death due to dust suppression with saline water	3	B	M	Highly disturbed pit area where pipeline will be located is devoid of vegetation. Presence of local halophytic flora indicates tolerance of underlying salinity. Photo point monitoring of site at nearby creek. Install pipeline in a bunded corridor. Minimise spray drift into vegetation alongside roads by use of dribble bars.	2	B	L
Biodiversity / Flora / Fauna / Ecosystem	Introduction and increased prevalence of weeds	2	B	L	Implementation of Westgold Weed Management Procedure. There are no groundwater dependent ecosystems due to saline groundwater.	2	B	L
Biodiversity / Flora / Fauna / Ecosystem	Loss or destruction of fauna habitat due clearing or vehicle movement.	2	B	L	Implementation of the Westgold Surface Disturbance Procedure. Speed limits in place.	2	B	L
Land Degradation - Salinity	Localised soil contamination from saline water spills.	3	B	M	Existing bunding surrounding the pits contains any saline water from possible burst pipe within pit area. Short distance of pipeline carrying saline water (approx. 80m). Daily	2	B	L

Environmental factor	Potential environmental impact	Inherent risk			Control	Residual risk		
		L	C	RR		L	C	RR
					inspections of pipeline			
Land Degradation - Hydrocarbons	Localised contamination of soil, sediment, surface water and groundwater	4	B	M	No chemicals will be stored on site. Diesel generator will be bunded and spill kits made available. Implementation of the Westgold Hydrocarbon Management Procedure and Spill and Clean-Up Procedure	2	B	L
Land Degradation - Waste	Contamination of the project area with domestic and industrial waste	4	A	L	Waste taken to Fortnum landfill	3	A	L
Air Quality	Excessive greenhouse gas pollution	3	A	L	Regular maintenance of infrastructure and emission controls.	2	A	L
Air Quality - Dust Emissions	Generation of fugitive dust from light vehicle movements and maintenance work.	5	A	L	Water truck made available and utilised when required.	5	A	L
Noise Emissions	Excessive noise generation causing public nuisance or an alteration in the behaviour of local fauna	3	A	L	Daily maintenance and inspection of infrastructure.	2	A	L
Light emissions	Excessive light emissions causing decreased amenity for passing traffic and an alteration in the behaviour of local fauna.	2	A	L	All monitoring and maintenance will be conducted during daylight hours therefore no artificial lighting is required. No lighting towers will be used for dewatering.	2	A	L

14 MONITORING & REPORTING

Monitoring will take place as outlined in Table 11 as well as monitoring conditions in GWL 159877(8) and pit water parameters in Prescribed Premises Licence L8103/1989/3. All recorded monitoring data will be summarised in the 'Annual Groundwater Monitoring Summary' as well as reported in an Annual Environmental Report which will be outlined in the licence yet to be granted.

15 REFERENCES & BIBLIOGRAPHY

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APPENDIX A

Government of Western Australia
Department of Mines, Industry Regulation and Safety

eMiTS MINERAL TITLES ONLINE

MINING TENEMENT SUMMARY REPORT

MINING LEASE 52/338

Status: Live

TENEMENT SUMMARY

Area: 684.35000 HA
Mark Out : 25/06/1992 15:08:00
Received : 29/06/1992 12:45:00
Term Granted : 21 Years (Renewed)
Death Reason :
Death Date :
Commence : 28/10/1992
Expiry : 27/10/2034

CURRENT HOLDER DETAILS

Name and Address
ARAGON RESOURCES PTY LTD
AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, PO BOX 1434, WANGARA, WA, 6947, xxxxxxxxx@austwidemining.com.au, xxxxxxx400

DESCRIPTION

Locality: Horseshoe Range
Datum: Datum is situated at the north east corner of surveyed M 52/104
Boundary: Thence 1010.01 metres bearing 175 degrees 33 minutes along eastern boundary of M 52/104 to its south east corner Thence 131.25 metres bearing 123 degrees 34 minutes along surveyed boundary of M 52/141 Thence 797.14 metres bearing 121 degrees 18 minutes and 721.92 metres bearing 117 degrees 41 minutes along surveyed boundaries of M 52/141 to its most easterly corner Thence 710.22 metres bearing 210 degrees 08 minutes and 694.30 metres bearing 217 degrees 52 minutes along surveyed boundaries of M 52/141 to its most southerly corner Thence 235.17 metres bearing 300 degrees 08 minutes along surveyed boundary of M 52/141 to corner of M 52/114 Thence 508.00 metres bearing 222 degrees 36 minutes along surveyed boundary of M 52/114 to corner of P 52/536 Thence 980.00 metre sbearing 300 degrees to most easterly corner of M 52/145 Thence 235.52 metres bearing 296 degrees 18 minutes, 31.13 metres bearing 024 degrees 25 minutes, 1395.71 metres bearing 290 degrees 29 minutes and 164.10 metres bearing 281 degrees 24 minutes along surveyed boundaries of M 52/145 to south east corner of late surveyed GML 52/745 Thence 277.10 metres bearing 020 degrees 24 minutes along boundary of late surveyed GML 52/745 to its most easterly corner Thence 399.15 metres bearing 021 degrees 33 minutes along boundary of late surveyed GML 52/910 to most southerly corner of M 52/15 Thence 233.60 metres bearing 313 degrees 34 minutes along surveyed boundary of M 52/15 to its most westerly corner

Thence 417.56 metres bearing 022 degrees 38 minutes along surveyed boundary of M 52/15 to its most northerly corner Thence 123.50 metres bearing 120 degrees 33 minutes and 88.85 metres bearing 123 degrees 25 minutes along surveyed boundaries of M 52/15 to its most easterly corner Thence 236.87 metres bearing 123 degrees 28 minutes along surveyed boundary of M 52/30 to its most easterly corner Thence 602.41 metres bearing 032 degrees 32 minutes along boundary of late surveyed M 52/31 to its most easterly corner Thence 310.40 metres bearing 306 degrees 56 minutes along surveyed boundary of M 52/104 to its most westerly corner Thence 402.33 metres bearing 032 degrees 21 minutes along surveyed boundary of M 52/104 to its north west corner Thence 1394.70 metres bearing 088 degrees 24 minutes along surveyed boundary of M 52/104 Back to datum Application covers area contained within M 52/15, M 52/30, M 52/104, M 52/141, M 52/174, M 52/288 and P 52/435

Area :	Type	Dealing No	Start Date	Area
	Surveyed		31/05/2008	684.35000 HA
	Granted		28/10/1992	680.73000 HA
	Applied For		25/06/1992	680.73000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MEEKATHARRA SHIRE	5250	25/06/1992		684.35000 HA

RENT STATUS

Due For Year End 27/10/2018: PAID IN FULL
Due For Year End 27/10/2019: $12,809.50

EXPENDITURE STATUS

Expended Year End 27/10/2017: EXPENDED IN FULL
Current Year Commitment : $68,500.00

APPENDIX B

HORSESHOE GOLD MINE

HYDROGEOLOGICAL ASSESSMENT OF HORSESHOE AND CASSIDY PITS

REPORT FOR
WESTGOLD GROUP

OCTOBER 2018

Rockwater
HYDROGEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

Report No 500-1/18/01b

76 Jersey Street Jolimont 6014 Western Australia Postal: PO Box 201 Wembley 6913 Western Australia
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REVISION	AUTHOR	REVIEW	AUTHORISED	ISSUED
0	PHW	JRP		13/9/18
1	PHW	JRP		11/10/18

1. INTRODUCTION

Aragon Resources Pty Ltd, part of the Westgold Group (Westgold) is planning to recommence mining of the Horseshoe and Cassidy pits at the Horseshoe gold mine, located 28 km south-east of Fortnum mine and 126 km north of Meekatharra. The pits lie on a low rise between two creeks which drain northwards to the Gascoyne River, about 30 km to the north.

Aragon Resources engaged Rockwater to make a desktop hydrogeological assessment of the pits to estimate dewatering pumping rates and to recommend means of water disposal.

This report presents the results of the hydrogeological assessment. The pits at Horseshoe mine are shown in Fig. 1.

1.1. CLIMATE

The project site has a semi-arid climate. The nearest Bureau of Meteorology (BoM) station is Milgun (Stn. 007050), located 36 km north-north-west of Horseshoe.

Table 1: Average Rainfall (Milgun) and Dam Evaporation (Meekatharra) (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	28.4	39.7	32.2	20.6	23.6	24.4	14.1	8.5	2.3	4.4	7.6	14.2	220.7
Dam Evap.	380	314	267	190	131	87	92	121	170	259	293	333	2,637

Rainfall at Milgun (1916 to 2016) averages 221 mm per annum, with on average, 77 % falling in the months January to June, mainly due to thunderstorms or the remnants of cyclones in summer and the passage of frontal systems in winter.

Average dam evaporation at Meekatharra, 126 km to the south (Luke, Burke and O'Brien, 1988) exceeds Milgun's average rainfall in all months of the year (Table 1), and by a factor of 12 overall.

Temperatures recorded at Meekatharra airport (BoM station 007045) indicate monthly mean minimum temperatures ranging from 7.4 ^{o}C in July to 24.4 ^{o}C in January; and mean maximum temperatures ranging from 19.1 ^{o}C in July to 38.3 ^{o}C in January.

2. GEOLOGY

The Horseshoe and Cassidy pits are within an area of colluvium overlying lithic wacke and siltstone of the Ravelstone Formation of the Paleoproterozoic Bryah Group (Cutten et. al., 2013). They lie on the trend of a west-north-westerly trending chert bed (Swager, Occhipinti and Pirajno, 1998).

The local mine geology was described by Groves (1996), and is summarised as follows.

The mineralised rocks are bounded by argillite and siltstone, which Groves described as the Thaduna Greywacke, but is evidently part of the Ravelstone Formation. The mine pits are mainly within mafic and ultramafic rocks near the core of a south-westerly plunging anticline, with a west-north-west strike and dipping to the south at 20 to 85 degrees. These rocks include tuff, chert (jasperoid) and jasperoid breccia, high Mg basalt and mafic basalt, and ultramafic talc-chlorite and carbonate schist.

An east-west dolerite dyke intrudes these rocks in the Horseshoe pit.

Mineralisation is mainly associated with a deeply weathered mafic tuff; and sheared quartz-carbonate-chlorite fuchsite rock with quartz veining. Weathering is up to 120 m deep.

3. HYDROGEOLOGY

3.1. PREVIOUS STUDIES

Hydrogeological studies of the Horseshoe pits were conducted by Clifton (2006 and 2016); and by Golder (2012). Relevant information from those reports is given below.

The Horseshoe, Cassidy and The Pod pits were initially mined by Dominion Mining from January 1992 to early 1993. The natural ground surface is about 535 m AHD and the original water table was about 25 m deep, i.e. about 510 m AHD. Horseshoe pit was first dewatered with three in-pit bores and a sump. The first bore (WB1 or 91-HRPB-01) was 103 m deep with 12 m of stainless steel screens set in a jasperoidal unit. Its location is shown in Figure 1. The locations of the other two bores are not recorded. WB1 was test-pumped at 290 m^3/d for up to 16 days resulting in a few metres of drawdown. Water from the bore had a salinity of 14,600 mg/L TDS, and Golder (2012) cited a Dominion 1994 report that said groundwater TDS was in the order of 12,000 mg/L.

In April 1993 an internal memorandum recorded that there were two dewatering bores in each of the Horseshoe and Cassidy pits, and they were only just able to keep the pit floors dry.

In October 2016, the pit lakes were at elevations of 490.2 m (Horseshoe) and 475 m AHD (Cassidy); slightly above the 2006 water levels of 488 m and 470 m AHD, respectively. The salinities of water from near the surfaces of the pit lakes were 19,000 mg/L TDS (Horseshoe) and 50,000 mg/L TDS (Cassidy). Using a salt water balance, Clifton (2016) estimated that groundwater inflows were 11 m^3/d (Horseshoe) and 30 m^3/d (Cassidy). He also predicted that when the pits reached total depth and were fully drained, groundwater inflows would be about 165 m^3/d (Horseshoe) and 155 m^3/d (Cassidy).

Golder (2012) reported the pit lakes to have been at 488 m (Horseshoe) and 473 m AHD (Cassidy) in July 2012. Site observations suggested that Horseshoe pit receives runoff from the nearby creek (which originally would have passed close to the western edge of the pit), explaining the low salinity of water in the pit, and possibly the higher water level in the pit. The salinities in 2012 were 17,000 mg/L TDS (Horseshoe) and 33,500 mg/L TDS (Cassidy).

Golder (2012) reported anecdotal evidence from a former mine superintendent that during 1989 to 1990, pit dewatering rates totalled 1,000 m^3/d; and that the Dominion 1993/94 environmental report indicated that only 1,250 m^3 were pumped from the Horseshoe dewatering bores during the reporting period. Mining may have largely ceased by then. Golder estimated future dewatering rates of 14 to 20 L/s for Horseshoe pit and 9 to 14 L/s for Cassidy.

3.2. ADDITIONAL DATA AVAILABLE

The additional data that are available for this assessment are listed below with comments on relevance and how they are used.

- A contour plan of the current (2017) pit configuration. This information was used in assessing the volumes of water in the pits and potential storage volumes available. The surface areas at the pit

rims, and the areas of the pit lakes were used in estimating the pit water balances and groundwater inflows.

- 2016 pit designs. These are taken to represent planned pit cut-backs and depths that are used to estimate dewatering requirements.
- Jamindi 1:100 000 Geological map produced by the Geological Survey of Western Australia. This shows outcrop geology, and some station bores and wells.
- Water levels of the pit lakes measured every few months from October 2015 to July 2018. The level in Horseshoe was somewhat irregular, ranging over about 1.2 m. The level in Cassidy was generally within a 0.4 m range. Higher water levels were recorded in both lakes on 4/10/16 and 16/4/17. There were no major rainfall events recorded in any of the nearby stations before 4/10/16, but 107 mm were recorded at Mingah Springs (BoM Stn. 7165) from 18 to 25 March 2017. The water-level data suggest stream flow and/or runoff may have entered both pits after that rainfall event.
- There are no bores and wells within 10 km of the pits recorded in the Department of Water and Environmental Regulation (DWER) Water Information Reporting (WIR) database. The nearest bores shown on the geological maps are Windalah Bore, 11 km to the east, Gullgogo Bore 12 km east-north-east, Grain Bore 8 km to the north, and Dandy Well 10 km to the north-west. No data are available for these bores and wells.

3.3. HYDROGEOLOGICAL ASSESSMENT

3.3.1. AQUIFER CHARACTERISTICS

The rocks in and surrounding the pits, in particular the siltstone and wacke country rocks, are generally of low hydraulic conductivity (permeability). The mineralised zones and the jasperoidal pods are likely to be moderately permeable; and transition zone rocks (between weathered and fresh) are also likely to be permeable, and there may also be fractured rocks along fault zones and the margins of the dolerite dyke. However, the pods and mineralised zones are not extensive, and so long-term dewatering rates are likely to be limited.

Geological mapping by Groves (1996) indicates there is no continuity of rock units, particularly those likely to be permeable, between Horseshoe and Cassidy and so there is unlikely to be significant hydraulic connection between the pits. This is supported by the substantial (15 m) difference in pit lake levels. However, there is likely to be hydraulic connection via the mineralised zones between Cassidy and The Pod.

3.3.2. DEWATERING FLOW RATES

The pit water levels have stabilised at about 490 m AHD (Horseshoe) and 474.5 m AHD, apart from some short-term peaks following heavy rainfalls. Assuming there is a balance in pits where rainfall accumulation plus groundwater inflow are equal to evaporation losses, it is estimated that groundwater inflows are about 76 m^3/d (Horseshoe) and 37 m^3/d (Cassidy) at those pit lake levels, which are about 20 m and 35 m below the original static water level.

By linear extrapolation, groundwater inflows could be about 350 m^3/d when Horseshoe pit is dewatered to 415 m AHD (its planned base); and 80 m^3/d when Cassidy is dewatered to 450 m AHD. In addition, there is a large volume of water to be pumped from Horseshoe pit (Table 2) and a smaller volume from Cassidy pit; as well as water stored in the rocks to be mined and those in rocks outside of the mining area that will be drained during the dewatering. These need to be added to the rates above, which represent a long-term steady state when the drawdown cones around the completed pits have stabilised.

Table 2: Calculated Pit Water Volumes, and Volumes above Pit Lakes

Pit	Av. Lake Level (m AHD)	Water Volume (m^3)	Volume above Lake (m^3)
Horseshoe	490	282,000	1,180,000
Cassidy	474.5	66,500	2,097,000
The Pod	NA	0	33,200

The time taken to empty water from each pit will depend on the pumping rate – time estimates for various pumping rates are given in Table 3.

Table 3: Estimated Times to Dewater Pits

Pumping Rate	Est. Time to Dewater Pit (Days)	
(m^3/d)	Horseshoe	Cassidy
1,000	369	80
1,500	227	52
2,000	163	37
2,500	127	29
3,000	104	24

The planned depth of Cassidy pit is much the same as the present depth and so it could be dewatered via an in-pit pump and later, sumps. A combination of in-pit bores and sumps will probably be needed to complete the dewatering of Horseshoe pit – there will probably not be any suitable locations for out-of-pit bores. It might be possible to restore existing bores once they are uncovered as the pit lake level is lowered. Horizontal drainholes will probably be needed to lower pressures behind the pit walls.

3.3.3. WATER DISPOSAL OPTIONS

Some of the water pumped, probably 300 to 500 m^3/d, will be needed for dust suppression. The best means of the disposal of excess water would be to pump the water into the pit that is not being mined. As shown in Table 2, there is plenty of volume available for storage in both the Horseshoe and Cassidy pits, and as discussed in Section 3.3.1 above there should be little recirculation between the pits. Storing water this way will increase evaporative losses from the pit used for storage, and reduce groundwater inflows or possibly cause pit water to flow back into the groundwater.

However, it is understood that Aragon Resources wishes to minimise the time taken to dewater pits, and so means of reducing the volume of water to be pumped from the second pit to be mined will be important. The potential methods of achieving this aim are to enhance evaporative losses on discharge of the water using evaporation fans, sprinklers or fountains; or by using evaporation ponds.

3.3.3.1. Using Evaporation Fans

Companies such as Mintek supply fan evaporators which are used at a number of mine sites in Queensland including Mt Morgan, and McArthur River mine in the Northern Territory. At the latter mine sprinklers are also used to increase evaporative losses. The evaporators would need to be directed over a pit or evaporation ponds, and used in suitable wind conditions to prevent saline water drifting over vegetated areas.

A Mintek 75 kW mobile evaporator was said to be capable of evaporating at least 1,300 m^3/d. Evaporation rates will be lower for saline water than fresh water; and whether evaporators are suitable for saline water would need to be checked with the supplier.

At the Mt Morgan mine, three large evaporators and one smaller unit are said to have disposed of 1,500 m^3/d (Pump Industry magazine, July 2004).

At McArthur River, six large fan evaporators on a pit wall removed up to 1,280 m^3/d (WRM, 2016), although an independent review (Xerias, 2017) stated that the volumes of water removed using evaporators had not been accurately quantified.

In Western Australia, an evaporator was used to increase evaporative losses at the Rav8 nickel mine near Ravensthorpe, but the quantities of water lost using this method were not quantified.

Evaporators were used at BHP's Area C mine west of Newman, and anecdotal evidence indicates the quantities of water evaporated were somewhat less than indicated by the company supplying them. They were also considered at a Fortescue Minerals project, but were not used.

3.3.3.2. Using Evaporation Ponds

In the past, small evaporation and infiltration ponds, and a turkeys nest dam (Fig. 1), have been used for water disposal. These could again be reconditioned and used if necessary; and a dam will be needed with a quick-fill for water trucks.

The total area of these water storages was about 14,000 m^2, and so would be able to evaporate between 40 m^3/d in June to 170 m^3/d in January. Additional or larger ponds could be constructed if necessary. Aragon Resources has suggested six 100 m x 100 m ponds could be used, with water applied using sprinklers. This could increase water disposal volumes to between about 250 m^3/d in June to 900 m^3/d in January, depending on the efficiency of the sprinklers.

Unless lined the evaporation ponds would leak which would increase their capacity for water disposal. Some of the leakage could daylight near the pond or waste-dump walls. This could be captured using drains, and the water pumped back to the ponds. Deeper leakage would eventually reach the water table and flow with the groundwater towards the pits, which are and will continue to be permanent groundwater sinks.

The regulatory authorities may require monitoring bores around the evaporation ponds, even though pond water and groundwater salinities should be very similar. The bores could be used to monitor groundwater quality around the ponds, and water levels to demonstrate groundwater flow directions.

3.3.4. GROUNDWATER LEVELS, FLOW DIRECTIONS

Other than pit lake levels, there are no records of groundwater levels in and around the mine site.

Surface drainages flow northwards, and the surface topography also slopes in that direction, so pre-mining groundwater levels would have sloped down from about 510 m AHD at the mine site, to about 480 m AHD at the Gascoyne River, 30 km to the north.

The Horseshoe and Cassidy pits have become groundwater sinks, and so all groundwater at the mine site now flows towards the pits.

3.3.5. WATER QUALITY

Clifton (2006) cited a 1991 monitoring report by Coffey Partners that included an analysis of water from production bore 91-HRPB-01. The sample had a salinity of 14,600 mg/L TDS, and was slightly alkaline (pH 7.6). The water was too saline for stock use.

Golder (2012) took water samples from near the surface of the pit lakes and had them analysed by SGS laboratories. The results are given in Table 4. Four sets of samples have been taken by Aragon Resources since September 2016, and these are also included in the table.

Table 4: Results of Pit Water Analyses

Parameter	Unit	Horseshoe Pit					Cassidy Pit				
		Aug-12	Sep-16	Apr-17	Jul-17	Mar-18	Aug-12	Sep-16	Apr-17	Jul-17	Mar-18
Field pH	pH	7.4	8.68	8.76	8.59	8.16	8.3	8.56	8.85	8.72	8.15
TDS	mg/L	17,100	19,000	19,000	19,000	20,000	33,500	50,000	38,000	44,000	43,000
ORP	mV	250		150.8	110.2	204.1	240		119.8	96.6	202.4
DO	%Sat	99		71.4	53		94.5		5.13	3.98	5.89
TOC	mg/L	1.7					6.3				
SO4	mg/L	2,200	4,000			4,000	7,100	11000			8600
CL	mg/L	7,600	12,000			8,200	19,000	24000			18000
NOX-N	mg/L	22				25	4.3				17.8
NH3-N	mg/L	0.024				<0.06	0.035				<0.05
TP	mg/L	<0.01				<0.01	<0.01				<0.002
TKN	mg/L	0.16				1.7	0.26				1.7
TN	mg/L	23					20				
S	mg/L	1,400					3,600				
Mg	mg/L	770	1,100			920	1,500	2600			2000
Al	µg/L	<10	<10			<25	<20	<10			<50
As III	µg/L	<10					<20				
As V	µg/L	<10					<20				
As	µg/L		<1			<5		<1			<10
B	µg/L	10,000					18,000				
Cd	µg/L	<1	<0.1			<0.5	<2	1			<1
Cr	µg/L	71	46			63	<20	29			14
Cu	µg/L	<10	<1			<5	<20	3			<10
Fe	µg/L	<50				<25	<100				<50
Pb	µg/L	<10	<1			<5	<20	<1			<10
Mn	µg/L	<10	<10			5	<20	<10			37
Ni	µg/L	<10	4			7	<20	10			17
Sn	µg/L	<10					<20				
Zn	µg/L	15	<5			<25	<20	5			<50

They indicate that the water is slightly alkaline to alkaline, of high salinity, with elevated nitrogen, boron, and chromium. Generally, metal concentrations were below limits of reporting.

Salinity in Horseshoe Pit has been gradually increasing, indicating evapo-concentration. It has been more variable in Cassidy pit, which receives some surface water flows.

4. CONCLUSIONS AND RECOMMENDATIONS

The mineralised zones (deeply weathered mafic tuff, and sheared quartz-carbonate-chlorite fuchsite rock with quartz veining) and jasperoidal pods are likely to be moderately permeable and form the main aquifers at the mine site. Transition zone rocks are also likely to be permeable, and there may be fractured rocks along fault zones and on the margins of a dolerite dyke. The unmineralised country rock of mainly siltstone and wacke rocks are considered to be of low permeability.

Geological mapping by Groves (1996) indicates there is no continuity of rock units between Horseshoe and Cassidy pits, and so there is unlikely to be significant hydraulic connection between the pits. This is supported by the substantial (15 m) difference in pit lake levels. However, there is likely to be hydraulic connection via the mineralised zones in Cassidy and The Pod pits.

Based on current pit water balances, it is estimated that groundwater inflows could be about 350 m^3/d when Horseshoe pit is dewatered to 415 m AHD (its planned base); and 80 m^3/d when Cassidy is dewatered to 450 m AHD. In addition, there is a large volume of water within Horseshoe pit and a smaller volume within Cassidy pit that will need to be removed, as well as water stored in the rocks to be mined and those adjacent to the mining areas. It is estimated that Horseshoe pit could be dewatered in about 370 days with pumping at 1,000 m^3/d, decreasing to about 100 days at 3,000 m^3/d; and Cassidy pit in about 80 days with pumping at 1,000 m^3/d, decreasing to about 24 days at 3,000 m^3/d.

Cassidy pit can probably be dewatered using an in-pit pump and sumps. A combination of in-pit bores and sumps will probably be needed to complete the dewatering at Horseshoe. Existing bores may be able to be restored once the pit lake is lowered. There will probably not be any suitable locations for pit perimeter bores. Horizontal drainholes will probably be needed to lower pressures behind the pit walls.

Some of the water pumped, probably 300 to 500 m^3/d, will be needed for dust suppression. The best means of the disposal of excess water during dewatering of Horseshoe pit would be to pump the water into Cassidy pit. There is plenty of volume available for storage in that pit, and there should be little recirculation between the pits.

In order to minimise the dewatering time of the second pit to be mined, the volumes of water discharged could be minimised by increasing evaporative losses. This can be accomplished by using fan evaporators, fountains, or sprinklers; and by discharging water to evaporation ponds. No definitive information could be found on the effectiveness of fan evaporators, but four large evaporators might dispose of about 1,500 m^3/d. Care would need to be taken to prevent saline spray from falling on vegetated areas.

Six 100 m by 100 m evaporation ponds with water discharged via sprinklers might dispose of about 250 m^3/d (June) to 900 m^3/d (January). Any shallow leakage around the evaporation ponds could be controlled and collected using drains, and pumped back to the ponds.

The Horseshoe and Cassidy pits have become groundwater sinks, and so all groundwater at the mine site now flows towards the pits and will continue to do so once the planned mining is completed.

Dated: 30 October 2018 **Rockwater Pty Ltd**

P H Wharton
Principal

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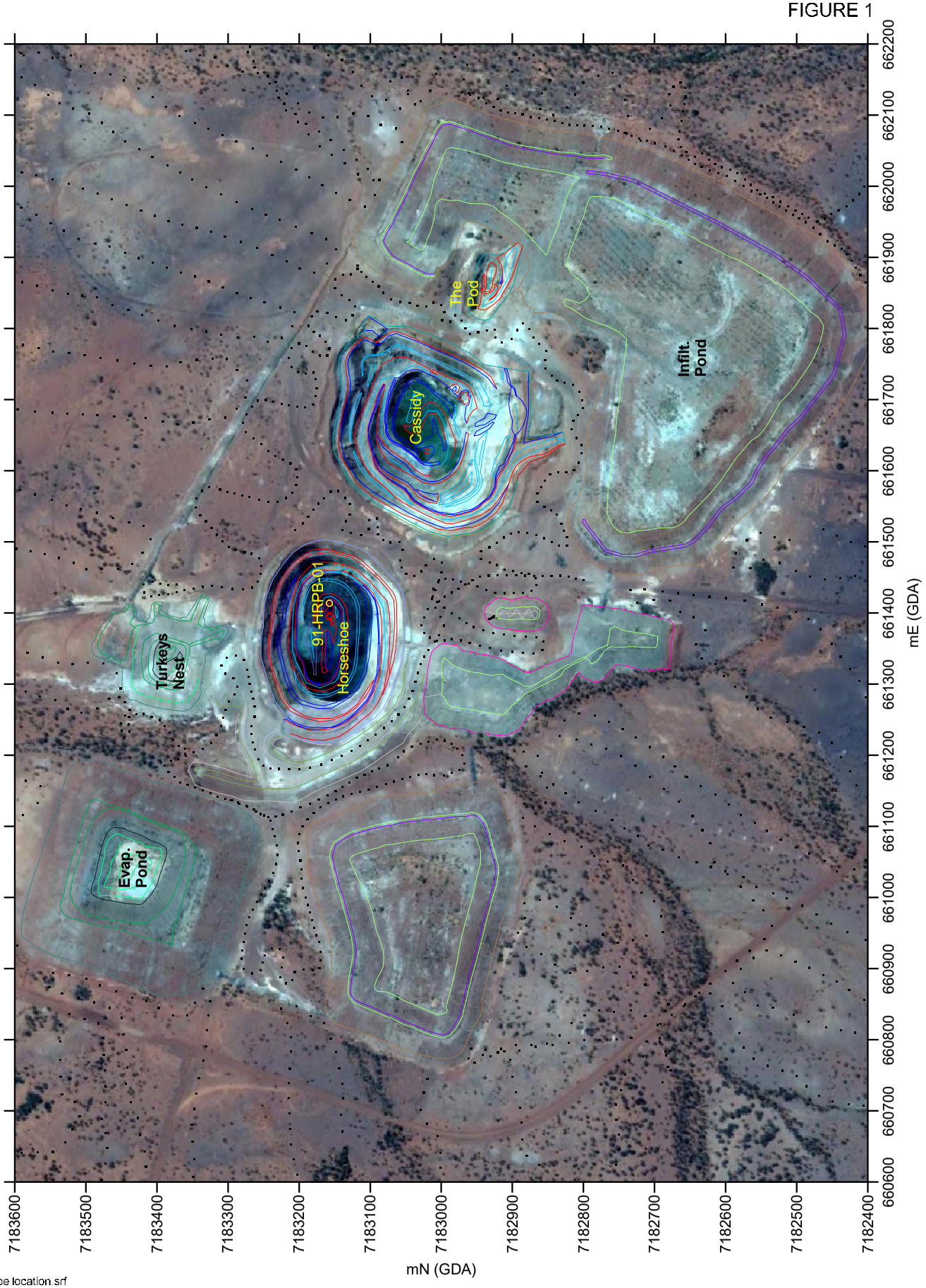
FIGURE

FIGURE 1



horseshoe location.srf

CLIENT: Westgold Group

PROJECT: Horseshoe Mine

DATE: September 2018

Dwg No: 500-1/18/1-1

LOCATION PLAN, HORSESHOE PITS

Rockwater Pty Ltd

APPENDIX C

umwelt

Inspired people | Dedicated team
Quality outcomes

HORSESHOE GOLD MINE
LEVEL 1 FLORA & FAUNA SURVEY

Mining Leases 52/251, 52/338 and Miscellaneous Lease 52/102

FINAL

August 2013

HORSESHOE GOLD MINE
LEVEL 1 FLORA & FAUNA SURVEY

Mining Leases 52/251, 52/338 and
Miscellaneous Lease 52/102

FINAL

August 2013

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
Grosvenor Gold Pty Ltd

Project Director:	**Cathy Galli**
Project Manager:	**Tristan Sleigh**
Report No.	**6098/R01/Final**
Date:	**August 2013**

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Executive Summary

Grosvenor Gold Pty Ltd (Grosvenor) is a wholly owned subsidiary of Resource and Investment NL (RNI) which is a Western Australian mineral exploration company listed on the Australian Stock Exchange (ACN: 085 806 284). Grosvenor owns the Grosvenor Gold Project which includes the Horseshoe Gold Mine located on Mining Lease (M) 52/338, Miscellaneous Lease (L) 52/102 and the newly acquired M52/251, herein collectively referred to as the Project area. The Project area is located approximately 135 kilometres (km) north of Meekatharra and 770 km northeast of Perth, Western Australia (WA).

Umwelt (Australia) Pty Ltd (Umwelt) was engaged by Grosvenor in April 2013 to undertake a Level 1 Flora and Vegetation Survey (Level 1 Flora Survey) and a Level 1 Fauna Survey and targeted fauna habitat survey for species of conservation significance (Level 1 Fauna Survey) to collect baseline information for recommencement of mining on M52/338, M52/251 and L52/102 at Horseshoe Gold Mine.

The flora and fauna surveys were conducted in accordance with the Environmental Protection Authority's (EPA) relevant Position and Guidance Statements.

Results from the database searches recorded one Priority Ecological Community (PEC) that could occur within the Project area, in addition to one Threatened Flora and 23 Priority Flora (PF) which potentially occur within the survey area (DEC[1], 2013a, 2013b). Sixteen fauna species of conservation significance could potentially occur within the Project area.

Eighty flora taxa (species, subspecies and varieties) were recorded within 24 families and 43 genera. Fabaceae, Chenopodiaceae Malvaceae, Poaceae and Scrophulariaceae were the most common families containing most taxa.

No Declared rare Flora (DRF) pursuant to Section 23F (2) of the *Wildlife Conservation Act 1950* (WC Act) or Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the survey area. No PF were recorded in the survey area.

Only one introduced flora species was recorded, *Portulaca oleracea* Purslane.

Eleven vegetation communities were identified in the Project area, with low open Acacia woodland considered the dominant vegetation. The Project area is located within the boundary of the PEC Robinson Range vegetation complexes (banded ironstone formation) (Priority 1). Two communities identified during the survey (X1 and X2) may express similarities with the PEC. The location of these vegetation communities are not in close proximity to existing mine site infrastructure and are unlikely to be impacted by any future works at Horseshoe Gold Mine.

The condition of the vegetation communities across the survey area ranged from 'Excellent' to 'Completely Degraded' in accordance with Keighery's (1994) condition scale. Vegetation condition varied within vegetation communities across the Project area. Various causes of disturbance were recorded throughout the survey area including mineral exploration, vehicle tracks and cattle grazing.

Results of the Level 1 Flora Surveys of the Project area conclude no significant impacts to the flora and vegetation will occur as a result of the recommencement of mining on M52/338, M52/251 and L52/102 at Horseshoe Gold Mine.

[1] Please note: From the 1 July 2013, the Department of Environment and Conservation (DEC) no longer exists. This Department has been split into two: Department of Parks and Wildlife (DPaW) and Department of Environment and Regulation (DER).

From a fauna perspective, four fauna habitats can be broadly described with the Project area with Acacia woodland/shrubland (plains) representing up to 71% of the total area (979.22 ha); and the remainder comprises creekline vegetation (~8.7%), Acacia woodland (hills) (~6%); and Mulga (<1%).

The desktop study identified 285 fauna species that potentially could occur in the local area. This includes two fish species, six species of amphibians, 69 species of reptiles, 31 species of native mammals, ten species of non-native mammals, 100 native bird species and one exotic species of bird. Of these species, 16 are considered to be fauna of conservation significance.

Sixty-four species of vertebrate fauna were recorded during the on-site reconnaissance survey, with three species of conservation significance recorded:

- abandoned burrows of *Pseudomys chapmani* Western Pebble Mound Mouse;
- *Burhinus grallarius* Bush Stone-curlew; and
- *Oreoica gutturalis* Crested Bellbird.

A further three species of conservation significance are considered likely to occur in the Project area:

- *Sminthopsis longicaudata* Long-tailed Dunnart;
- *Ardeotis australis* Australian Bustard; and
- *Merops ornatus* Rainbow Bee-eater.

Generic impacts for fauna from anthropogenic disturbances in the area include:

- degradation, fragmentation and/or loss of habitat through clearing, off-road driving; dust, alternation of topography and drainage etc.;
- destruction and loss of breeding, roosting, foraging and dispersal sites;
- increased mortality (leading to population decline and/or survival) through vehicular and equipment movements;
- potential increase in feral fauna resulting in increased predation and resource competition;
- potential increase in wildfire with the associated consequences on habitat and faunal assemblages.

Notwithstanding this, best management practice would minimise such disturbances resulting in no significant impact on either fauna occurring in the area or local fauna habitat. Further, given the ecology of the species of conservation significance recorded or possibly present in the area, disturbances associated with mining activities in the area are not likely to alter their conservation status.

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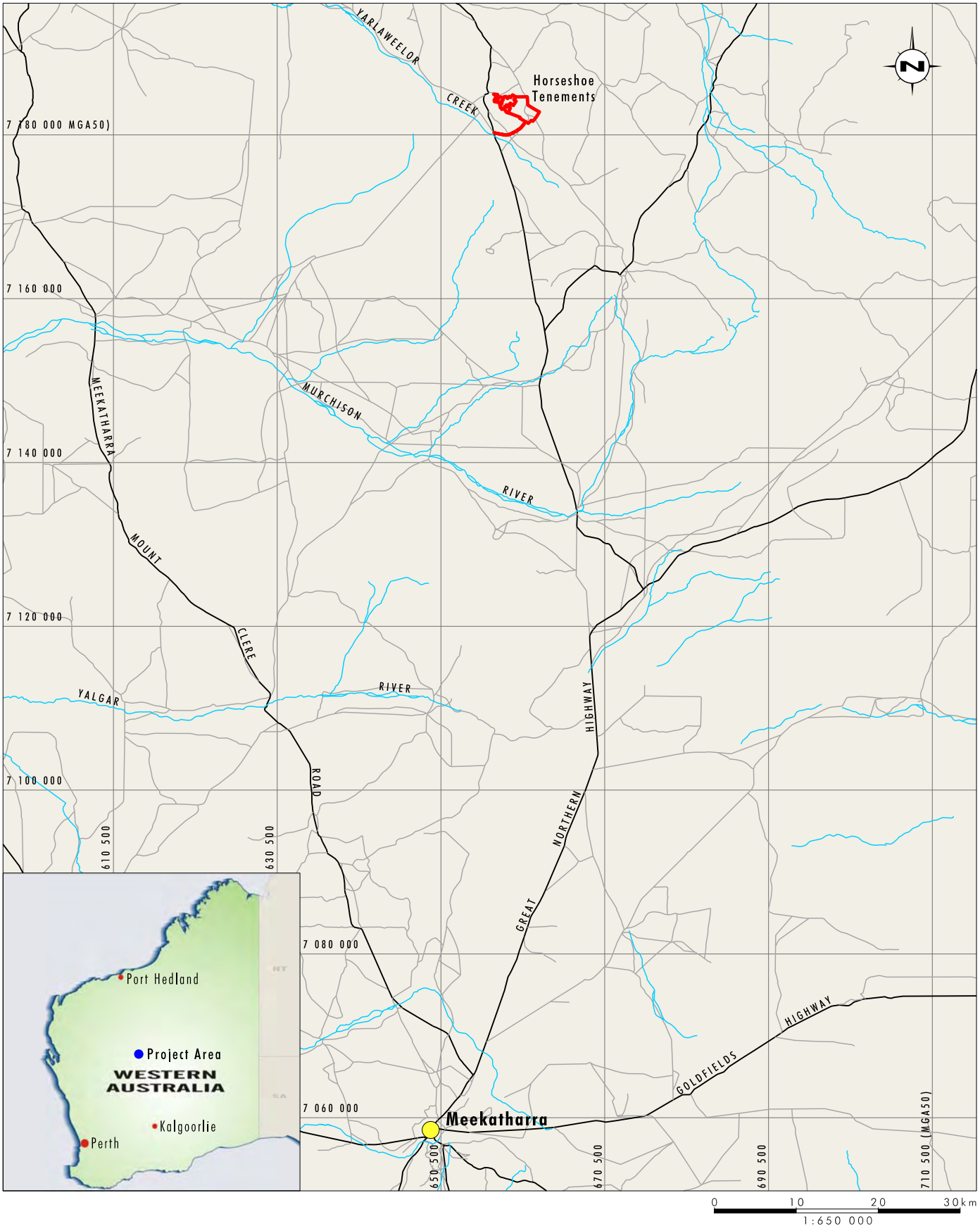
1.0 Introduction

1.1 Project Background and Location

Grosvenor Gold Pty Ltd (Grosvenor) is a wholly owned subsidiary of Resource and Investment NL (RNI) which is a Western Australian mineral exploration company listed on the Australian Stock Exchange (ACN: 085 806 284). Grosvenor owns the Grosvenor Gold Project which includes the Horseshoe Gold Mine located on Mining Lease (M) 52/338, Miscellaneous Lease (L) 52/102 and the newly acquired M52/251, herein collectively referred to as the Project. The Project is located in the Bryah-Padbury Basin, on Vacant Crown Land (VCL) approximately 135 kilometres (km) north of Meekatharra and 770 km northeast of Perth, Western Australia (WA). The location of the Project is illustrated in **Figure 1.1**. The Project is also located in the Peak Hill mining province, Shire of Meekatharra and the Mid-West Region of WA.

Umwelt (Australia) Pty Ltd (Umwelt) was engaged by Grosvenor in April 2013 to undertake a Level 1 Flora and Vegetation Survey (Level 1 Flora Survey) and a Level 1 Fauna Survey and targeted fauna habitat survey for species of conservation significance (Level 1 Fauna Survey) to collect baseline information for recommencement of mining on M52/338, M52/251 and L52/102 at Horseshoe Gold Mine.



Legend

- Grosvenor Gold Tenements
- Creek Line
- Major Road
- Minor Road and Tracks

FIGURE 1.1

Project Area Location Plan

2.0 Existing Environment

2.1 Biogeographic Region

The Interim Biogeographic Regionalisation for Australia (IBRA) classification system describes 85 biogeographic regions which cover Australia. The bioregions are defined on the basis of geology, landforms, climate, vegetation and fauna (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013a). The Project area lies within the Gascoyne Bioregion which is comprised of three sub-regions: Augustus, Ashburton and Carnegie (DSEWPaC 2013a). The Project area lies within the Augustus sub-region which is characterised by sedimentary and granite ranges and broad flat valleys (Desmond *et al*., 2001). Most of the drainage of this sub-region is provided by the Gascoyne River System. Shallow stony loams on rises contain mulga woodland with *Triodia* and the plains with shallow earthy loams over hardpan are covered by mulga parkland (Desmond *et al*., 2001).

2.2 Climate

The Project area experiences an arid climate typified by hot dry summers and cold winters with summer and winter rainfall (Beard, 1990 and Bureau of Meteorology (BOM), 2013). The nearest official operating meteorological station is located at Three Rivers (Station Number (No.). 007080) approximately 71 km north-east of the survey area. Mean annual minimum temperature at Three Rivers is 14.6°C and mean annual maximum temperature is 30.5°C. The coldest month is July (mean minimum temperature 4.8°C), the hottest is January (mean maximum temperature 39.3°C) and diurnal temperature variations are relatively consistent throughout the year (BOM, 2013).

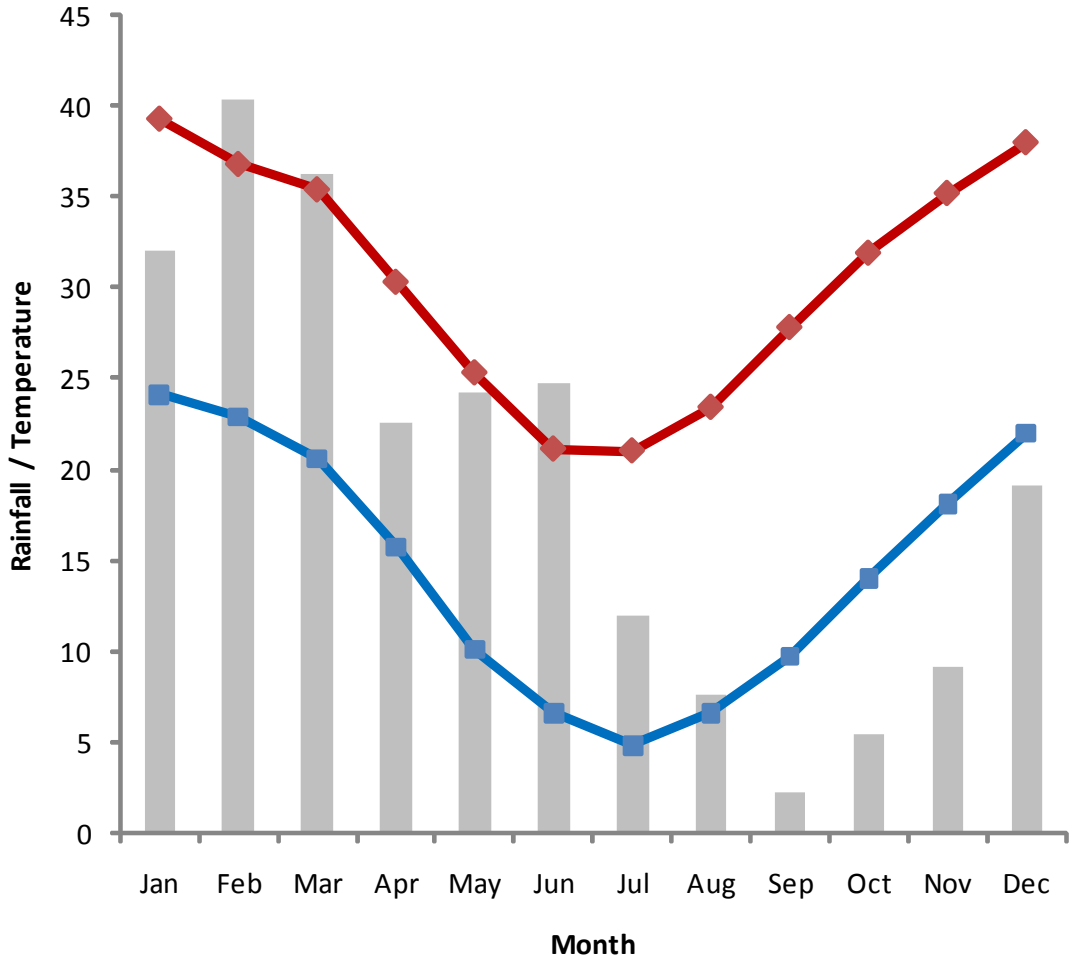
Rainfall is highly variable from year to year with the average annual rainfall at Three Rivers of 236.2 millimetres (mm). The average monthly rainfall typically varies from 2.2 mm in September to a peak of approximately 40 mm in February. Most rainfall occurs from January to March (BOM, 2013). **Figure 2.1** illustrates mean maximum and mean minimum temperatures at Three Rivers and mean monthly rainfall.

2.3 Geology

2.3.1 Regional Geology

The regional geology consists of numerous formations including:

Horseshoe Formation:	A banded iron-formation with interbedded quartz and shales; metamorphosed.
Labouchere Formation:	An arenite, quartz wacke, shale, and quartz pebble conglomerate lenses.
Narracoota Formation:	Metabasaltic lavas; locally with pillow structures and dolerite sills.
Peak Hill Schist:	Rounded fragments of quartz mylonite in quartz-sericite matrix.
Ravelstone Formation:	Lithic and quartz wacke; metamorphosed.
Robinson Range:	A banded iron-formation.
Wilthorpe Formation:	Sandstone and shale; minor quartz wacke and lenses of conglomerate.



Source: BOM (2013)

Legend
- Mean Monthly Rainfall (mm)
- Mean Maximum Temperature (°C)
- Mean Minimum Temperature (°C)

FIGURE 2.1

Mean Monthly Rainfall and Mean Minimum and Maximum Temperature at Three Rivers BOM Station No. 007080

2.3.2 Local Geology

The following regional geology has been taken from Dominion Mining Limited's (Dominion) Notice of Intent (NOI) for Horseshoe Range Peak Hill Mineral Field (Dominion, 1991):

"The Horseshoe Range Prospect lies within a complexly folded and faulted sequence of Lower Proterozoic volcanic and sedimentary units belonging to the Glengarry Group. The geology consists of a unit of mafic and ultramafic volcanics belonging to the Narracoota Volcanics within the sedimentary sequence of greywacke and argillite of the Thaduna Greywacke and an upper unit of banded iron formation (BIF) and manganiferous shale of the Horseshoe Formation. The lease area is extensively soil covered with laterite further concealing bedrock in places. The lithologies in the immediate lease area trend east-west and dip south at approximately 80 degrees".

"Host lithologies comprise a sheared westerly thinning sequence of ultramafic schist, mafic tuffaceous rock and jasper of the Narracoota Volcanics wedged between argillaceous sediments of the Thaduna Greywacke. This volcano-sedimentary sequence is at least 1 km in strike length. The orebody sequence consists of an unaltered argillite footwall overlain by a sheared argillite and pyritic jasper zone. A highly oxidise and sheeted mafic tuffaceous rock with quartz veining is the main host lithology. This unit is overlain by talc-chlorite schist, limonite-sericite schist and a hanging wall argillite. The sequence is intruded by a vertical east-west dolerite dyke and disrupted by several north-south fault zones".

2.4 Land Systems

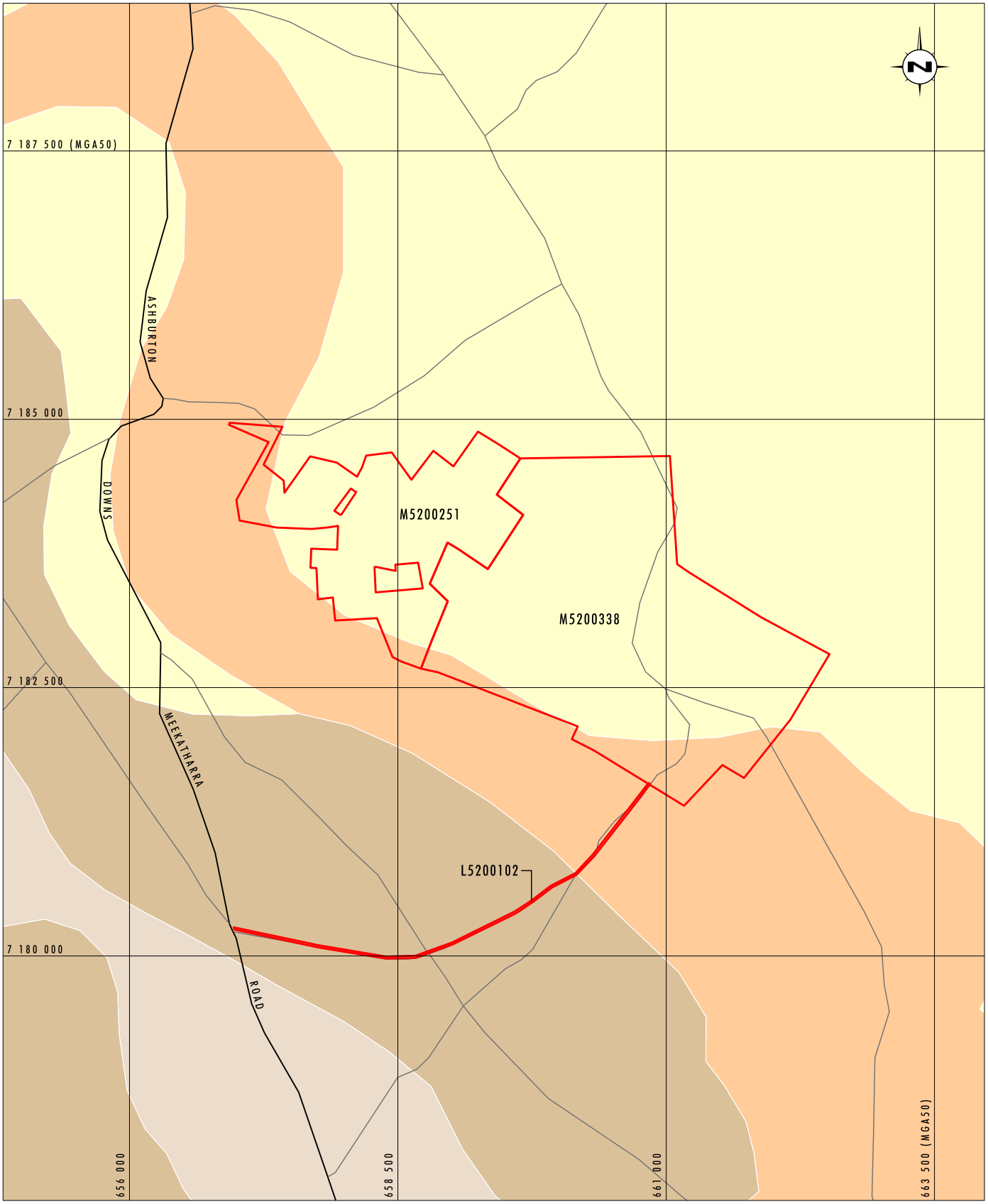
The Project area lies partially within two land systems; Beasley and Peak Hill. **Figure 2.2** shows the land systems of the Project area.

The Beasley land system is characterised by low ridges and hills above stony footslopes and broad stony lower plains which support scattered mulga and snakewood-dominated shrublands (Curry *et al*., 1994).

The Peak Hill land system is characterised by ranges and rugged hills with banded ironstone and hematitic shale, supporting stunted mulga and cottonbush shrublands (Curry *et al*., 1994).

2.5 Regional Vegetation

The Murchison Region is located within the Eremaean Botanical Province and the Austin Botanical District. The vegetation of the Austin Botanical District is dominated by mulga (*Acacia aneura*) communities (Beard, 1990). A Geographical Information System (GIS) dataset of pre-European vegetation in WA Shepherd, 2003) is compiled largely from published and unpublished mapping by J.S. Beard (1:250,000 scale). The dataset indicates three vegetation associations are present in the Project area. These are described in **Table 2.1**.



Data Source: Curry et al. (1994), Payne et al. (1988) & van Vreeswyk et al. (2004)

0 0.5 1.0 2.0km
1:50 000

Legend

- Grosvenor Gold Tenements
- Beasley Land System
- Horseshoe Land System
- Three Rivers Land System
- Peak Hill Land System
- Major Road
- Minor Track

FIGURE 2.2

Land Systems of the Project Area

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20130624 13.32

Table 2.1 – Vegetation Associations within Project Area

Vegetation Association	Description
18	Low woodland, mulga (*Acacia aneura*).
29	Sparse low woodland; mulga, discontinuous in scattered groups
39	Shrublands; mulga scrub

Source: Shepherd, 2003.

The pre-European and current extent of WA vegetation associations has been assessed by the Department of Environment and Conservation[2] (DEC) and Department of Agriculture and Food WA (DAFWA) using remote sensing and GIS analysis to produce a statistical compendium called the Comprehensive, Adequate and Representative Reserves System (Shepherd, 2003). The past and present extent of vegetation associations in the Project area determined from the most recently updated 2012 data are summarised in **Table 2.2** (Government of Western Australia, 2012). Less than 10 % of vegetation associations 18, 29 and 39 are currently protected within internationally recognised conservation areas (International Union for Conservation of Nature (IUCN) Reserve classes 1 to 4). These associations, whilst present in the Project area, are still abundant and the present distribution represents more than 99 % of their pre-European extent. For all three vegetation associations, the Project area represents less than 0.01 % of the current extent.

Figure 2.3 illustrates the extent of pre-European vegetation within the survey area.

Table 2.2 - Past and Present Extent of Western Australia Vegetation Associations within Project Area

Vegetation Association	Pre-European extent (ha)	Current extent (ha)	Remaining %	% Pre-European Extent protected under IUCN 1 - 4	% Current extent in survey area
18	19,892,304.78	19,843,727.37	99.76	2.13	< 0.01 %
29	7,903,991.47	7,900,200.44	99.95	0.29	< 0.01 %
39	6,613,569.14	6,602,580.10	99.83	7.25	< 0.01 %

Source: Government of Western Australia, 2012.

2.6 Land Use

Most of the land in the region is used for pastoral grazing, with some smaller portions of Unallocated Crown Land (UCL) and Crown Reserves (Desmond *et al*., 2001). The Project area is located on VCL.

[2] Please note: From the 1 July 2013, the Department of Environment and Conservation (DEC) no longer exists. This Department has been split into two: Department of Parks and Wildlife (DPaW) and Department of Environment and Regulation (DER).

Legend

- Grosvenor Gold Tenements
- Vegetation Association 18
- Vegetation Association 29
- Vegetation Association 39
- Major Road
- Minor Track

FIGURE 2.3

Pre-European Vegetation Surrounding the Project Area

2.7 Conservation Reserves

Two conservation reserves are located in the vicinity of the Project area within the Augustus subregion:

- Mt Augustus National Park (state approved) is located approximately 218 km north-west covering 9,158 hectares (ha); and

- Collier Range National Park (gazetted) approximately 79 km north covering 235,162 ha (Desmond *et al*., 2001).

Many former leaseholds exist in close proximity to the Project area which are now UCL and proposed for conservation in the future. The former leaseholds include Doolgunna (approximately 20 km south-east), Mooloogool (approximately 60 km south-east) and Waldburg (approximately 104 km north-west).

3.0 Flora and Vegetation

3.1 Survey Methodology

The flora component of the ecological survey was conducted in accordance with the following Position Statements and Guidelines:

- Environmental Protection Authority (EPA) Position Statement No 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA, 2002); and
- Guidance Statement No. 51 “Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia” (EPA, 2004a).

3.1.1 Desktop Study

A desktop study was undertaken ahead of the field survey using resources available through database searches, available literature and previous reporting.

Objectives of the desktop to study were to:

- identify historic records of conservation significant flora within the survey area;
- identify Threatened Flora (Declared Rare Flora) (DRF)) and Priority Flora (PF) species that are likely to occur in the survey area; and
- identify Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) that may potentially occur in the survey area.

Conservation categories and descriptions of the conservation status of flora are provided in **Appendix 1.**

3.1.1.1 Database Searches

Searches of DEC databases were undertaken in April 2013. The searches included:

(1) DEC’s Threatened (Declared Rare) Flora and Priority Flora database (50 km buffer – 9 April 2013, Ref: 09-0413FL) (DEC, 2013a);

(2) DEC’s Western Australian Herbarium Specimen database for priority species opportunistically collected in the area of interest (50 km buffer – 9 April 2013, Ref: 09-0413FL) (DEC, 2013a);

(3) DEC’s Threatened and Priority Flora List (this list is searched using ‘place names’) (50 km buffer – 9 April 2013, Ref: 09-0413FL) (DEC, 2013a); and

(4) DEC’s Threatened and Priority Ecological Communities (10 km buffer – 19 April 2013, Ref: 19-0413EC) (DEC, 2013b).

In addition, a search for Threatened Flora (DRF) and PF previously recorded within the survey area (25° 27' 41.00" S; 118°36'20.02" E) was carried out using the DEC online search tool NatureMap (DEC, 2013c). A 10 km buffer was included in the search.

Listed Matters of National Environmental Significance (MNES) and other matters protected under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) in the vicinity of the survey area were searched for using the on-line 'Protected Matters Search Tool' (DSEWPaC, 2013b). Coordinates for the area search were: -25.46139; 118.60556 and included a 10 km buffer.

3.2 Taxonomy and Nomenclature

Specimens collected were assigned temporary field names and numbers. These were pressed for subsequent taxonomic determination using existing taxonomic keys and reference material held at the Western Australian Herbarium (WAH) if required. For problematic taxa, specialist WAH botanists were consulted where required. The nomenclature in this report is consistent with that published by DEC on FloraBase (WAH, 2008).

3.3 Field Survey

The flora survey was undertaken between 8 and 10 April 2013 in accordance with EPA Guidance Statement No. 51 (EPA, 2004a).

The objectives of the single season flora survey were to:

- verify accuracy of background information and data from DEC searches and federal database searches;
- broadly delineate and characterise flora and vegetation;
- identify and record any Threatened Flora (DRF), PF, TECs or PECs; and
- record locations of introduced species.

3.3.1 Survey Team

Lead Botanist was Tristan Sleigh who has a BSc (Environmental Biology) (Hons) with six years experience conducting Level 1 and 2 Flora and Vegetation Surveys, Targeted Threatened and PF Surveys and vegetation health and condition monitoring throughout WA.

3.3.2 Licences and Permits

The flora survey was conducted under Flora Licence number SL010028 belonging to Tristan Sleigh.

3.3.3 Access

All flora quadrats were accessed with a four wheel drive vehicle using existing tracks and on foot where tracks were not available.

3.3.4 Approach to Survey

Prior to undertaking field work, investigations into access, land system boundaries, preliminary vegetation communities and sampling locations were conducted using a geo-referenced aerial photograph in Manifold.

During the survey, each vegetation type, vegetation composition, vegetation structure and site factors were assessed in detail in 50 m radius releves established at representative locations. Ten releves within the survey area were recorded. Within each releve, all vascular plant species were listed and their mean height and percentage cover were estimated. Other factors assessed included vegetation structure, fire age (based on the presence of burnt stumps and stems), soil type and landform. Vegetation communities were described in accordance with the National Vegetation Information System (NVIS) structural formation terminology (ESCAVI, 2003) (**Appendix 2**). Vegetation condition was assessed from evidence of disturbances such as grazing, clearing, frequent fires, presence of feral animal species and presence and density of weed species using the vegetation condition scale of Keighery (1994) (**Appendix 2**).

GPS coordinates were recorded and at least one photograph was taken from the centre of each releve.

Vegetation communities were defined using data collected during the field survey and aerial photographic interpretation.

3.3.5 Limitations

Limitations encountered during the survey are assessed in **Table 3.1**.

Table 3.1 - Potential Limitations Affecting the Flora and Vegetation Survey

Potential limitations	Constraint	Comment
Competency and experience of the Botanists undertaking the survey	No	The survey was led by Tristan Sleigh who has six years botanical survey experience in WA.
Spatial uncertainty	No	Field maps were used in conjunction with GPS units to ensure spatial certainty.
Seasonality	Possible	Survey was conducted approximately eight weeks after autumn rainfall. Annual and ephemeral species were present in and adjacent to creeks and drainage areas but were largely absent or unidentifiable on stony plains and hills.
Survey intensity and effort	No	Duration of the survey enabled 30 sites to be surveyed. Approximately 85% of the theoretical maximum species richness was surveyed. This facilitated broad delineation and characterisation of the flora and vegetation communities within the survey area applicable to a Level 1 flora survey.
Burn Cycle	No	There was no evidence of recent burning (within the last 5 years). All vegetation had re-grown sufficiently to be effectively surveyed.
Resources	No	Adequate resources were available to conduct the survey.
Accessibility	No	No areas were inaccessible during the survey.
Taxonomic uncertainty	No	The flora of the Gascoyne and Murchison regions has several taxonomic uncertainties. If required, confirmation of identification of plant specimens collected was obtained through WAH.
Vegetation mapping reliability	Moderate	Vegetation mapping reliability utilised spatial accuracy of a geo-referenced aerial. Reliability was also limited by historical disturbance by exploration and mining activities.

3.4 Statistical Analysis

PATN analysis was undertaken on site data collected during the field survey using the statistical software package PATN (Belbin, 1989). Both presence/absence data and percentage cover data were used to assist with vegetation community classification.

3.5 Flora Results

Results of the desktop study and field survey are detailed in **Sections 3.6** and **3.7**.

3.6 Desktop Review

3.6.1 Environment Protection Biodiversity and Conservation Act 1999 Protected Matters Database Search

Results of a search of Matters of National Environmental Significance and other matters protected under the EPBC Act referred to one conservation significant species; *Pityrodia augustensis* (DSEWPaC, 2013b).

3.6.2 NatureMap Database Search Tool

Results of the NatureMap database search recorded two conservation significant species as potentially occurring in the survey area; two Priority 3 species (**Table 3.2**). Three weed species were identified as potentially occurring in the survey area (DEC, 2013c).

3.6.3 Department of Environment and Conservation Database Search – Threatened (Declared Rare) Flora and Priority Flora

Results of DEC's DRF and PF search recorded one DRF and 23 PF as potentially occurring within the survey area (Ref: 48-1112FL) (DEC, 2013a). Descriptions of these species and assessment of likelihood of occurrence of each species in the survey area are presented in **Table 3.2.** Species with recorded locations adjacent to the survey area were rated as likely to occur if the preferred habitat was located within the survey area, and possible to occur if the preferred habitat is not found within the survey area. Species with no location provided were rated as possible to occur if their preferred habitat was located within the survey area and unlikely to occur if the preferred habitat is not found within the survey area. **Figure 3.1** illustrates the location of conservation significant flora within the survey area.

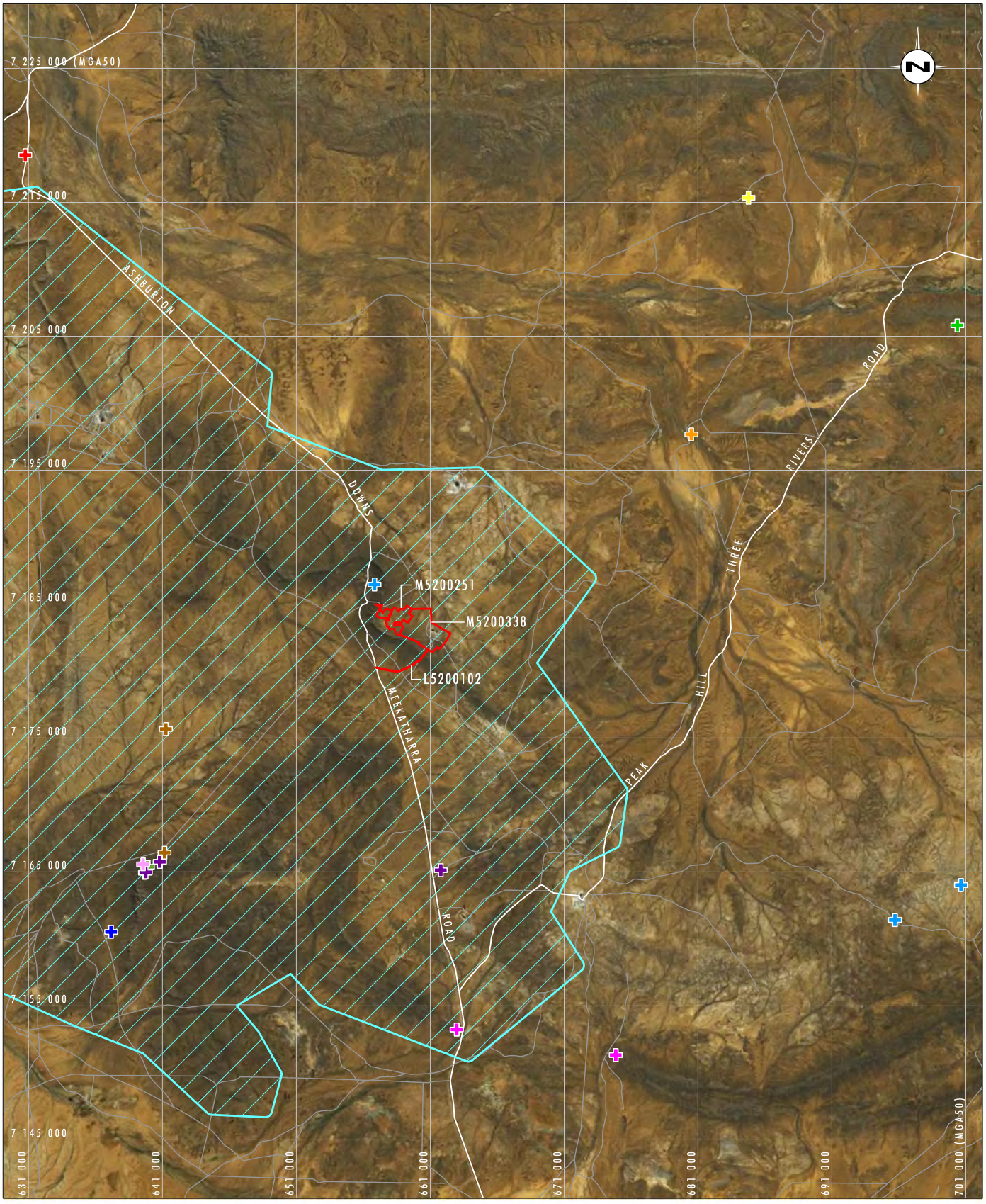

Image Source: Google Earth (2003)
Data Source: DEC (2013a, 2013b)

0 5.0 10.0 20.0 km
1:400 000

Legend

- Grosvenor Gold Tenements
- Eremophila lanata (Priority 3)
- Eremophila micrantha (Priority 3)
- Eremophila obliquisepala (Priority 3)
- Euphorbia sarcostemmoides (Priority 1)
- Hemigenia virescens (Priority 3)
- Maireana prosthecochaeta (Priority 3)
- Pityrodia augustensis (Priority 0)
- Pityrodia iphthima (Priority 1)
- Prostanthera ferricola (Priority 3)
- Ptilotus lazaridis (Priority 3)
- Tribulus adelacanthus (Priority 3)
- Robinson Range vegetation complexes - banded ironstone formation (Priority 1)
- Major Road
- Minor Track

FIGURE 3.1

DEC Database Search Results for Threatened and Priority Flora and Threatened and Priority Ecological Communities

File Name (A4): R01/6098_006.dgn
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Table 3.2 – Likelihood of Threatened (Declared Rare) Flora and Priority Flora Occurring in the Survey Area

Species	Description	Priority Status	Flowering Period	Habitat	Source	Likelihood of Occurrence
Acacia speckii	Bushy, rounded shrub/tree to 3 m high.[6]	P4	-	Rocky soils over granite, basalt or dolerite on rocky hills and rises. [6]	TPList[1]	Possible
Calytrix verruculosa	Shrub to 0.8 m high; with pink and white flowers.[6]	P3	Aug-Oct	Sandy clay. [6]	TP List[1]	Possible
Eremophila anomala	Low shrub to 0.4 m high; white flowers.[7]	P1	Jul-Aug	Flats. [7]	TP List1	Unlikely
Eremophila lanata	Compact shrub to 0.3 m high; purple flowers.[6]	P3	Aug	Stony, red, clayey sand. [6]	TP List[1] WAHerb[2]	Likely
Eremophila micrantha	Upright, spreading shrub to 2.5 m high; white flowers.[6]	P3	Oct-Nov	Red-brown sand or sandy clay with quartz, ironstone, laterite and sandstone on flats, slopes and hillsides. [6]	TPList[1] TPFL[3]	Likely
Eremophila obliquisepala	Spreading, rotund shrub to 0.5 m high; blue flowers. [6]	P3	May	Open hardpan plains. [6]	WAHerb[2]	Likely
Eremophila prolata	Erect shrub to 1.5 m high; blue-purple/red flowers. [6]	P1	Jul-Aug	Red, stony clay on flats and rises. [6]	TPList[1]	Possible
Eremophila pungens	Erect, viscid shrub to 1.5 m high; purple-violet flowers. [6]	P4	Jun-Oct	Sandy loam, clayey sand over laterite on plains, ridges and breakaways. [6]	TPList[1]	Possible
Eremophila retropila	Spreading shrub to 1.7 m high; purple-red-white flowers. [6]	P1	Jul-Aug	Gravelly loam on stony flats. [6]	TPList[1]	Possible
Eremophila shonae subsp. diffusa	Erect, open and straggly shrub to 0.4 m high; purple flowers. [6]	P3	Aug-Oct	Stony red and yellow sandy soils. [6]	TPList[1]	Possible
Eremophila warnesii	Erect, compact shrub to 0.5 m high; purple flowers. [7]	P1	Aug	Red-brown clayey sand and sandy loam in open mulga shrubland. [7]	TPList[1]	Likely
Euphorbia sarcostemmoides	Erect, multi-stemmed, semi-succulent shrub to 2 m high. [6]	P1	-	Sandstone ridges and quartzite hills. [6]	TPFL[3] WAHerb[2]	Unlikely

Table 3.2 – Likelihood of Threatened (Declared Rare) Flora and Priority Flora Occurring in the Survey Area (continued)

Species	Description	Priority Status	Flowering Period	Habitat	Source	Likelihood of Occurrence
Grevillea inconspicua	Intricately branched, spreading shrub to 2 m high; white-pink flowers. [6]	P4	Jul-Aug	Loam and gravel along drainage lines on rocky outcrops and creeklines. [6]	TPList[1]	Possible
Hemigenia virescens	Compact shrub; white flowers.	P3	-	Shallow loam in sparse grasslands. [2]	WAHerb[2]	Possible
Maireana prosthecochaeta	Open, densely-leaved shrub to 0.6 m high. [6]	P3	Jul	Laterite on hills and salty ground. [6]	TP List[1] WAHerb[2] TPFL[3] Naturemap[4]	Unlikely
Menkea draboides	Prostrate, spreading, annual herb to 0.6 m wide; white-cream flowers. [6]	P3	Aug-Sep	Red sand and clay with granite.	TP List[1]	Possible
Pityrodia augustensis	Bushy shrub to 1 m high; purple-red flowers. [6]	T	Aug-Sep	Amongst rocks on slopes and in drainage lines. [6]	TPFL[3] WAHerb[2] EPBC[5]	Unlikely
Pityrodia iphthima	Tomentose shrub to 1.2 m high. [6]	P1	-	Skeletal red-brown sandy loam over banded ironstone on upper hillslopes. [6]	TPFL[3] WAHerb[2]	Unlikely
Prostanthera ferricola	Erect, openly-branched shrub to 1 m high; purple flowers. [6]	P3	-	Shallow red-brown skeletal sandy loam over banded ironstone, laterite, basalt or quartz on gently inclined mid to upper slopes of hills, rocky crests, outcrops. [6]	WAHerb[2] Naturemap[4]	Unlikely
Ptilotus crosslandii	Prostrate herb; white flowers. [6]	P3	Sep-Oct	Sandy soils on colluvial plains. [6]	TP List[1]	Likely
Ptilotus lazaridis	Herb or shrub to 0.6 m high; pink-red flowers.[6]	P3	Jul or Oct	Clay loam on floodplains. [6]	TP List[1] WAHerb[2]	Possible

Table 3.2 – Likelihood of Threatened (Declared Rare) Flora and Priority Flora Occurring in the Survey Area (continued)

Species	Description	Priority Status	Flowering Period	Habitat	Source	Likelihood of Occurrence
Ptilotus luteolus	Shrub to 0.2 m high; lilac flowers.[8]	P3	Dec	Orange clay loam with ironstone pebbles. [8]	TP List[1]	Possible
Rhodanthe sphaerocephala	Erect, annual herb to 0.3 m high, with ascending branches. [6]	P	Oct	Clayey loam on flats. [6]	TP List[1]	Possible
Tribulus adelacanthus	Prostrate, villous herb. [6]	P	-	Red-brown shallow sandy loam on lower slopes of banded ironstone formations. [2]	WAHerb[2]	Unlikely

Sources:

1 – Threatened and Priority Flora List
2 – Western Australian Herbarium Specimen database
3 – Threatened (Declared Rare) and Priority Flora database
4 – NatureMap database
5 – EPBC Protected Matters database
6 – WAH, 2008-
7 – Brown and Buirchell, 2011
8 – Davis, 2009a

3.6.4 Department of Environment and Conservation Database Search – Threatened and Priority Ecological Communities

Results of DEC's TEC and PEC searches identified one PEC (DEC, 2013b):

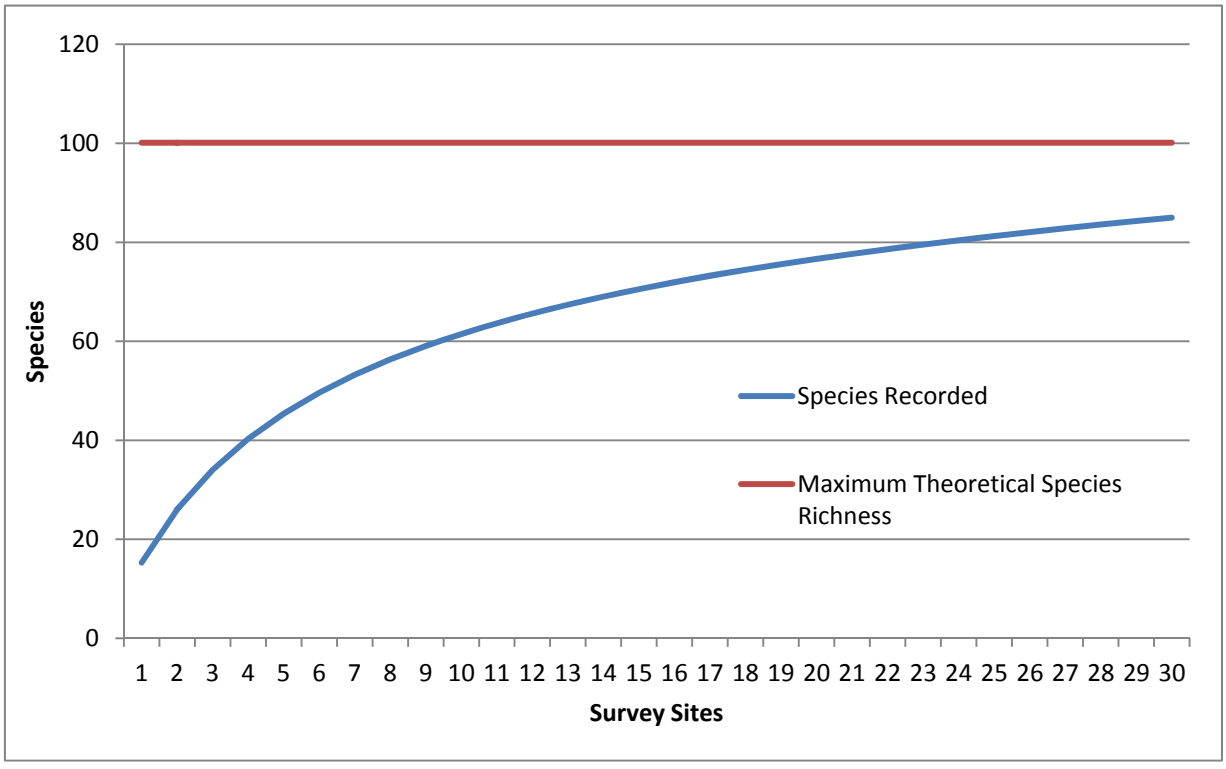
- Robinson Range vegetation complexes (banded ironstone formation) (Priority 1).

3.7 Field Survey

Eighty taxa (species, subspecies and varieties) were recorded within 24 families and 43 genera (**Appendix 3**). Fabaceae, Chenopodiaceae Malvaceae, Poaceae and Scrophulariaceae were the most common families containing most taxa.

A species accumulation curve is shown in **Chart 3.1**. This shows the cumulative no of species recorded over the course of the survey. The theoretical total species is a statistical value of the maximum number of species within the survey area calculated using the statistical package EstimateS (Colwell, 2006). During the survey, 85% of the theoretical maximum total species present were recorded.

Chart 3.1 – Flora Species Accumulation throughout Survey



3.7.1 Threatened and Priority Flora

No DRF pursuant to Section 23F (2) of the *Wildlife Conservation Act 1950* (WC Act) or Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the survey area. No PF were recorded in the survey area.

3.7.2 Introduced Species

One introduced species was recorded. *Portulaca oleracea* Purslane was recorded at six locations. The locations of this species are shown in **Table 3.4**.

Table 3.4 - Location of Introduced Species Recorded in the Survey Area

Introduced Species	Site	MGA94 Zone 50	
		Easting	Northing
Portulaca oleracea (Purslane)	HS03	660643	7183146
	HS05	660839	7182496
	HS06	660685	7182647
	HS11	660543	7181857
	HS12	660417	7181728
	HS16	659209	7182720

3.7.3 Vegetation

Eleven vegetation communities were identified in the survey area (**Table 3.5**) (**Appendix 3**). Mapped vegetation communities are illustrated in **Figure 3.2**. Vegetation structure was classified and described using NVIS structural formation terminology (**Appendix 2**). A summary of vegetation communities with representative photographs is provided in **Appendix 4**.

Classification of vegetation communities was assisted using the statistical analysis package PATN (Belbin, 1989). The resulting row fusion dendrogram is provided in **Appendix 4**.

3.7.4 Vegetation Condition

The condition of the vegetation communities across the survey area ranged from ‘Excellent’ to ‘Completely Degraded’ in accordance with Keighery’s (1994) condition scale (**Appendix 2**). Vegetation condition varied within vegetation communities across the Project area. Various causes of disturbance were recorded throughout the survey area. These included mineral exploration, vehicle tracks and cattle grazing.

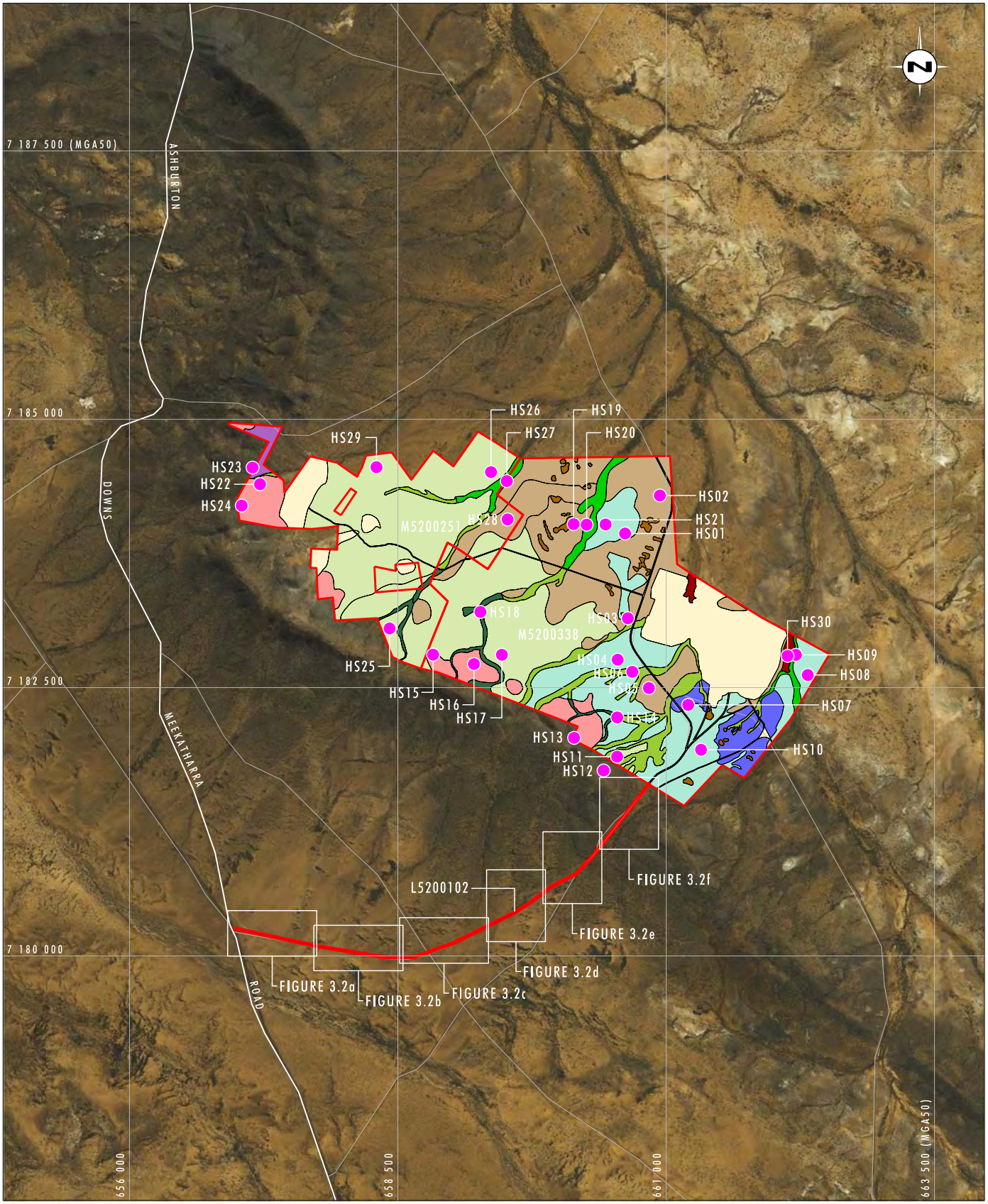


Image Source: Google Earth (2003)

0 0.5 1.0 2.0km
1:50 000

Legend

- Grosvenor Gold Tenements
- Major Road
- Minor Track
- Vegetation C1
- Vegetation C2
- Vegetation C3
- Cleared Vegetation
- Vegetation M1
- Vegetation S1
- Vegetation S2
- Vegetation S3
- Vegetation S4
- Vegetation S5
- Vegetation X1
- Vegetation X2
- Survey Sites

FIGURE 3.2

Level 1 Flora and Vegetation Mapping 2013

File Name (A4): R01/6098_007.dgn
20130625 9.53

Image Source: Google Earth (2003)

0 50 100 150m
1:3 000

Legend

- Grosvenor Gold Tenements
- Major Road
- Minor Track
- Vegetation C2
- Cleared Vegetation
- Vegetation S1

FIGURE 3.2a

Level 1 Flora and Vegetation Mapping 2013

File Name (A4): R01/6098_008.dgn
20130625 16.49

Image Source: Google Earth (2003)

0 50 100 150m
1:3 000

Legend

- Grosvenor Gold Tenements
- Vegetation C2
- Cleared Vegetation
- Vegetation S1
- Vegetation S2

FIGURE 3.2b

Level 1 Flora and Vegetation Mapping 2013

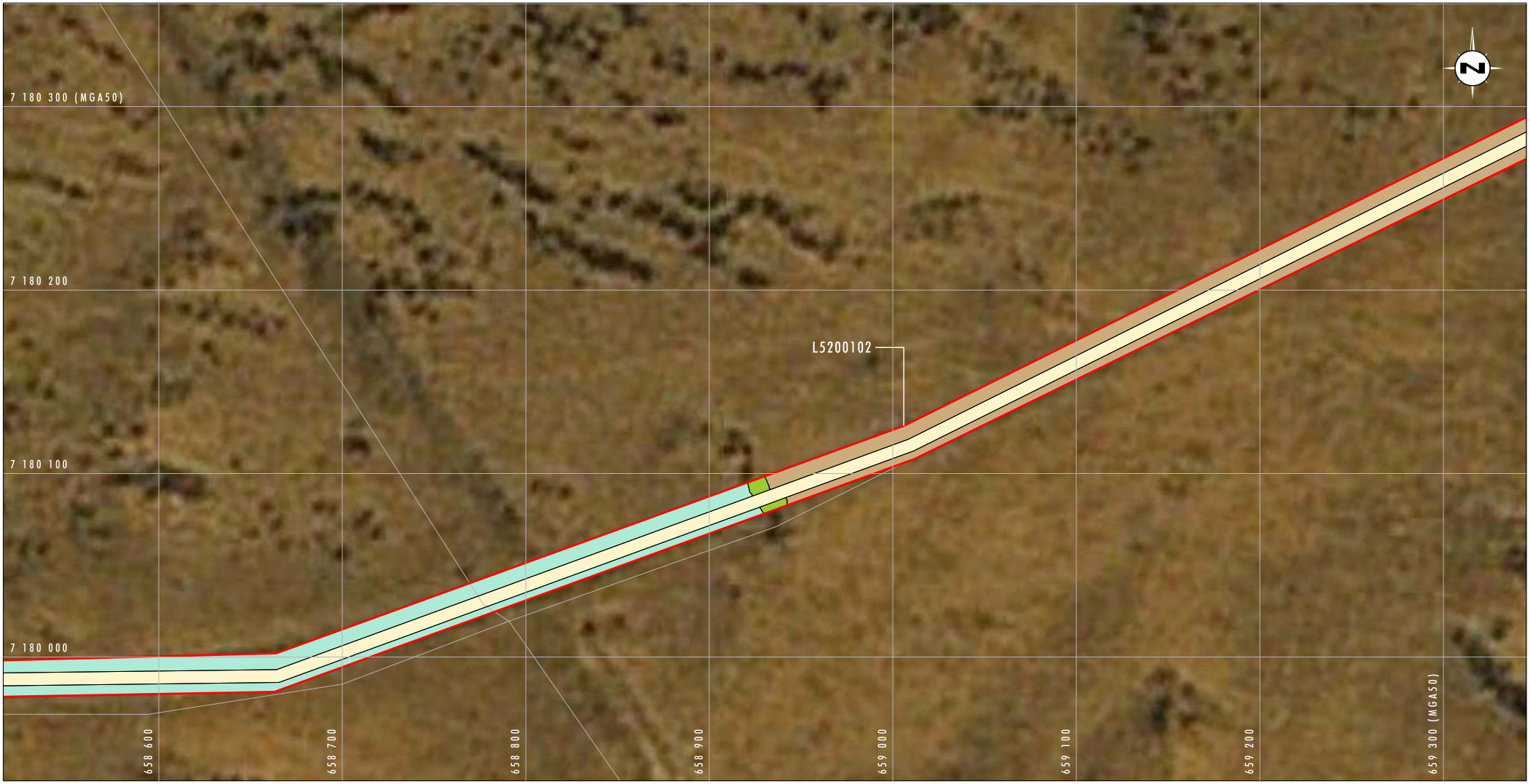


Image Source: Google Earth (2003)

0 50 100 150m
1:3 000

Legend

- Grosvenor Gold Tenements
- Minor Track
- Vegetation C2
- Cleared Vegetation
- Vegetation S1
- Vegetation S2

FIGURE 3.2c

Level 1 Flora and Vegetation Mapping 2013

File Name (A4): R01/6098_010.dgn
20130625 17.04

Image Source: Google Earth (2003)

0 50 100 150m

1:3 000

Legend

- Grosvenor Gold Tenements
- Minor Track
- Cleared Vegetation
- Vegetation S1

FIGURE 3.2d

Level 1 Flora and Vegetation Mapping 2013

Image Source: Google Earth (2003)

0 50 100 150m

1:3 000

Legend

- Grosvenor Gold Tenements
- Minor Track
- Cleared Vegetation
- Vegetation S1

FIGURE 3.2e

Level 1 Flora and Vegetation Mapping 2013

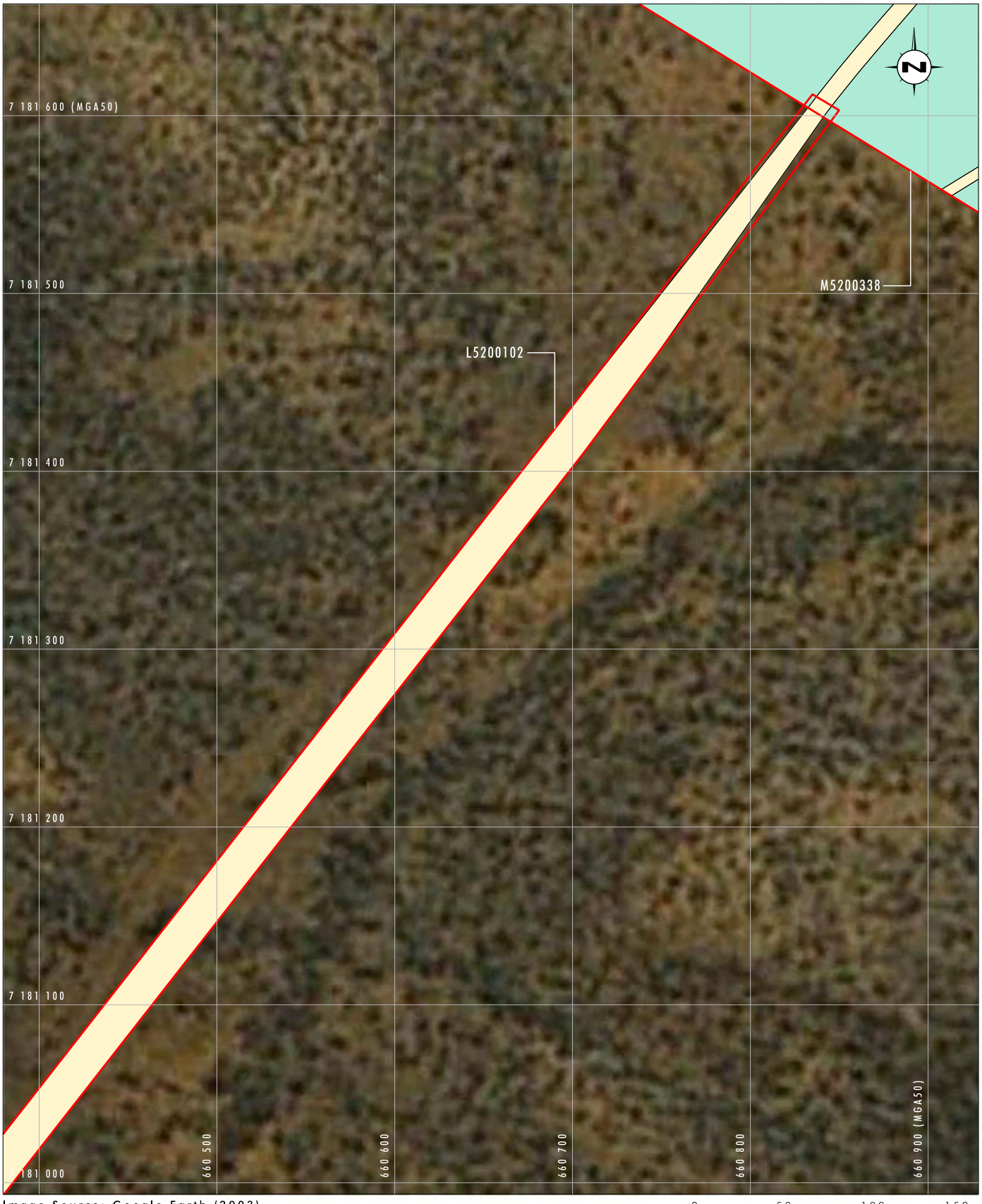


Image Source: Google Earth (2003)

0 50 100 150m

1:3 000

Legend

- Grosvenor Gold Tenements
- Cleared Vegetation
- Vegetation S2

FIGURE 3.2f

Level 1 Flora and Vegetation Mapping 2013

Table 3.5 – Vegetation Communities Described within Survey Area

	Description	Area (ha)	% of Survey Area
Acacia Woodlands			
S1	Low sparse woodland of *Acacia aptaneura* with *Acacia pruinocarpa* over mid sparse shrubland of *Senna glutinosa* subsp. *chatelainiana*, *Senna artemisioides* subsp. x *sturtii*, *Eremophila jucunda* subsp. *jucunda* and *Psydrax latifolia* over low sparse forbland of *Hibiscus gardneri* ms and *Ptilotus obovatus* and low sparse grassland of *Aristida contorta*. This community occurs on stony, hardpan plains	191.89	19.60
S2	Low sparse woodland of *Acacia aptaneura* with *Acacia pruinocarpa*, *Acacia tetragonophylla*, *Acacia aptaneura* and *Acacia cuspidifolia* over low sparse shrubland of *Ptilotus obovatus*, *Senna glutinosa* subsp. *chatelainiana*, *Senna artemisioides* subsp. x *sturtii* and *Eremophila spectabilis* subsp. *brevis* over low sparse chenopod shrubland of *Tecticornia doleiformis*, *Sclerolaena cuneata*, *Maireana aphylla* and *Maireana triptera*. This community occurs on hardpan plains with quartz pebbles.	147.79	15.09
S3	Low sparse woodland of *Acacia aptaneura* and *Acacia ayersiana* over mid sparse shrubland of *Eremophila gilesii* subsp. *variabilis*, *Senna glutinosa* subsp. *chatelainiana*, *Rhagodia eremaea* and *Scaevola spinescens* over low sparse chenopod shrubland of *Maireana tomentosa*, *Enchylaena tomentosa* and *Tecticornia doleiformis*. This community occurs on flats and small rises with ironstone pebbles.	29.67	3.03
S4	Low open woodland of *Acacia cyperophylla* subsp. *cyperophylla* over low sparse shrubland of *Eremophila galeata* over low sparse grassland of *Aristida contorta*.	4.49	0.46
S5	Low open woodland of *Acacia aptaneura* with *Acacia cuthbertsonii*, *Acacia tetragonophylla* and *Grevillea berryana* over low sparse shrubland of *Senna artemisioides* subsp. x *sturtii*, *Eremophila galeata* and *Eremophila spectabilis* subsp. *brevis* over low sparse forbland and grassland of Eria*chne mucronata*, *Ptilotus rotundifolius* and *Ptilotus obovatus*. This community occurs at the base of small ironstone ranges on stony plains.	323.93	33.08
M1	Low open woodland of *Acacia aptaneura* and *Acacia cuthbertsonii* with *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Psydrax latifolia* over low sparse shrubland of *Maireana aphylla* with *Senna artemisioides* subsp. x *sturtii*, *Senna artemisioides* subsp. *helmsii* and *Atriplex vesicaria* over low forbland and grassland of *Sclerolaena cuneata* and *Eriachne pulchella* with *Ptilotus obovatus*, *Maireana triptera* and *Aristida contorta*. This community occurs on deeper soils on hardpan plains.	8.83	0.90
Hills and Ranges			
X1	Low open woodland of *Acacia rhodophloia* and *Acacia aptaneura* over mid sparse shrubland of *Eremophila galeata* and *Senna artemisioides* subsp. x *sturtii* over low sparse forbland and grassland of *Heliotropium* sp., *Ptilotus obovatus*, *Tribulus suberosus* and *Enneapogon caerulescens*. This community occurs on low, mid and upper slopes of small ironstone ranges.	52.64	5.38
X2	Woodland of *Acacia aptaneura* over mid sparse shrubland of *Senna artemisioides* subsp. x *sturtii*, *Senna artemisioides* subsp. *helmsii* and *Acacia tetragonophylla* over low sparse forbland and grassland of *Tribulus suberosus*, *Eremophila spectabilis* subsp. *brevis*, *Maireana triptera* and *Enneapogon caerulescens*. This community occurs on mid slopes of small ironstone ranges.	6.43	0.66

Table 3.5 – Vegetation Communities Described within Survey Area (continued)

	Description	Area (ha)	% of Survey Area
Creeks and Drainages			
C1	Low open woodland of *Acacia cyperophylla* subsp. *cyperophylla* with scattered *Eucalyptus camaldulensis* over tall open shrubland of *Acacia aptaneura* over low sparse shrubland of *Eremophila galeata*, *Acacia tetragonophylla* and *Grevillea deflexa* over low sparse grassland of *Eriachne helmsii and Eriachne pulchella* subsp. *dominii*. This community occurs on ephemeral creeks.	20.58	2.10
C2	Low open woodland of *Acacia aptaneura* with *Acacia kempeana*, *Acacia tetragonophylla* and *Psydrax latifolia* over low sparse shrubland of *Senna glutinosa* subsp. *chatelainiana*, *Senna glutinosa*, *Senna artemisioides* subsp. *helmsii* and *Eremophila spectabilis* subsp. *brevis* over low sparse grassland of *Enneapogon caerulescens* and *Eriachne mucronata* and low sparse forbland of *Ptilotus obovatus*, *Hibiscus burtonii* and *Sida* sp. Dark green fruits (S. van Leeuwen 2260). This community occurs in minor flowlines and creeks with shallow channels.	50.54	5.16
C3	Low open woodland of *Acacia aptaneura* with *Acacia rhodophloia* and *Grevillea berryana* over open shrubland of *Acacia kempeana* over low sparse shrubland of *Senna artemisioides* subsp. *helmsii*, *Eremophila galeata* and *Acacia cuthbertsonii* over low sparse grassland of *Enneapogon caerulescens*, *Eriachne mucronata* and *Cymbopogon ambiguus* and low sparse forbland of *Ptilotus obovatus*, *Indigofera monophylla* and *Abutilon cryptopetalum*. This community occurs in minor flowlines and creeks with shallow channels.	14.11	1.44
CL	Cleared Land	128.33	13.11
	Total	**979.22**	**100**

4.0 Fauna

Umwelt was commissioned to undertake a Level 1 fauna survey in addition to a targeted fauna habitat for species of conservation significance within the Horseshoe area.

4.1 Survey Methodology

The fauna component of the ecological survey was conducted in accordance with the following Position Statements and Guidelines:

- EPA Position Statement No 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA, 2002);
- Guidance Statement No. 56 “Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia” (EPA, 2004b); and
- “Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment” (EPA and DEC, 2010).

4.1.1 Desktop Study

A desktop study was undertaken ahead of the field survey using resources available through database searches, available literature and previous reporting.

Objectives of the desktop study were to:

- identify historic records of all fauna including conservation significant fauna within the survey area;
- identify likely habitat that may support conservation significant fauna from regional information and from aerial imagery of the survey area.

Conservation categories and descriptions of the conservation status of fauna are provided in **Appendix 1.**

4.1.1.1 Database Searches

Searches of databases were undertaken in April 2013. The searches included:

- Listed MNES and other fauna related matters protected under the EPBC Act in the vicinity of the survey area were searched for using the on-line ‘Protected Matters Search Tool’ (DSEWPaC, 2013b). Coordinates for the area search were: -25.46139; 118.60556 and included a 10 km buffer.
- DEC Threatened and Priority Fauna database (50 km buffer – 10 April 2013, Ref: 4479, coordinates: MGA50 661420 E, 7182988 N) (DEC, 2013d);
- DEC’s NatureMap was searched for vouchered fauna specimens at the Western Australian Museum (WAM) (25º 27’ 41”S; 118º 36’ 20”E with a 20 km buffer) (DEC,2013c);
- Birdlife Australia Atlas database, including birds listed in international agreements between the Government of Australia and the People's Republic of China (CAMBA), the

Government of Japan (JAMBA) and the Government of the Republic of Korea (ROKAMBA) (25º 41S; 118º 41'E with a 20 km buffer) (Birdlife Australia, 2013a);

- International Union for Conservation of Nature (IUCN) database (species specific) (IUCN 2013);
- Atlas of Living Australia database (ALA) (25º 27' 41"S; 118º 36' 20"E with a 10 km buffer) (ALA, 2013); and
- Online Zoological Collections of Australian Museums database (OZCAM) (Search conducted for Shire of Meekatharra) (OZCAM, 2013).

The results from all database searches are detailed in **Appendix 5**.

Recent surveys in the area include:

- a desktop survey of the Proposed Horseshoe Ranges Mining Area by Davis (2009b) for Auvex Resources Limited;
- a Level 1 Fauna survey of the Fortnum Gold Mine area (Rapallo, 2012); and
- a Level 1 Flora, vegetation and fauna survey in RNI's 'Montezuma' tenements <35 km south, southeast of the Project area (Umwelt, 2013).

Results from these studies have been used as contextual information.

4.2 Taxonomy and Nomenclature

Nomenclature and taxonomic order are presented in accordance with advice in the '*Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment'* (EPA/DEC 2010). Specifically, for herpetofauna and mammals, nomenclature and taxonomic order are based on the WAM *Checklist of the Vertebrates of Western Australia,* and for avifauna, Christidis and Boles (2008). The authorities used for herpetofauna are Doughty (2013) and for mammals How *et al*. (2013). Latin names of species with corresponding common (English) names are presented in all tables and appendices. Common names are used for birds in text, whilst Latin names are used for amphibians, reptiles and mammals as not all of these species have common names.

4.3 Field Survey

The reconnaissance and targeted habitat fauna survey was conducted by Dr Vi Saffer (Umwelt) between 8 to 10 April and 9 and 10 May 2013.

The objectives of these assessments were to:

- generally verify vegetation associations within the survey area;
- identify local habitat that may be of significance to fauna indigenous to WA;
- identify local habitat that may be of significance to conservation significant fauna;
- identify fauna of conservation significance in the area;

- compile an inventory of terrestrial fauna species of the survey area based on the results of the desktop surveys and the results of the reconnaissance and targeted habitat survey;
- identify the regional context of conservation significant fauna identified by examining available data from other localities within the region to understand species occurrences, distribution and populations; and
- provide a risk assessment to determine potential impacts to fauna of conservation significance.

4.3.1 Survey Team

Principal Zoologist was Vi Saffer who has a PhD (Biological Science) with 20 years experience conducting Level 1 and 2 Fauna Surveys and targeted vertebrate and invertebrate fauna surveys throughout WA.

4.3.2 Licence and Permits

No licences or permits were required for this survey.

4.3.3 Access

All survey areas were accessible using a four wheel drive vehicle using existing tracks and on foot where tracks were not available.

4.3.4 Approach to survey

Prior to undertaking the field work, investigations into access and preliminary vegetation communities were undertaken. All species recorded in the vicinity of the survey, including species of conservation significance, were reviewed. For species of conservation significance that potentially occur in the area, the distributional range, ecology and preferred habitat of each species was researched.

For convenience and safety reasons, the flora and fauna surveys were undertaken at the same time in the same areas. Thus, sites were primarily selected based on vegetation complexes and, therefore different habitats for fauna. While floristic transects and releves were examined, fauna surveys were conducted. At each site a minimum 20 minute, 2 hectare (ha) bird survey was conducted in accordance with Atlas Search Methods for the Atlas of Australian Birds (Birdlife Australia, 2013b). This method involves recording all visual and auditory bird observations to species level where possible within a 2 ha search area (visually estimated area) for the 20 minute time interval. During this search, the observer is permitted to casually walk throughout the 2 ha area, taking note of individual bird movements to ensure abundance is not over-estimated due to individuals moving about. At some sites, the time limit extended beyond 20 minutes until the conclusion of floristic survey.

Searches were also conducted for secondary evidence of fauna presence at each site including nests, hollows, burrows, tracks, scats and diggings. This typically involved looking under rocks, under bark, under logs and in hollows of habitat logs on the ground. Specific invertebrate searches were not conducted; however, those sighted were recorded during the surveys. In addition, opportunistic observations of fauna (or signs of fauna) were recorded from anywhere within the Horseshoe area. This included when driving to and from sites and walking to and from sites.

Habitat evaluation was undertaken at all sites included assessing the vegetation strata, rocks and outcroppings, extent of understorey, availability of leaf litter, tree hollows, habitat logs refugia *etc.*

4.3.5 Limitations

In accordance with EPA's Guidance Statement No. 56 (EPA, 2004b) limitations of the Level 1 and targeted fauna habitat survey have been assessed and are presented in **Table 4.1.**

Table 4.1 – Summary of Fauna Survey Limitations

Possible Limitation	Constraint	Comment
Competency/experience of the consultant carrying out the survey	No	Experienced and competent personnel conducted the survey.
Scope	No	All components required for the Level 1 and targeted fauna habitat survey were completed in the areas surveyed.
Proportion of fauna identified, recorded and/or collected	Yes	A comprehensive vertebrate trapping survey has not been undertaken within the survey area. However, those species recorded during the onsite surveys were all positively identified.
Sources of information	Yes	A comprehensive vertebrate trapping survey has not been undertaken within the Project area. However, vertebrate fauna information was available from database searches and unpublished reports.
Proportion of task achieved and further work that may be required	No	Sufficient information was collected for assessment; no further work is required at this stage.
Timing/weather/season/cycle	No	The survey was completed during daylight hours in temperate weather, both appropriate for this level of survey.
Disturbances which affected the results of the survey	No	No disturbances affected the results of the survey.
Intensity of survey effort	No	The intensity of the survey is sufficient for a reconnaissance and fauna habitat assessment.
Completeness	No	Proposed survey area was sufficiently surveyed.
Resources	No	Surveyor sufficiently experienced to identify the majority of animals observed to species level.
Remoteness and/or access problems	No	Access was not a problem.
Availability of contextual information on the region	Yes	A comprehensive vertebrate trapping survey has not been undertaken within the survey area. Limited regional data is available for the survey area.

4.4 Fauna Results

4.4.1 Desktop Review

The desktop study identified 285 fauna species that potentially could occur in the local area (**Table 4.2**), with the local area defined as the Project area in addition to the buffer areas as nominated in the database searches (**Section 4.1.1.1**). Of these fauna species, 16 are considered to be of conservation significance. A summary of the desktop study results including all species, conservation significant species and previously recorded species are detailed in **Section 4.4.3**.

Table 4.2 – Number of Fauna Potentially Occurring and Recorded within the Local Area

Fauna Type	Number of potentially occurring species	Number of potentially occurring conservation significant species	Number of species recorded (including evidence)
Fish	2	0	1*
Amphibians	7	0	1
Reptiles	96	1	6
Native mammals	33	6	3
Birds	137	9	53
Total native species	**275**	**16**	**64**
Introduced mammals	9	9 invasive spp.	1
Introduced birds	1	1 invasive sp.	0
Total species	**285**	**16**	**65**

* Fish were not assessed in this report but one fish species was seen opportunistically.

4.4.2 Fauna Habitats within the Survey Area

The dominant land use within the Augustus sub-region is 'native pasture grazing' representing 84.2% (Desmond *et al.* 2001). The remaining uses include UCL and Crown Reserves (9.76%), Aboriginal reserves (3.37%) and conservation (2.5%).

The vegetation survey identified eleven vegetation communities within the total survey area (979.22 ha) (**Section 3.7.3)**. From a fauna perspective, based on these results and verified during the reconnaissance survey, four fauna habitats can be broadly described with the Project area:

- Acacia woodland/shrubland (plains) (S1 – 5) (~71%);
- Creekline vegetation (C1-3) (~8.7%);
- Acacia woodland (hills) (X1-2) (~6%); and
- Mulga (M1) (<1%).

Representative photographs are included in **Appendix 4.**

4.4.3 Fauna within the Survey Area

A total of 285 vertebrate fauna species have been identified as potentially occurring within the local area (**see Section 4.4.1**). This includes two fish species, seven species of amphibians, 96 species of reptiles, 33 species of native mammals, ten species of non-native mammals, 137 native bird species and one exotic species of bird. All results are presented in **Appendix 5***.* Sixteen species are considered of conservation significance and these will be addressed in detail in **Section 4.4.4**.

4.4.3.1 Fish

Two native freshwater fish species have been recorded in the local area, neither of which are considered of conservation significance.

No surveys for fish have been undertaken in the Project area. However, *Leiopotherapon unicolor* Spangled Perch has been recorded approximately 27 km away from the Project area (Rapallo, 2012) and one unidentified species was recorded during the current reconnaissance survey.

Leiopotherapon unicolor is a known biosecurity risk but only south of the Murchison River in WA. The recording of this species by Rapallo (2012) was well within its normal distributional range.

4.4.3.2 Amphibians

Up to six species of frogs have been recorded in the Project area, none of which are considered of conservation significance. Previous studies have recorded only one species from the Project area: *Litoria rubella* Little Red Tree Frog (Rapallo, 2012, Umwelt, 2013).

During the reconnaissance survey, two unidentified species of frog in larval form were sighted in a creek, and *L. rubella* was sighted at the camp site.

4.4.3.3 Reptiles

A total of 96 reptile species have been recorded in the local area. While the EPBC and DEC results did not include *Aspiditis ramsayi* Woma for the area, this species which is classified as a Schedule 4 species under the *Wildlife Conservation Act 1050* and as a Priority 1 species on the DEC Threatened and Priority fauna database is listed in the OZCAM results. However, the recording is from 1893 with no recent recordings. No other reptilian species of conservation significance have been recorded in the local area.

Rapallo's (2012) survey recorded only three reptile species, none of which are considered of conservation significance, while Umwelt (2013), recorded five species of reptile species with no species of conservation significance.

Six species were recorded opportunistically during the current reconnaissance survey, none of which are of conservation significance.

4.4.3.4 Mammals

Thirty one species of native mammals have been recorded in the local area, in addition to nine species of non-native mammals. Of these, six native mammals are classified as species of conservation significance (**see Section 4.4.4**) and all nine non-native species are classified as Invasive species under the EPBC Act.

The survey conducted at Fortnum Gold Mine identified three native mammals with one unidentified (*Macropus* sp.), and three non-native species (Rapallo, 2012). While none of the native mammals are considered of conservation significance, all three non-native mammals are classified as Invasive under the EPBC Act. The survey at Montezuma, recorded six species, including two native mammals and four EPBC classified Invasive species (Umwelt, 2013). Evidence of one species of conservation significance was recorded, *Pseudomys chapmani* Western Pebble-mound Mouse (Umwelt, 2013).

Three species of native mammals and one non-native mammal species were recorded within the Project area during the current reconnaissance survey. Of the native mammals, evidence of one species of conservation significance was identified; the abandoned burrows of *P. chapmani* were recorded.

4.4.3.5 Avifauna

A total of 100 species have been recorded in the local area. Eight of these species are classified as species of conservation significance (**see Section 4.4.4**) and one classified as Invasive species under the EPBC Act.

The Fortnum Gold Mine survey recorded 37 bird species (Rapallo, 2012). Of these, three species are considered of conservation significance:

- *Ardeotis australis* Australian Bustard;
- *Burhinus grallarius* Bush Stone-curlew; and
- *Oreoica gutturalis* Crested Bellbird.

The Montezuma survey recorded 41 bird species, of which two species are considered of conservation significance, the Crested Bellbird and *Pomatostomus superciliosus* White-browed Babbler (Umwelt, 2013).

Fifty-three species of birds were recorded during the current reconnaissance survey including two species of conservation significance;

- *B. grallarius* Bush Stone-curlew; and
- *O. gutturalis* Crested Bellbird.

4.4.3.6 Invertebrate Fauna

No specific invertebrate databases were interrogated during the desktop study and no species of conservation significance were listed from the databases that were searched.

A Level 1 survey at Fortnum Gold Mine recorded three types of spider burrows, scorpion burrows and at least three species of butterflies (Rapallo, 2012). None of these species were identified to species level.

Similarly, a moderate number of spider burrows were recorded during the current reconnaissance survey, in addition to butterflies, moths, dragon flies and water boatmen. None of the spider burrows recorded during the survey displayed any external features that could distinguish what species or family the spider belonged to. Notwithstanding this, the majority of habitats within the Project area are not likely to support Short-range Endemic invertebrate fauna.

4.4.4 Conservation Significant Fauna

Results of the database searches indicated that 16 species of conservation significance have been recorded within the survey area (**Table 4.4**) in addition to nine non-native species that area classified as Invasive species under the EPBC Act (**Table 4.5**). For the species of conservation significance, a short description of each of the species follows, which states their assessed likelihood of occurrence and the potential impact on their conservation status.

Table 4.5 Invasive Species recorded within the Local Area

Common name	Species Name
Mammals	
Dromedary, Camel	*Camelus dromedarius*
Dog	*Canis lupus*
Goat	*Capra hircus*
Donkey	*Equus asinus*
Horse	*Equus caballus*
Cat	*Felis cattus*
House Mouse	*Mus musculus*
Rabbit	*Oryctolagus cuniculus*
Red Fox	*Vulpes vulpes*
Birds	
Rock Dove, Rock Pigeon, Domestic Pigeon	*Columba livia*

4.4.5 Habitat Condition

Overall, the condition of the vegetation was determined to range from '"Completely Degraded" to "Excellent' in accordance with Keighery's (1994) condition scale (**Appendix 2**). As stated in **Section 3.7.1**, vegetation condition varied within vegetation communities across the Project area. Degradation in varying degrees was the result of trampling and grazing of livestock, in addition to historic and more recent presence of invasive species including camels and goats.

Table 4.4 – Terrestrial Fauna Species of Conservation Significance Recorded within the Local Area

	Species Name	Conservation Status*		
		EPBC Act	WC Act	DPaW database
Reptiles				
Woma**	*Aspidites ramsayi*		S4	P1
Mammals				
Northern Quoll	*Dasyurus hallucatus*	Endangered		
Long-tailed Dunnart	*Sminthopsis longicaudata*			P4
Northern Marsupial Mole	*Notoryctes caurinus*	Endangered		
Bernier Is. Banded Hare-wallaby, Mernine	*Lagostrophus fasciatus* subsp. *fasciatus*		S1	
Pilbara Leaf-nosed-bat	*Rhinonicteris aurantia* (Pilbara form)	Vulnerable		
Western Pebble-mound Mouse**	*Pseudomys chapmani*			P4
Birds				
Eastern Great Egret	*Ardea modesta*	Migratory	S3	
Peregrine Falcon	*Falco peregrinus*		S4	
Australian Bustard	*Ardeotis australis*			P4
Bush Stone-curlew	*Burhinus grallarius*			P4
Oriental Plover	*Charadrius veredus*	Migratory		
Common Sandpiper	*Actitis hypoleucos*		S3	
Rainbow Bee-eater	*Merops ornatus*	Migratory	S3	
Slender-billed Thornbill (Western)	*Acanthiza iredalei* subsp. *iredalei*	Vulnerable		
Crested Bellbird***	*Oreoica gutturalis*			P4

* for further information regarding conservation status see **Appendix 1**
** Record from OZCAM database search results
*** Record from OZCAM, Birds Australia and ALA database search results.

Aspidites ramsayi Woma

Family:	Boidae
Conservation Status:	Schedule 4 under WC Act and P1 on DEC Threatened and Priority Fauna Database.
Distribution:	The Woma lives in semi-arid and arid environments in central and south-west Australia, although there are few recent records of the snake within the southern parts of its range. In Western Australia it can be found in two separate populations, the northern one from the Pilbara coast north to the Eighty Mile Beach area, and southern one from Cape Peron south and east to the eastern Goldfields region, although records suggest that the Peron population is isolated from the nearest southwestern locality (DEC 2010).
Ecology:	This moderately large python's preferred habitat appears to be sandy plains or desert dunes, usually with hummock grasslands. Due to its nocturnal nature, it is rarely seen. They often utilise rabbit or varanid burrows and hollow logs for shelter or make their own under hummock grasses or other dense vegetation (Cogger, 2000, Storr *et al,.* 2002, Ehmann and Watson, 2011). The Woma grows up to 2.7 m long, with an average length of 1.5 m and is occasionally mistaken for a venomous snake due to its narrow pointed head (Cogger, 2000, DEC, 2010). This python's diet consists of reptiles, small mammals and birds (Cogger, 2000, DEC, 2010). Mating most likely occurs between May to August with a clutch of 5 –19 eggs laid between September and October (DEC, 2010).
Likelihood of occurrence:	The Project area appears to be located north and south of the distributional range of the southern and northern populations respectively. The last recording of the Woma in the area relates to a specimen collected in 1893 (OZCAM, 2013). While there may be some areas of potentially suitable habitat for the Woma in the Project area, given the location and lack of recent records, it is **unlikely** that the Woma is present in the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Dasyurus hallucatus Northern Quoll

Family:	Dasyuridae
Conservation Status:	Endangered under the EPBC Act.
Distribution:	The distribution of the Northern Quoll previously extended across broader Northern Australia but it's now restricted to several disjunct populations in five regional populations across Queensland, the Northern Territory and Western Australia both on the mainland and on offshore islands (DSEWPaC, 2013c)
Ecology:	The Northern Quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert (DSEWPaC, 2013c). Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal They are opportunistic foragers that feed on a broad range of items switching dietary resources according to season and availability (Hill and Ward, 2010). This solitary species is both terrestrial and arboreal with preferred habitat including dissected rocky escarpments and eucalypt forest or woodlands. The Northern Quoll is predominantly nocturnal but is occasionally active during the day and uses a variety of dens sites including tree hollows, rock crevices, logs and termite mounds. Breeding occurs once a year with two to three young born between June and September. Typical of the Dasyurids, males die after mating with the Northern Quoll being the largest mammal species to do so (Oakwood, 2008; Menkhorst and Knight, 2011). Therefore, if survivorship of juvenile males, or females, is compromised, this may lead to local extinctions of the species.
Likelihood of occurrence:	While the Project area may support some preferred habitat for the Northern Quoll, the location is well south of currently known populations (Hill and Ward, 2010). No evidence or sightings of quolls were recorded during the survey period. Given the above, it is considered **unlikely** that the Northern Quoll occurs in the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Sminthopsis longicaudata Long-tailed Dunnart

Family	Dasyuridae
Conservation Status:	Priority Four: Rare, Near Threatened and other taxa in need of monitoring on the DEC Threatened and Priority Fauna Database.
Distribution:	The Long-tailed Dunnart is found in the Pilbara, Murchison, Northeastern Goldfields, Ashburton and Gibson Desert regions of Western Australia. It is also found in small areas in the Northern Territory (McKenzie et al., 2008). While it is patchily distributed, it can be common locally (Burbidge *et al.* 2008)
Ecology:	The Long-tailed Dunnart, a nocturnal species, prefers rocky habitats that support low open woodlands or Acacia shrublands with an understorey of Spinifex (McKenzie *et al.,* 2008). It is the only dunnart with a tail at least twice the length of its head and body combined with a terminal tuft of long hairs (Menkhorst and Knight, 2011). The main diet of this species is arthropods and it appears to be a spring-summer breeder (Burbidge et al., 2008). Females in captivity give birth to up to five young between the months of October and December (McKenzie *et al.,* 2008).
Likelihood of occurrence:	The most recent recording of the Long-tailed Dunnart in the area was in 2009. The lack of more recent records may be an artefact of no comprehensive surveys being undertaken rather than local extinctions. Albeit potentially in low abundance, the Long-tailed Dunnart is considered **likely** to occur in the Project area.
Potential Impacts:	Some areas of the Project area may provide preferred habitat for the Long-tailed Dunnart. However, given their low abundance and the vast tracks of similar undisturbed vegetation locally, the conservation status of the species is unlikely to be altered by any disturbance associated with any proposed mining activity in the Project area.

Notoryctes caurinus Northern Marsupial Mole

Family:	Notoryctidae
Conservation Status:	Endangered under the EPBC Act.
Distribution:	The Northern Marsupial Mole occurs within sand dune deserts, namely the Great Sandy and Little Sandy Deserts of north-western Australia (Benshemesh and Aplin, 2008). There seems to be an overlap of the Northern and Southern Marsupial Moles distributions (Benshemesh and Aplin, 2008).
Ecology:	The Northern Marsupial Mole a fossorial species, living in underground burrow systems within sand dunes, interdunal flats, and in sandy soils along river flats. Little is known of the Northern Marsupial Mole, and it is assumed that its ecology is similar to that of its smaller relative, the Southern Marsupial Mole (Benshemesh and Aplin, 2008, Benshemesh, 2008, DSEWPaC, 2013c). Marsupial Moles are fossorial mammals and are highly adapted to this underground lifestyle where they spend the majority of their time. Moles are blind with no visible eyes; lack external ears; have a tubular body shape with dense silky fur and a short neck with a horny shield to protect their snout. They exhibit strong fore-limbs with spade-like claws and a short, strong tail which assists with tunnelling underground. Tracks on the surface are very distinctive and differ between the two species (Benshemesh, 2008). The Southern Marsupial Mole drags its tail on the surface; however, the northern species does not seem to do this. The Marsupial Moles seem to spend most of their time 20 to 60 centimetres (cm) below the surface with a preference for dune crests and slopes, possibly due to easier digging in these areas. They tunnel through the sand and backfill the tunnels as they go and do not re-use tunnels. The backfilled tunnels can be seen in the soil profile for many years after use. Moles feed on small subterranean prey such as ants and termites or other colonial type insects. Little is known of their reproduction or social interactions. The female has a backward opening pouch with two teats. It is thought that the young do not tunnel until they reach adulthood due to the size of the tunnels recorded (Benshemesh, 2008).
Likelihood of occurrence:	The Project area is south and west of the known distributions of the Northern Marsupial Mole. The Project area also does not contain suitable habitat for this species. No evidence or sightings of moles were recorded during the survey. It is therefore considered **unlikely** that the Northern Marsupial Mole occurs in the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Lagostrophus fasciatus Banded Hare-wallaby or Mernine

Family:	Macropodidae
Conservation Status:	Endangered under the EPBC Act and Schedule 1 under the WC Act 1950**.**
Distribution:	Bernier and Dorre Islands, Shark Bay.
Ecology:	The Banded Hare-wallaby is endemic to Australia, where it was formerly present on the mainland from south-western parts of the country to the Lower Murray region. It is now restricted to the two islands in Shark Bay off the western Australian coast and has been reintroduced to a third island in the area, Faure Island (Prince and Richards, 2008). . The Banded Hare-wallaby is nocturnal and is found in areas of dense scrub and bushes, beneath which it forms runs and shelters (Prince and Richards 2008, Menkhorst and Knight, 2011). This species lives in small groups although the adults appear to have well defined home ranges. Interactions between adult males, females and juveniles are generally non-aggressive. However contact between males is typically very aggressive with fighting linked to competition for food resources (Prince and Richards, 2008). Births usually occur between December and September and most females raise one young per year (Menkhorst and Knight, 2011).
Likelihood of occurrence:	There are no records publically available of sightings of this species in the area since 1909. No Banded Hare-wallaby or evidence of their presence was recorded during the surveys. It is considered **unlikely** that the Banded Hare-wallaby occurs within the survey, local or regional area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat

Family	Hipposideridae
Conservation Status:	Vulnerable under EPBC Act 1999.
Distribution:	The Pilbara Leaf-nosed Bat occurs within the Pilbara and upper Gascoyne regions of Western Australia. It is separated from the Northern Australian population by 400 km of desert (Armstrong, 2008, DSEWPaC, 2013c).
Ecology:	The Pilbara leaf-nosed Bat typically roosts in caves with which are warm and maintain a constant humidity. They are also known to occupy abandoned, deep and partially flooded mines that trap pockets of warm, humid air. These roosts are used to limit energy expenditure and water loss. A large colony exists at Marble Bar with smaller populations within the eastern Pilbara and Hamersley Range in granite rock pile terrain and remnant sedimentary landscape units. Another large colony has been recorded in the western Pilbara where caves are formed in gorges that dissect massive siliceous sedimentary geology (Armstrong, 2008). This insectivorous species usually commences foraging at dusk and continues for several hours. They hawk flying prey and glean from foliage and the ground in riparian vegetation within gorges, open hummock grasslands, sparse tree and shrub savanna (Armstrong, 2008, DSEWPaC, 2013c). Little information is available on diet and reproduction but it is thought to be similar to the Orange Leaf-nosed Bat. Mating for this species occurs in July with females giving birth in late December to early January (DSEWPaC, 2013c).
Likelihood of occurrence:	Given this species range is restricted to the Pilbara and upper Gascoyne regions of WA, and the lack of suitable habitat, it is considered **unlikely** that this species occurs within the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Pseudomys chapmani Western Pebble-mound Mouse

Family	Muridae
Conservation Status:	Priority Four: Rare, Near Threatened and other taxa in need of monitoring on the DEC Threatened and Priority Fauna Database.
Distribution:	The Western Pebble-mound Mouse is endemic to the non-coastal, central and eastern parts of the Pilbara, Western Australia. It is considered sparsely distributed although preferred habitat is abundant. This species has undergone a range contraction as evidence of their mounds can be seen within the Gascoyne and Murchison regions of WA (Start, 2008, Morris and Burbidge, 2008).
Ecology:	This mouse has a preference for rocky ranges where it prefers the less steep slopes covered by a stony mulch with spinifex and sparse overstorey of eucalypts and scattered shrubs, This species has also been recorded close to drainage lines with *Acacia* dominated scrub (Start, 2008, Morris and Burbidge, 2008). This unique murid species constructs mounds from pebbles which can cover an area of 0.5 to 9.0 square metres (m^2) with an average pebble weighing 3.5 grams (g). The pebbles are carried in their mouths and arranged in a pile, they utilise their fore-arms to move the pebbles into the correct position. This species lives in small family groups in burrows underneath the mounds (Start, 2008, Morris and Burbidge, 2008). Not all apparently active mounds contain mice; they use a 'home mound' during the day and will visit others during night-time foraging. Breeding can occur throughout the year with females producing several litters of four young (Start, 2008, Morris and Burbidge, 2008).
Likelihood of occurrence:	Only old, abandoned mounds were recorded during the survey period. No new, active mounds were recorded. The last specimen collected from the area was in 1994. Therefore it is considered **unlikely** that the Western Pebble-mound Mouse has persisted within the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Ardea modesta Eastern Great Egret

Family	Ardeidae
Conservation Status:	Migratory Species under the EPBC Act and Schedule 3 under the WC Act. This species is also listed in the CAMBA and JAMBA agreements.
Distribution:	The Eastern Great Egret's distribution extends across the greater part of Western Australia but is absent from the arid interior south of Lake Gregory in the Kimberley, east of Lake Nabberu in the Murchison and north of Esperance in the south (Johnstone and Storr, 1998). The Eastern Great Egret is common to very common in well-watered Kimberley flatlands and scarce to moderately common elsewhere (Johnstone and Storr, 1998).
Ecology:	The Eastern Great Egret's preferred habitat includes a wide range of shallow wetland habitats including inland and coastal freshwater or saline waters, such as: swamps, marshes, flooded grasslands, salt lakes and estuarine mudflats (DSEWPaC, 2013c). This egret has a diverse diet including fish, insects, molluscs, frogs and some reptiles. Generally, the breeding season extends from November to April; however, this is somewhat dependent on rainfall. Nesting is in colonies in bulky stick structures located in wooded swamps with between two and six eggs laid (DSEWPaC, 2013c, Johnstone and Storr, 1998).
Likelihood of occurrence:	No Eastern Great Egret or evidence of their presence was recorded during the survey. As no preferred habitat is present in the area subject to disturbance, it is considered **unlikely** that the Eastern Great Egret utilises the Project area.
Potential Impacts:	The conservation status of the Eastern Great Egret is unlikely to be altered by the disturbance associated with the proposed mining activities in the Project area.

Falco peregrinus Peregrine Falcon

Family	Falconidae
Conservation Status:	Schedule 4 under the WC Act..
Distribution:	The Peregrine Falcon occurs throughout most of Western Australia and across the rest of Australia including Tasmania. It is generally considered uncommon to rare (Johnstone and Storr, 1998, Morcombe, 2003).
Ecology:	This species inhabits cliff faces along the coast, near rivers and ranges and has also been recorded around wooded watercourses and lakes (Johnstone and Storr 1998). This falcon feeds almost entirely on flocking birds such as pigeons, parrots and seabirds (Johnstone *et al*. 1998, Debus, 2012). It nests on ledges in cliffs, granite outcrops, quarries and also utilises mine pits. The Peregrine Falcon will also use hollow trees near wetlands and large abandoned nests of other birds. Pairs nest solitarily with eggs laid between August and October. Clutch size ranges from one to five but is usually three or four (Johnstone and Storr, 1998, Debus, 2012).
Likelihood of occurrence:	Peregrine Falcons were recorded in the area in 1999 and 2007. No Peregrine Falcon or evidence of their presence was recorded during the survey. As some preferred habitat is present within close proximity to the Project area, it is considered **possible** that the Peregrine Falcon may utilise the Project area.
Potential Impacts:	The conservation status of the Peregrine Falcon is unlikely to be altered by the disturbance associated with the proposed mining activities in the Project area.

Ardeotis australis Australian Bustard

Family	Otitidae
Conservation Status:	Priority Four: Rare, Near Threatened and other taxa in need of monitoring on the DEC Threatened and Priority Fauna Database.
Distribution:	The Australian Bustard occurs over much of WA, with the exception of the more heavily wooded southern portion of the State (Johnstone and Storr, 1998). Its wider distribution includes eastern Australia, southern Papua New Guinea and Indonesia (BirdLife International, 2012).
Ecology:	The Australian Bustard is a large ground-dwelling bird known to occur in open or lightly wooded country. It is nomadic and ranges over very large areas, largely dependent on rainfall and hence food availability. Although not flightless, Bustards spend the greater proportion of time on the ground. The diet of this species is variable including insects, lizards, young birds, small rodents, leaves, seeds and fruit. Breeding occurs from November to June and usually one or occasionally two eggs are laid on bare, preferably stony ground (Johnstone and Storr, 1998, BirdLife International, 2012).
Likelihood of occurrence:	The DEC Threatened and Priority Fauna Database lists one recent sighting (2009) within approximately 50 km of the survey area. Some habitats within the Project area may be considered suitable for this species. It is therefore considered **likely** that this species may occur within the Project area. However, given its range and mobility, it is likely to avoid disturbance and move to less disturbed areas.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Burhinus grallarius Bush Stone-curlew

Family	Burhinidae
Conservation Status:	Priority Four: Rare, Near Threatened and other taxa in need of monitoring on the DEC Threatened and Priority Fauna Database.
Distribution:	The Bush Stone-curlew occupies much of the western part of WA, and is also found in eastern Australia and New Guinea. It is common to uncommon in sub-humid and semi-arid zones and near the coast in arid zones and is rare to uncommon and locally extinct further south (Johnstone and Storr, 1998).
Ecology:	A well camouflaged, mainly nocturnal bird that inhabits lightly wooded open woodlands, preferring a scattering of fallen timber and ground carpeted with dead leaves. The Bush Stone-curlew has a varied diet but prefers insects, molluscs, small lizards and seeds. Its nest is a slight or no depression on the ground and usually, two eggs are laid from July to January (Johnstone and Storr, 1998).
Likelihood of occurrence:	The DEC Threatened and Priority Fauna Database list two sightings of this species from 2006 at two separate water pools within 50 km of the Project area. Rapallo (2012) reported several records of the Stone-curlew during the Level 1 survey locally. Opportunistic evidence of this species during the current reconnaissance survey recorded Stone-curlew tracks sighted within a dry creek bed. It is, therefore, reasonable to state that the Bush Stone-curlew is **likely** to utilise the habitat within the project area
Potential Impacts:	Given that the Bush Stone-curlew is likely to utilise the habitat within the Project area, few individuals within the local population may be impacted. However, the conservation status of the species generally is not likely to be altered by the proposed mining activity in the area.

Charadrius veredus Oriental Plover

Family	Charadriidae
Conservation Status:	Migratory Wetland Species under the EPBC Act. This species is also included in the JAMBA and ROKAMBA agreements.
Distribution:	The Oriental Plover is a non-breeding visitor to Australia. This species is a migrant from Mongolia, South Siberia and north China that usually inhabits the Kimberley, north-eastern interior and north-west coastal plains of WA and parts of eastern Australia (Johnstone and Storr, 1998).
Ecology:	Once arriving in Australia, the plovers spend a few weeks in coastal habitats such as estuarine mudflats and sandbanks before dispersing further inland. They prefer open grasslands, claypans and dry paddocks in semi-arid to arid regions (DSEWPaC, 2013c, Johnstone and Storr, 1998). Little is known about the diet of this species, although it has been recorded eating insects including termites, beetles, crickets and bugs. Breeding occurs from April to July in the northern hemisphere (DSEWPaC, 2013c).
Likelihood of occurrence:	Given the ecology of the species and lack of preferred habitat, the Oriental Plover is **unlikely** to utilise the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Actitis hypoleucos– Common Sandpiper

Family:	Scolopacidae
Conservation Status:	Migratory, Marine under EPBC Act and Schedule 3 under the WC Act. This species is also listed in the Bonn, CAMBA, JAMBA and ROKAMBA agreements.
Distribution:	Within Australia, the Common Sandpiper is distributed along all coastlines and many areas inland. This species is widespread in low numbers. The majority of the Australian population is within northern and western Australia (DSEWPaC, 2013c).
Ecology:	The Common Sandpipers non-breeding habitat within Australia consists of a wide range of coastal wetlands and some inland wetlands, with varying salinity levels. It is usually recorded around muddy margins and rocky shores. This typically carnivorous species forages in shallow water on bare soft mud for molluscs, crustaceans and insects. Breeding occurs in Europe and Asia where it then migrates south for the boreal winter (DSEWPaC, 2013c).
Likelihood of occurrence:	Most records for the Common Sandpiper are located on the coastline with isolated, very dated inland records. No Common Sandpipers or evidence of their presence was recorded during the reconnaissance survey. Given the ecology of this species, it is **unlikely** to utilise the habitat within the Project area.
Potential Impacts:	Given the above, the conservation status of the species is unlikely to be altered by the disturbance associated with the proposed mining activity in the Project area.

Merops ornatus – Rainbow Bee-eater

Family	Meropidae
Conservation Status:	Migratory Species under EPBC Act and Schedule 3 under the WC Act. This species is also included in the JAMBA agreement.
Distribution:	The Rainbow Bee-eater is distributed across much of mainland Australia, and is a common summer migrant to southern Australia. Within Western Australia, it is absent from the arid regions. They range from scarce to common across their range depending on suitable habitat and breeding grounds (Johnstone and Storr, 1998).
Ecology:	The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands and in a variety of cleared to semi-cleared habitats. They often occur in close proximity to water. This species spends winter north of Gascoyne to Indonesia and generally migrate south at the beginning of spring. This species breeding season extends from August to January with timing dependent on latitude. Nests are usually built by both sexes and consist of a burrow with an enlarged chamber at the end. The nests are built within flat or sloping ground in areas such as river banks, roadside cuttings, quarries or cliff faces (DSEWPaC, 2013c, Johnstone and Storr, 1998). The diet of the Rainbow Bee-eater consists of insects, mainly bees and wasps but also dragonflies, grasshoppers and bugs. This species catches the majority of its prey aerially, foraging from open perches (DSEWPaC, 2013c, Johnstone and Storr, 1998).
Likelihood of occurrence:	The DEC Threatened and Priority Fauna Database include dated records (1978 and 1999) of the Rainbow Bee-eater in the area. Rainbow Bee-eater were not seen or heard during the survey period as this was their over-wintering period in the north of Australia. Notwithstanding this, the Rainbow Bee-eater is **likely** to use the Project area within their migratory path and possibly for breeding in the sandy banks of the creeklines.
Potential Impacts:	Given that the Rainbow Bee-eater may utilise the habitat within the Project area, few breeding individuals may be impacted. However, the conservation status of the species generally is not likely to be altered by the proposed mining activity in the area

Acanthiza iredalei iredalei Slender-billed Thornbill

Family:	Acanthizidae
Conservation Status:	Vulnerable under EPBC Act.
Distribution:	The Slender-billed Thornbill is sparsely distributed in disjunct populations across the southern arid and semi-arid portions of southern Western Australia and south-western South Australia (DSEWPaC, 2013c, Garnett *et al.,* 2011, Johnstone and Storr, 2004).
Ecology:	The preferred habitat for this species includes chenopod shrublands with bluebush *Maireana* spp., saltbush *Atriplex* spp. and samphires ; treeless or sparsely wooded flatlands and saline flats associated with salt lakes. The Thornbill forages mainly on the ground and in low vegetation for insects including caterpillars, beetles and small ants. Globular nests are constructed in low shrubs with 2-4 eggs laid. (DSEWPaC, 2013c, Garnett *et al.,* 2011, Johnstone and Storr, 2004).
Likelihood of occurrence:	No Slender-billed Thornbill or evidence of their presence was recorded during the surveys. No preferred habitat of this species was present within the Project Area. Given the above, it is considered **unlikely** that the Slender-billed Thornbill occurs or utilises the Project area.
Potential Impacts:	The conservation status of the species is unlikely to be altered by the disturbance associated with any proposed mining activity in the Project area.

Oreoica gutturalis gutturalis Crested Bellbird

Family	Pachycephalidae
Conservation Status:	Priority Four: Rare, Near Threatened and other taxa in need of monitoring on the DEC Threatened and Priority Fauna Database.
Distribution:	The Crested Bellbird occupies the greater part of WA but not the wetter regions (north and west Kimberley, Darling Range and deep South-West) (Johnstone and Storr, 2004). This species also occurs in eastern Australia.
Ecology:	This sedentary and solitary species inhabits most types of scrub and thicket including *Acacia* thickets, mulga scrub, mallee scrub and eucalypt woodlands. It forages mainly on the ground, primarily for insects, but also spiders and seeds. The Crested Bellbird breeds from March through to December with both sexes tending to incubation and subsequent feeding (Johnstone and Storr, 2004).
Likelihood of occurrence:	The Crested Bellbird does not appear on the DEC Threatened and Priority Fauna Database for the area but is included on the Birds Australia, OZCAM and ALA databases as having been recorded in the area. This species was **recorded** within the Project area.
Potential Impacts:	The Crested Bellbird (southern) is listed as a Priority 4 species on the DEC Threatened and Priority Fauna database for the Goldfields, Midwest, Wheatbelt and South Coast. While the Gascoyne areas falls within the Midwest region, the conservation classification refers principally to areas where the preferred habitat of the Crested Bellbird has been disturbed, particularly by clearing of native vegetation and resultant fragmentation. The area proposed to be impacted is relatively undisturbed regionally and large tracts of undisturbed native vegetation are present and will remain intact adjacent to the proposed mining operations. The large home range and mobility of the Crested Bellbird strongly suggests that its conservation classification will not be compromised by the proposed mining activities within the Project area.

5.0 Discussion

5.1 Flora

One hundred and one taxa (species, subspecies and varieties) were recorded within 26 families and 59 genera. Fabaceae, Poaceae, and Scrophulariaceae were the most common families and contained most taxa.

No Threatened Flora (DRF) pursuant to Section 23F (2) of the WC Act and no plant taxa listed as Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the survey area. No PF were recorded in the survey area.

No Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Protection Act 1976* (WA) were recorded. *Portulaca oleracea* (Purslane) was the only introduced species encountered and was recorded at six locations.

Eleven vegetation types were identified and mapped in the survey area. The majority of the survey area consisted of disturbed land and open *Acacia* shrubland (Vegetation Types Cl, S1, S2 and S5). Small areas of grove Mulga were also mapped. The vegetation is consistent with that of the surrounding area. No TECs or PECs were identified in the Project area.

The row fusion dendrogram produced during PATN analysis demonstrates grouping of survey sites within vegetation communities (**Appendix 4**). A small number of survey sites were classified as different vegetation communities to those they were grouped within. While species composition was similar, structural and landform attributes were also used to group survey sites into vegetation communities.. Overall, the grouping of the row fusion supports the classification of vegetation using raw site data and aerial photographic interpretation.

The Project area is located within the boundary of the PEC Robinson Range vegetation complexes (banded ironstone formation) (Priority 1). Communities X1 and X2 may express similarities with the PEC. No further information is publicly available concerning this PEC which limits potential for further analysis. These two communities occur on the western and northern boundaries of the survey area on ironstone hills. Given the elevation of these communities above the remaining lease area and away from existing mine site infrastructure, impacts to these vegetation communities is unlikely if exploration and mining activities are restricted from these areas.

The condition of the vegetation communities across the survey area ranged from ‘Excellent’ to ‘Completely Degraded’. No vegetation was assessed to be in ‘Pristine’ condition. Considering the amount of rainfall in the preceding 12 months, minimal seedling recruitment was observed throughout the survey area. This indicates grazing impacts from cattle.

5.1.1 Potential Impacts

Results of the Level 1 Flora Surveys of the Project area conclude no significant impacts to the flora and vegetation will occur as a result of the proposed project. The effects of long term grazing on the vegetation condition have reduced the capability of the land to support a pre-European diversity of flora through soil erosion and reduction of humic layers. Based on the assumption that any future mining would be restricted to areas in close proximity to Horseshoe Gold Mine, would be away from the ironstone hills, no further survey of flora or vegetation will be required for the project area. Survey level and intensity was appropriate for the site and in the context of expansion around existing infrastructure.

5.2 Fauna

While 285 vertebrate fauna species have been recorded from the local area, a total of 64 species were recorded during the reconnaissance survey. These included one fish species, three frog species, six species of reptiles, four mammalian species of which three were native and one was non-native, and fifty bird species.

From a faunal perspective, four vegetation habitats were identified in the Project area with the majority comprising Acacia woodland/shrubland, and small areas of creekline vegetation and Acacia woodland on hills. No habitat was identified as significant for indigenous fauna generally and no habitat was identified specifically for fauna of conservation significance that may occur in the area. Habitats within the Project area were not limited to the area but were extensive locally.

The condition of the vegetation varied within all vegetation habitats from "Completely Degraded" to "Excellent". Given that there are no exclusion fences in the area and that invasive species may (continue to) utilise the area, further degradation of the vegetation is likely, primarily through trampling and grazing. This has been and will continue to be exacerbated by the lack of rainfall in the preceding months and in the future.

Following the targeted habitat assessment, of the 16 fauna species of conservation significance that may occur in the area, up to six are likely to occur with the sighting of the Crested Bellbird and evidence of the Bush Stone-curlew being recorded during the reconnaissance survey.

5.2.1 Potential Impacts

Generic impacts for fauna from anthropogenic disturbances in the area include:

- degradation, fragmentation and/or loss of habitat through clearing, off-road driving; dust, alternation of topography and drainage *etc.*;
- destruction and loss of breeding, roosting, foraging and dispersal sites;
- increased mortality (leading to population decline and/or survival) through vehicular and equipment movements;
- potential increase in feral fauna resulting in increased predation and resource competition;
- potential increase in wildfire with the associated consequences on habitat and faunal assemblages.

Notwithstanding this, best management practice would minimise such disturbances resulting in no significant impact on either fauna occurring in the area or local fauna habitat. Further, given the ecology of the species of conservation significance recorded or possibly present in the area, disturbances associated with mining activities in the area are not likely to alter their conservation status.

6.0 Abbreviations

ALA	Atlas of Living Australia
BOM	Bureau of Meteorology
BSc	Bachelor of Science
CAMBA	China-Australia Migratory Bird Agreement
cm	centimetres
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DRF	Threatened (Declared Rare Flora – Extant)
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
GPS	Global Positioning System
ha	hectare
Hons	Honours degree
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
km	kilometre
m	metre
m^2	square metres
mm	millimetres
No.	number
NVIS	National Vegetation Information System
OZCAM	Online Zoological Collections of Australian Museums
P1	Priority 1

P3	Priority 3
P4	Priority 4
PEC	Priority Ecological Communities
PhD	Doctor of Philosophy
PF	Priority Flora and Fauna
Ref	Reference
ROKAMBA	Republic of Korea-Australia Migratory Bird Assessment
S1	Schedule 1
S3	Schedule 3
S4	Schedule 4
spp	species
SRE	Short-range Endemic Invertebrate
TEC	Threatened Ecological Communities
Umwelt	Umwelt Australia Pty Ltd
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950* (WA)
Umwelt	Umwelt (Australia) Pty Ltd
WA	Western Australia
WAH	Western Australian Herbarium
%	percent
°C.	degrees Celsius

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APPENDIX 1

Conservation Categories for Flora and Fauna

Appendix 1

Definitions of Conservation Categories and Codes for Flora and Fauna

Table 1 - International Union for Conservation of Nature (IUCN) Red List Categories – Version 3.1 and *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)**

Categories and Codes	Definition
Extinct (EX)	A taxon where there is no reasonable doubt the last individual has died.
Extinct in the Wild (EW)	A taxon where it is known only to survive in captivity, cultivation or as a naturalised population (or populations) well outside the past range.
Critically Endangered (CR)	A taxon that is considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon that is considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon that is considered to be facing a high risk of extinction in the wild.
Near Threatened (NT):	A taxon that is considered close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	A taxon that is considered widespread and abundant.
Data Deficient (DD)	A taxon that has inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.
Not Evaluated (NE)	A taxon that has not yet been evaluated against the criteria
Threatened Ecological Communities (TEC) Definitions under EPBC Act	
Critically Endangered (CR)	The ecological community is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	The ecological community it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable (VU)	The ecological community it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Source: IUCN, 2001 *EPBC Act 1999 is broadly consistent with IUCN red list criteria. Source TEC: SEWPaC, 2013a)

Table 2 - Bilateral Bird Agreements

Name	Definition
Intergovernmental Migratory Animal Agreement (BONN)	Convention on the Conservation of Migratory Species of Wild Animals
Japan-Australia Migratory Bird Agreement (JAMBA)	The agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment. Australian Treaty Series 1981 No 6.
China-Australia Migratory Bird Agreement (CAMBA)	The agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment. Australian Treaty Series 1988 No 22.
Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)	The agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds and their Environment. Australian Treaty Series 2007 ATS 24.

Source: SEWPaC, 2013b

Table 3 - Definitions of Conservation Categories and Codes for Fauna and Flora in Western Australia

Category	Definition
Western Australian *Wildlife Conservation Act 1950* categories and codes	
Schedule 1 (T): Threatened Fauna (Fauna that is rare or is likely to become extinct) and **Threatened Flora** (Declared Rare Flora – Extant)	Taxa that have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such. Schedule 1 species are further ranked by DEC according to their level of threat using IUCN Red List categories and criteria: Critically Endangered (CR), Endangered (EN) and Vulnerable (VU).
Schedule 2 (X): Presumed Extinct Fauna and Presumed Extinct Flora	Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
Schedule 3 (IA): Birds protected under an international agreement	Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4 (S): Other specially protected fauna	Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.
DEC Threatened and Priority Database categories and codes	
Priority One (P1): Poorly known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
Priority Two (P2): Poorly known taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
Priority Three (P3): Poorly known taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
Priority Four (P4) Rare, Near Threatened and other taxa in need of monitoring	a) **Rare.** Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Priority Five (P5): Conservation Dependent	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

Source: DEC, 2013

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APPENDIX 2

Vegetation Structural Formation and Condition Scale

Appendix 2 - Vegetation Structural Formation and Condition Scale

Table A2.1: NVIS Structural Formation Terminology (ESCAVI, 2003)

Cover Characteristics							
Foliage cover *	70-100	30-70	Oct-30	<10	» 0	0-5	unknown
Crown cover **	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
% Cover ***	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
Cover code	d	c	i	r	bi	bc	unknown

Table A2.1: NVIS Structural Formation Terminology (ESCAVI, 2003)

Growth Form	Height Ranges (m)	Structural Formation Classes						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses

Table A2.1: NVIS Structural Formation Terminology (ESCAVI, 2003) (continued)

Growth Form	Height Ranges (m)	Structural Formation Classes						
Sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
bryophyte	<0.5	closed bryophyteland	bryophyteland	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines
aquatic	0-0.5,<1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics	aquatics
seagrass	0-0.5,<1	closed seagrass bed	seagrassbed	open seagrassbed	sparse seagrassbed	isolated seagrasses	isolated clumps of seagrasses	seagrasses

Table A2.2: Vegetation Condition Scale (Keighery, 1994)

Pristine (1)	Pristine or nearly so; no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
Very Good (3)	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by very obvious signs of multiple disturbances. 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 (5)	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 frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	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

APPENDIX 3

Flora Species by Community

Appendix 3 – Species List

Table A3.1 - Species List by Vegetation Types

Sequence No.	Family	Taxa	Vegetation Types										
			C1	C2	C3	M1	S1	S2	S3	S4	S5	X1	X2
29	Pteridaceae	*Cheilanthes sp.*	+					+			+		
163	Poaceae	*Aristida contorta*	+	+		+	+	+		+	+	+	+
163	Poaceae	*Cymbopogon ambiguus*	+		+								
163	Poaceae	*Digitaria brownii*						+					
163	Poaceae	*Enneapogon caerulescens*	+	+	+		+	+			+	+	+
163	Poaceae	*Eragrostis eriopoda*	+										
163	Poaceae	*Eriachne mucronata*	+	+	+	+					+	+	
163	Poaceae	*Eriachne pulchella*		+									
163	Poaceae	*Monachather paradoxus*		+							+		
175	Proteaceae	*Grevillea berryana*	+		+		+	+	+		+		
199	Zygophyllaceae	*Tribulus suberosus*			+						+	+	+
201	Fabaceae	*Acacia aptaneura*	+	+	+	+	+	+	+	+	+	+	+
201	Fabaceae	*Acacia citrinoviridis*	+					+			+		
201	Fabaceae	*Acacia cuspidifolia*						+					
201	Fabaceae	*Acacia cuthbertsonii*		+	+					+	+		
201	Fabaceae	*Acacia cuthbertsonii* subsp. *cuthbertsonii*									+		
201	Fabaceae	*Acacia cyperophylla*	+							+			
201	Fabaceae	*Acacia kempeana*	+	+	+		+	+	+	+			
201	Fabaceae	*Acacia marramamba*									+	+	
201	Fabaceae	*Acacia pruinocarpa*		+			+	+			+	+	
201	Fabaceae	*Acacia rhodophloia*			+							+	
201	Fabaceae	*Acacia tetragonophylla*	+	+				+		+	+		+

Table A3.1 - Species list by Vegetation Types (continued)

Sequence No.	Family	Taxa	Vegetation Types										
			C1	C2	C3	M1	S1	S2	S3	S4	S5	X1	X2
201	Fabaceae	*Indigofera monophylla*	+		+								
201	Fabaceae	*Senna artemisioides* subsp. *helmsii*		+	+		+	+			+	+	+
201	Fabaceae	*Senna artemisioides* subsp. x *sturtii*		+	+			+	+		+	+	+
201	Fabaceae	*Senna glutinosa*		+							+	+	
201	Fabaceae	*Senna glutinosa* subsp. *chatelainiana*		+		+	+	+	+		+		
242	Euphorbiaceae	*Euphorbia drummondii*	+		+							+	
281	Myrtaceae	*Corymbia candida*	+										
281	Myrtaceae	*Eucalyptus camaldulensis*	+										
309	Malvaceae	*Abutilon cryptopetalum*		+	+			+				+	
309	Malvaceae	*Abutilon fraseri*	+										
309	Malvaceae	*Abutilon oxycarpum*	+										
309	Malvaceae	*Hibiscus brachychlaenus*											+
309	Malvaceae	*Hibiscus burtonii*	+	+		+		+			+	+	+
309	Malvaceae	*Hibiscus gardneri*	+	+		+		+			+	+	+
309	Malvaceae	*Hibiscus ?solanifolius*	+		+						+	+	
309	Malvaceae	*Sida cardiophylla*						+			+		
309	Malvaceae	*Sida* sp. Dark green fruits (S. van Leeuwen 2260)	+	+	+			+			+		
309	Malvaceae	*Malvaceae* sp.			+		+				+	+	
331	Cleomaceae	*Cleome viscosa*		+	+								
338	Santalaceae	*Santalum spicatum*			+							+	
339	Loranthaceae	*Amyema nestor*	+										
357	Amaranthaceae	*Amaranthus* sp.	+		+							+	
357	Amaranthaceae	*Ptilotus calostachyus*		+			+	+			+		+
357	Amaranthaceae	*Ptilotus nobilis*	+		+					+			+
357	Amaranthaceae	*Ptilotus obovatus*	+	+	+	+		+		+	+	+	+

Table A3.1 - Species list by Vegetation Types (continued)

Sequence No.	Family	Taxa	Vegetation Types										
			C1	C2	C3	M1	S1	S2	S3	S4	S5	X1	X2
357	Amaranthaceae	*Ptilotus roei*					+	+			+		
357	Amaranthaceae	*Ptilotus rotundifolius*	+			+	+				+		
358	Chenopodiaceae	*Atriplex vesicaria*		+									
358	Chenopodiaceae	*Enchylaena tomentosa*			+	+		+	+		+	+	
358	Chenopodiaceae	*Maireana aphylla*		+				+					
358	Chenopodiaceae	*Maireana tomentosa*						+	+				
358	Chenopodiaceae	*Maireana triptera*		+	+		+	+			+		+
358	Chenopodiaceae	*Rhagodia eremaea*						+	+		+		
358	Chenopodiaceae	*Salsola australis*			+								
358	Chenopodiaceae	*Sclerolaena convexula*										+	
358	Chenopodiaceae	*Sclerolaena cuneata*		+				+					
358	Chenopodiaceae	*Sclerolaena* sp.						+					
358	Chenopodiaceae	*Tecticornia doleiformis*						+	+				
367	Nyctaginaceae	*Boerhavia repleta*	+	+	+	+						+	
374	Portulacaceae	**Portulaca oleracea*		+	+			+			+	+	
409	Rubiaceae	*Psydrax latifolia*	+	+	+		+	+			+		
409	Rubiaceae	*Psydrax rigidula*				+		+			+		
409	Rubiaceae	*Psydrax suaveolens*				+		+					
413	Apocynaceae	*Rhyncharrhena linearis*	+										
415	Boraginaceae	*Heliotropium* sp.			+							+	
415	Boraginaceae	*Trichodesma zeylanicum*			+								
416	Convolvulaceae	*Evolvulus alsinoides* var. *villosicalyx*	+										
417	Solanaceae	*Solanum lasiophyllum*	+	+	+	+	+	+			+	+	+
428	Scrophulariaceae	*Eremophila forrestii*	+			+		+			+	+	
428	Scrophulariaceae	*Eremophila galeata*	+	+	+	+	+	+		+	+	+	

Table A3.1 - Species list by Vegetation Types (continued)

Sequence No.	Family	Taxa	Vegetation Types										
			C1	C2	C3	M1	S1	S2	S3	S4	S5	X1	X2
428	Scrophulariaceae	*Eremophila gilesii* subsp. *variabilis*							+				
428	Scrophulariaceae	*Eremophila jucunda* subsp. *jucunda*					+	+			+	+	
428	Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*				+		+					+
428	Scrophulariaceae	*Eremophila macmillaniana*						+					
428	Scrophulariaceae	*Eremophila spathulata*					+	+			+		
428	Scrophulariaceae	*Eremophila spectabilis* subsp. *brevis*		+			+	+		+	+		+
458	Goodeniaceae	*Scaevola spinescens*							+				
460	Asteraceae	*Asteraceae* sp.	+										

APPENDIX 4

Vegetation Community Summaries

Appendix 4: Vegetation Type Data Sheets

Vegetation Type S1: Low sparse woodland of *Acacia aptaneura* with *Acacia pruinocarpa* over mid sparse shrubland of *Senna glutinosa* subsp. *chatelainiana*, *Senna artemisioides* subsp. x *sturtii*, *Eremophila jucunda* subsp. *jucunda* and *Psydrax latifolia* over low sparse forbland of *Hibiscus gardneri* ms and *Ptilotus obovatus* and low sparse grassland of *Aristida contorta*. This community occurs on stony, hardpan plains

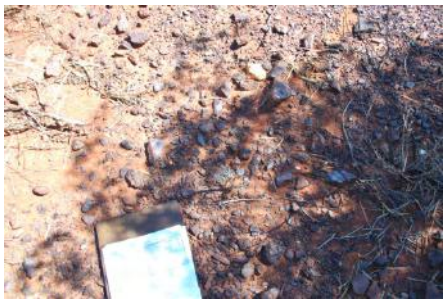
Vegetation area (ha):	191.89	**Rock type:**	Stony quartz
		Soil:	Sandy clay
Fire age:	Greater than five years		
Relevés:	HS02, HS28		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

Vegetation Type S2: Low sparse woodland of *Acacia aptaneura* with *Acacia pruinocarpa*, *Acacia tetragonophylla*, *Acacia aptaneura* and *Acacia cuspidifolia* over low sparse shrubland of *Ptilotus obovatus*, *Senna glutinosa* subsp. *chatelainiana*, *Senna artemisioides* subsp. x *sturtii* and *Eremophila spectabilis* subsp. *brevis* over low sparse chenopod shrubland of *Tecticornia doleiformis*, *Sclerolaena cuneata*, *Maireana aphylla* and *Maireana triptera*. This community occurs on hardpan plains with quartz pebbles.

Vegetation area (ha):	147.79	**Rock type:**	Stony quartz
		Soil:	Sandy clay
Fire age:	Greater than five years		
Relevés:	HS01, HS04, HS05, HS08, HS10, HS21		
Conservation species or ecological communities:	None recorded		
Introduced species:	*Portulacca oleracea* (Purslane)		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

Vegetation Type S3: Low sparse woodland of *Acacia aptaneura* and *Acacia ayersiana* over mid sparse shrubland of *Eremophila gilesii* subsp. *variabilis*, *Senna glutinosa* subsp. *chatelainiana*, *Rhagodia eremaea* and *Scaevola spinescens* over low sparse chenopod shrubland of *Maireana tomentosa*, *Enchylaena tomentosa* and *Tecticornia doleiformis*. This community occurs on flats and small rises with ironstone pebbles.

Vegetation area (ha):	29.67	**Rock type:**	Ironstone
		Soil:	Sandy clay
Fire age:	Greater than five years		
Relevés:	HS07		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Very Good – Some historical and current grazing effects		



Vegetation Type S4: Low open woodland of *Acacia cyperophylla* subsp. *cyperophylla* over low sparse shrubland of *Eremophila galeata* over low sparse grassland of *Aristida contorta*.

Vegetation area (ha):	4.49	**Rock type:**	Quartz and Ironstone
		Soil:	Sandy clay/gravel
Fire age:	Greater than five years		
Relevés:	HS30		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Very Good – Some historical and current grazing effects		

Vegetation Type S5: Low open woodland of *Acacia aptaneura* with *Acacia cuthbertsonii*, *Acacia tetragonophylla* and *Grevillea berryana* over low sparse shrubland of *Senna artemisioides* subsp. x *sturtii*, *Eremophila galeata* and *Eremophila spectabilis* subsp. *brevis* over low sparse forbland and grassland of Eriac*hne mucronata*, *Ptilotus rotundifolius* and *Ptilotus obovatus*. This community occurs at the base of small ironstone ranges on stony plains.

Vegetation area (ha):	323.93	**Rock type:**	Quartz and Ironstone
		Soil:	Sandy clay/gravel
Fire age:	Greater than five years		
Relevés:	HS11, HS17, HS25, HS26, HS29		
Conservation species or ecological communities:	None recorded		
Introduced species:	*Portulacca oleracea* (Purslane)		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

Vegetation Type M1: Low open woodland of *Acacia aptaneura* and *Acacia cuthbertsonii* with *Acacia pruinocarpa*, *Acacia tetragonophylla* and *Psydrax latifolia* over low sparse shrubland of *Maireana aphylla* with *Senna artemisioides* subsp. x *sturtii*, *Senna artemisioides* subsp. *helmsii* and *Atriplex vesicaria* over low forbland and grassland of *Sclerolaena cuneata* and *Eriachne pulchella* with *Ptilotus obovatus*, *Maireana triptera* and *Aristida contorta*. This community occurs on deeper soils on hardpan plains.

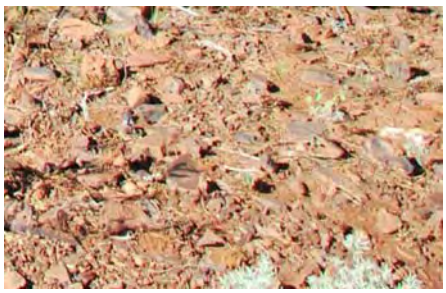
Vegetation area (ha):	8.83	**Rock type:**	None
		Soil:	Sandy clay/loam
Fire age:	Greater than five years		
Relevés:	HS19		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Excellent – Understory intact, only minor grazing disturbance		

Vegetation Type X1: Low open woodland of *Acacia rhodophloia* and *Acacia aptaneura* over mid sparse shrubland of *Eremophila galeata* and *Senna artemisioides* subsp. x *sturtii* over low sparse forbland and grassland of *Heliotropium* sp., *Ptilotus obovatus*, *Tribulus suberosus* and *Enneapogon caerulescens*. This community occurs on low, mid and upper slopes of small ironstone ranges.

Vegetation area (ha):	52.64	**Rock type:**	Ironstone and Quartz
		Soil:	Sandy clay
Fire age:	Greater than five years		
Relevés:	HS12, HS13, HS15, HS16, HS22, HS24		
Conservation species or ecological communities:	None recorded		
Introduced species:	*Portulacca oleracea* (Purslane)		
Vegetation condition:	Excellent – Understory intact, only minor grazing disturbance		

Vegetation Type X2: Woodland of *Acacia aptaneura* over mid sparse shrubland of *Senna artemisioides* subsp. x *sturtii*, *Senna artemisioides* subsp. *helmsii* and *Acacia tetragonophylla* over low sparse forbland and grassland of *Tribulus suberosus*, *Eremophila spectabilis* subsp. *brevis*, *Maireana triptera* and *Enneapogon caerulescens*. This community occurs on mid slopes of small ironstone ranges.

Vegetation area (ha):	6.43	**Rock type:**	Ironstone
		Soil:	Sandy clay
Fire age:	Greater than five years		
Relevés:	HS23		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Excellent – Understory intact, only minor grazing disturbance		



Vegetation Type C1: Low open woodland of *Acacia cyperophylla* subsp. *cyperophylla* with scattered *Eucalyptus camaldulensis* over tall open shrubland of *Acacia aptaneura* over low sparse shrubland of *Eremophila galeata*, *Acacia tetragonophylla* and *Grevillea deflexa* over low sparse grassland of *Eriachne helmsii* and *Eriachne pulchella* subsp. *dominii*. This community occurs on ephemeral creeks.

Vegetation area (ha):	20.58	**Rock type:**	Ferricrete
		Soil:	Sandy gravel
Fire age:	Greater than five years		
Relevés:	HS09, HS20, HS27		
Conservation species or ecological communities:	None recorded		
Introduced species:	None recorded		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

Vegetation Type C2: Low open woodland of *Acacia aptaneura* with *Acacia kempeana*, *Acacia tetragonophylla* and *Psydrax latifolia* over low sparse shrubland of *Senna glutinosa* subsp. *chatelainiana*, *Senna glutinosa*, *Senna artemisioides* subsp. *helmsii* and *Eremophila spectabilis* subsp. *brevis* over low sparse grassland of *Enneapogon caerulescens* and *Eriachne mucronata* and low sparse forbland of *Ptilotus obovatus*, *Hibiscus burtonii* and *Sida* sp. Dark green fruits (S. van Leeuwen 2260). This community occurs in minor flowlines and creeks with shallow channels.

Vegetation area (ha):	50.54	**Rock type:**	Silcrete
		Soil:	Sandy gravel
Fire age:	Greater than five years		
Relevés:	HS03, HS06		
Conservation species or ecological communities:	None recorded		
Introduced species:	*Portulacca oleracea* (Purslane)		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

Vegetation Type C3: Low open woodland of *Acacia aptaneura* with *Acacia rhodophloia* and *Grevillea berryana* over open shrubland of *Acacia kempeana* over low sparse shrubland of *Senna artemisioides* subsp. *helmsii*, *Eremophila galeata* and *Acacia cuthbertsonii* over low sparse grassland of *Enneapogon caerulescens*, *Eriachne mucronata* and *Cymbopogon ambiguus* and low sparse forbland of *Ptilotus obovatus*, *Indigofera monophylla* and *Abutilon cryptopetalum*. This community occurs in minor flowlines and creeks with shallow channels.

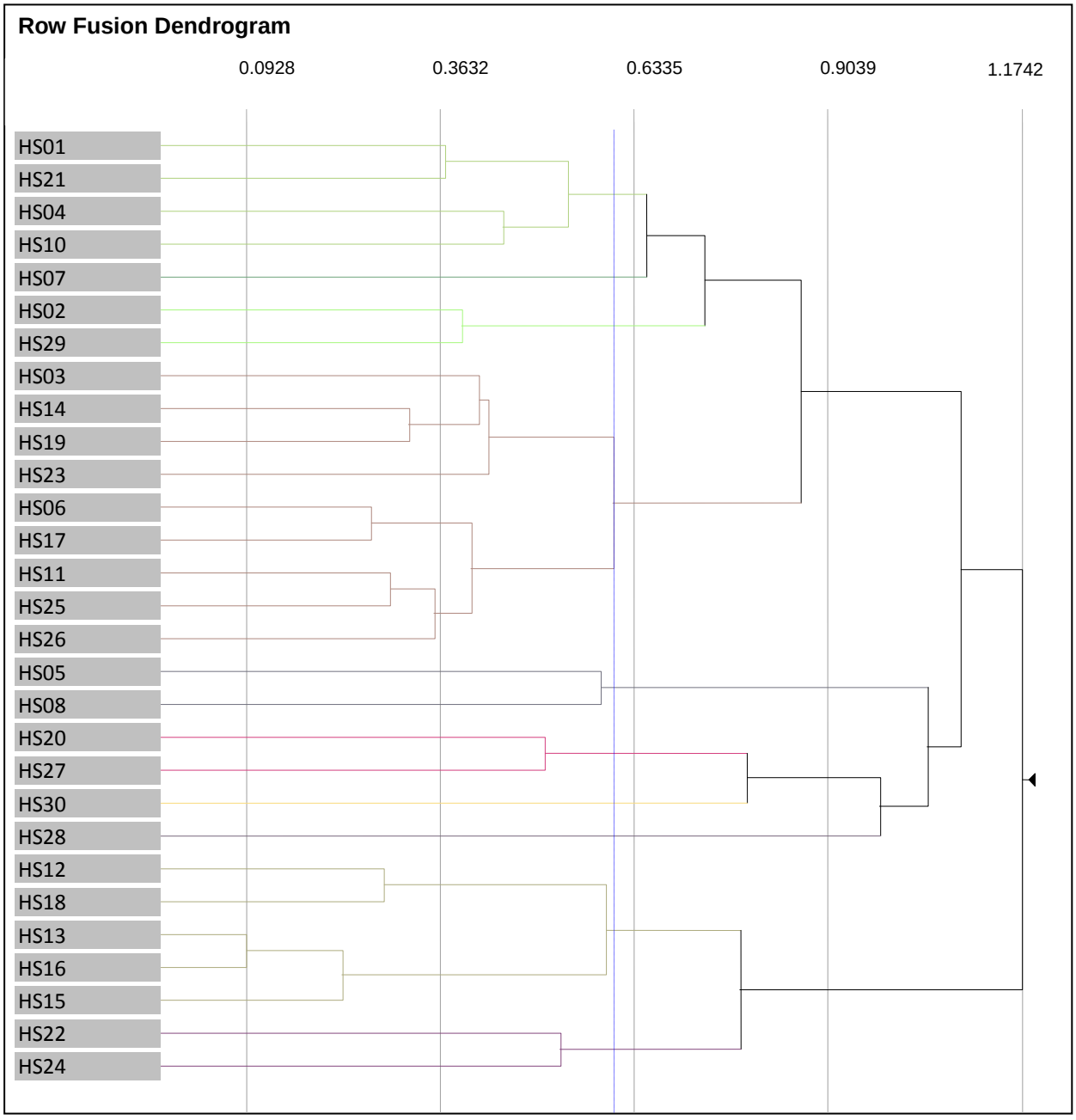
Vegetation area (ha):	14.11	**Rock type:**	Silcrete
		Soil:	Sandy gravel
Fire age:	Greater than five years		
Relevés:	HS14, HS18		
Conservation species or ecological communities:	None recorded		
Introduced species:	*Portulacca oleracea* (Purslane)		
Vegetation condition:	Very Good to Excellent – Some historical grazing effects		

APPENDIX 5

Fauna Potentially Occurring and Recorded within the Project Area

Appendix 5: Vegetation Community Dendrograms

Chart A5.1 – Row Fusion Dendrogram of Vegetation Survey Sites in M52/251, M52/338 and L52/102



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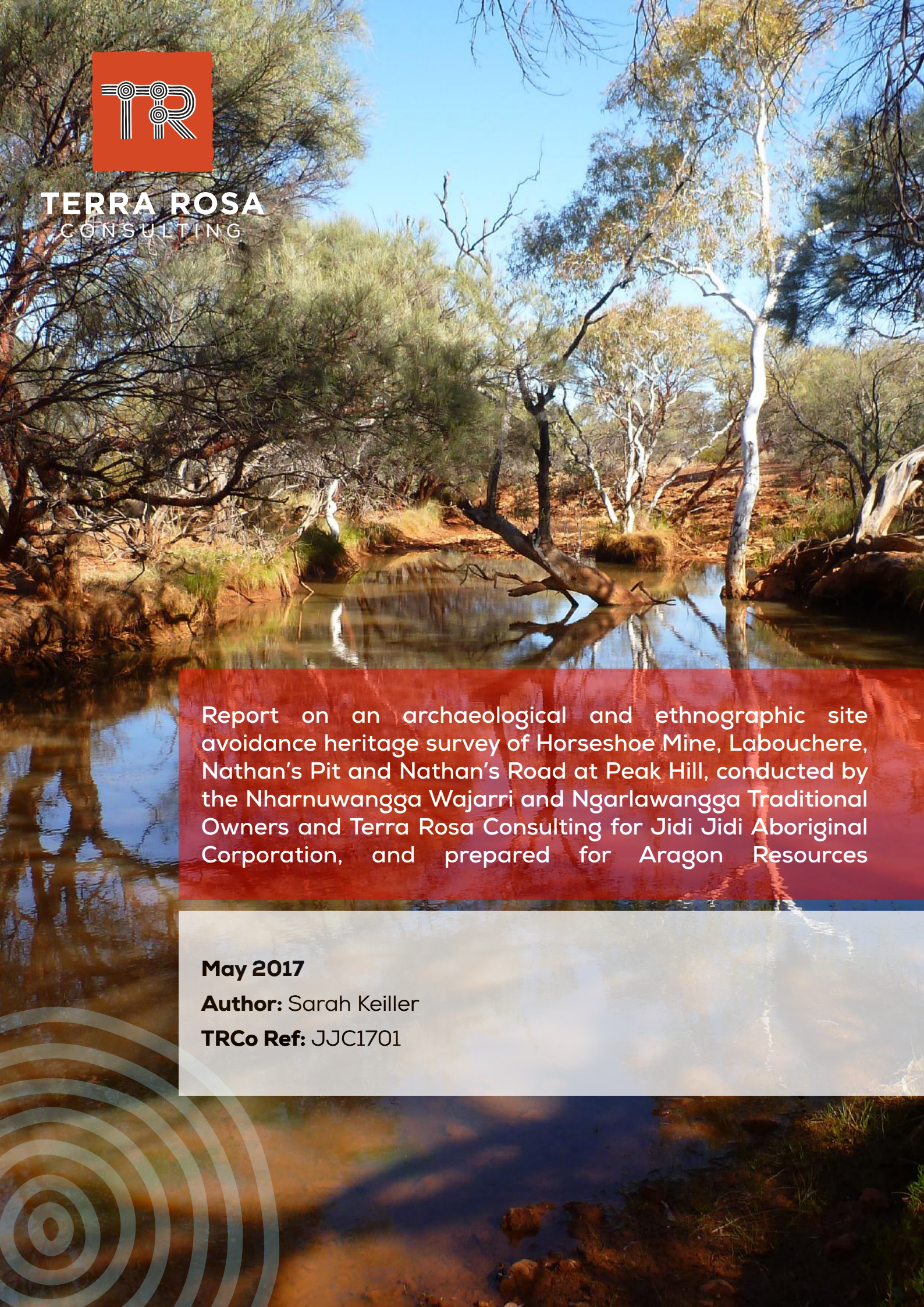
APPENDIX D



TERRA ROSA
CONSULTING

Report on an archaeological and ethnographic site avoidance heritage survey of Horseshoe Mine, Labouchere, Nathan's Pit and Nathan's Road at Peak Hill, conducted by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners and Terra Rosa Consulting for Jidi Jidi Aboriginal Corporation, and prepared for Aragon Resources

May 2017

Author: Sarah Keiller

TRCo Ref: JJC1701

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Coordinate capture

The authors advise that all coordinates quoted in this document were initially obtained with a Garmin hand held GPS using the GDA datum. All grid references are projected in MGA Zone 50, unless otherwise stated. Dependent on external conditions, these units afford an optimal spatial accuracy of ± 5 m.

Heritage project participants and contacts

The contact details of the heritage project stakeholders are provided below. The authors would like to thank everyone that participated in the heritage survey and assisted in organising the fieldwork.

The heritage survey was conducted between 14 and 19 May 2017.

Heritage service provider	**Terra Rosa Consulting**
Address	346 South Terrace, South Fremantle, Western Australia 6162
Field work participants	Sarah Keiller (archaeologist) Sunissa Brown (anthropologist)
Report authors	Sarah Keiller
Editor	Megan Tehnas
Executive sign-off	Scott Chisholm
Traditional Owners	**Nharnuwangga Wajarri and Ngarlawangga Traditional Owners**
Address	PO Box 5814, St Georges Terrace, Western Australia 6831
Contact	Ambrose Cummins of Cross Country Native Title Services Pty Ltd
Field work participants	Garry 'Cowboy' Robinson Snr Garry Robinson Jnr Leonard Smith Snr Leonard Smith Jnr Darren Mippy Glexis Robinson
Proponent	**Aragon Resources**
Address	168 Adelaide Terrace, East Perth, Western Australia 6004
Contact	Anthony Buckingham
Field work participants	Mathew Green (present 16 and 18 May 2017)

Contents

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Acronyms and definitions

The following terms and acronyms are utilised throughout the report. Definitions are provided below for reference.

Term / Abbreviation	Definition
ACMC	Aboriginal Cultural Materials Committee
AHIS	Aboriginal Heritage Inquiry System
BAM	Background archaeological material
DAA	Department of Aboriginal Affairs
GIS	Geographic information system
GPS	Global positioning system
Heritage object	An object to which the Act applies under s6
Heritage place	Any place which contains heritage values as defined by s5 of the *Aboriginal Heritage Act 1972 (WA).*
HISF	Heritage Information Submission Form
Isolated finds/objects	Isolated cultural material comprising of background artefactual material (BAM)
JJAC	Jidi Jidi Aboriginal Corporation
MGA	Map grid of Australia
NNTT	National Native Title Tribunal
Other Heritage Place	Other heritage places are heritage places catalogued by the DAA but not included on the Register of Aboriginal Sites for one of the following reasons: 1. Information about the OHP has been lodged with the DAA but is pending assessment by the ACMC (status L – lodged; also see definition for 'potential site', below); or 2. The ACMC assessed the OHP and considered it not to meet the evaluation criteria for inclusion on the Register of Sites (i.e. not a registered Aboriginal site) (status S – stored / not a site).
Registered Aboriginal site	A heritage place which has been determined as meeting criteria under section 5 of the *Aboriginal Heritage Act 1972 (WA),* and has been registered by the Registrar of Aboriginal Sites (DAA status R - registered).
Terra Rosa	Terra Rosa Consulting
Traditional Owners	Nharnuwangga Wajarri and Ngarlawangga native title claimants (NNTT no WCD 2000/001) and invited participants
The Act	*Aboriginal Heritage Act 1972 (WA)*

1 Heritage project overview

Aragon Resources (Aragon) plans to utilise land within the Nharnuwangga Wajarri and Ngarlawangga native title determination area (WCD 2000/001) for the purpose of expanding the current pits, widening tracks, drilling and clearing. The project overlaps prospecting licence tenements P5201435, P5201436, P5201508, P5201509 and P5201511 and also includes exploration licence mining tenements E5201860 and E5203236 as well as active mining tenements M5200006, M5200096, M5200098, M5200099 and M5200338 (see maps 1 - 3).

In order to minimise the likelihood of breaching the *Aboriginal Heritage Act 1972 (WA)* (the Act), Aragon commissioned a site avoidance heritage survey over the areas scoped for development. Jidi Jidi Aboriginal Corporation (JJAC) endorsed Terra Rosa Consulting (Terra Rosa) to undertake this work in consultation with the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners. The Traditional Owner participants were nominated by Jidi Jidi Aboriginal Corporation (see plate 1 below).

Plate 1: The heritage team

The scope of works details the requirement for a site avoidance heritage survey of the two survey areas within their Labouchere and Horseshoe Mine project areas (see table 1, below).

1.1 Qualifications to scope

Following the commencement of the heritage survey, Aragon Resources requested the following amendments and additions to the scope of works:

- The Horseshoe Mine survey area was divided into Priority 1 and Priority 2 areas;
- Nathan's Pit Priority Areas 1 and 2 were added to the scope of works; and
- Nathan's Road was added to the scope of works.

These amendments were approved by the JJAC prior to their commencement during the field trip.

Table 1: Heritage survey overview

Survey area	Total area (ha)	Assessment type
Horseshoe Mine Priority 1 (see map 1)	Three polygons totalling 310.91 ha	Archaeological and ethnographic site avoidance survey
Horseshoe Mine Priority 2 (see map 1)	Two polygons totalling 380 ha	Archaeological and ethnographic site avoidance survey
Labouchere (see map 2)	One polygon totalling 10 ha	Archaeological and ethnographic site avoidance survey
Nathan's Pit Priority 1 (see map 3)	One polygon totalling 160 ha	Archaeological and ethnographic site avoidance survey
Nathan's Pit Priority 2 (see map 3)	Two polygons totalling 80 ha	Archaeological and ethnographic site avoidance survey
Nathan's Road (see map 3)	One polygon totalling 10 ha	Archaeological and ethnographic site avoidance survey

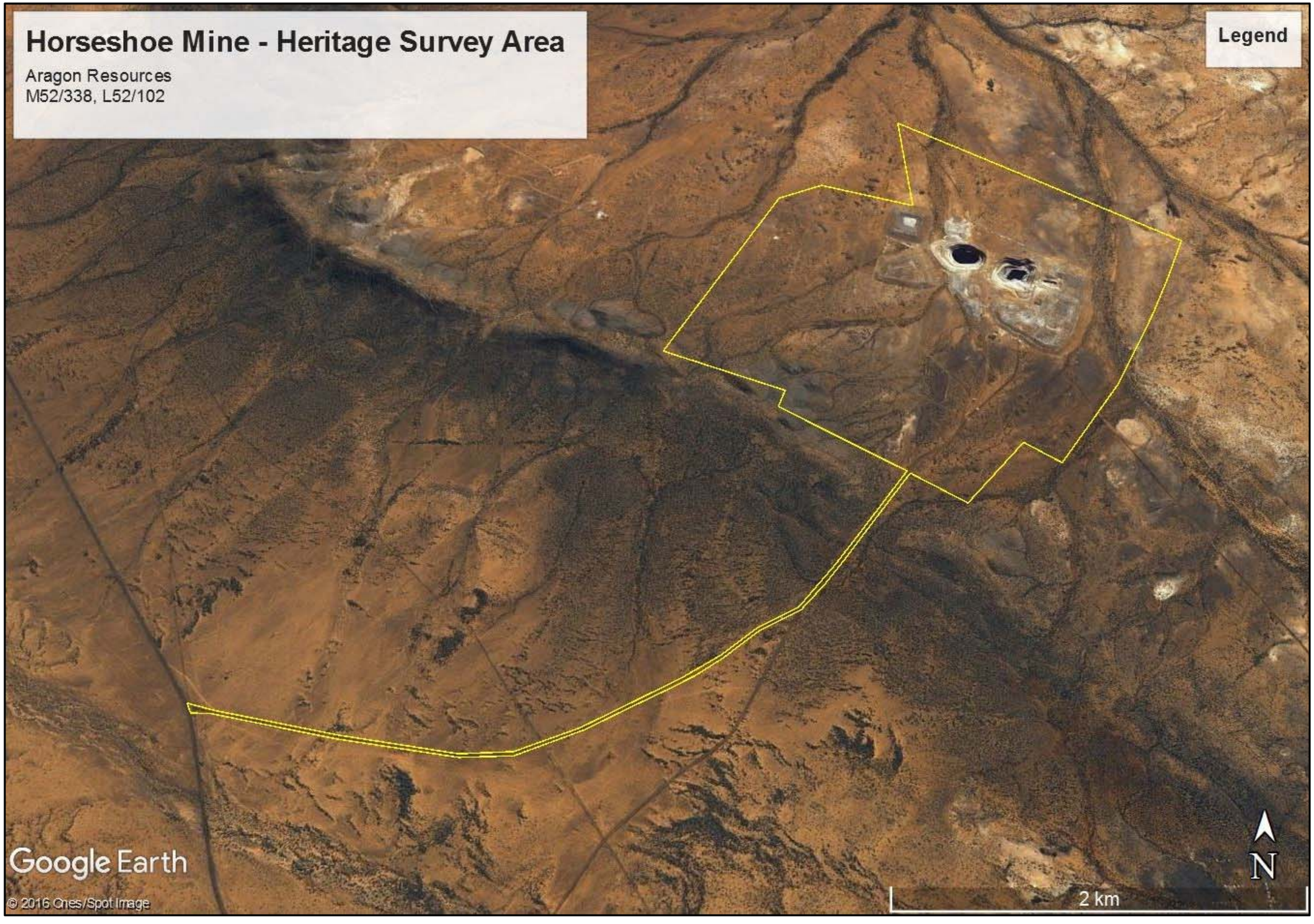
Plate 2: View southeast of the Labouchere survey area

Plate 3: View north of the Horseshoe Mine Priority 1 survey area

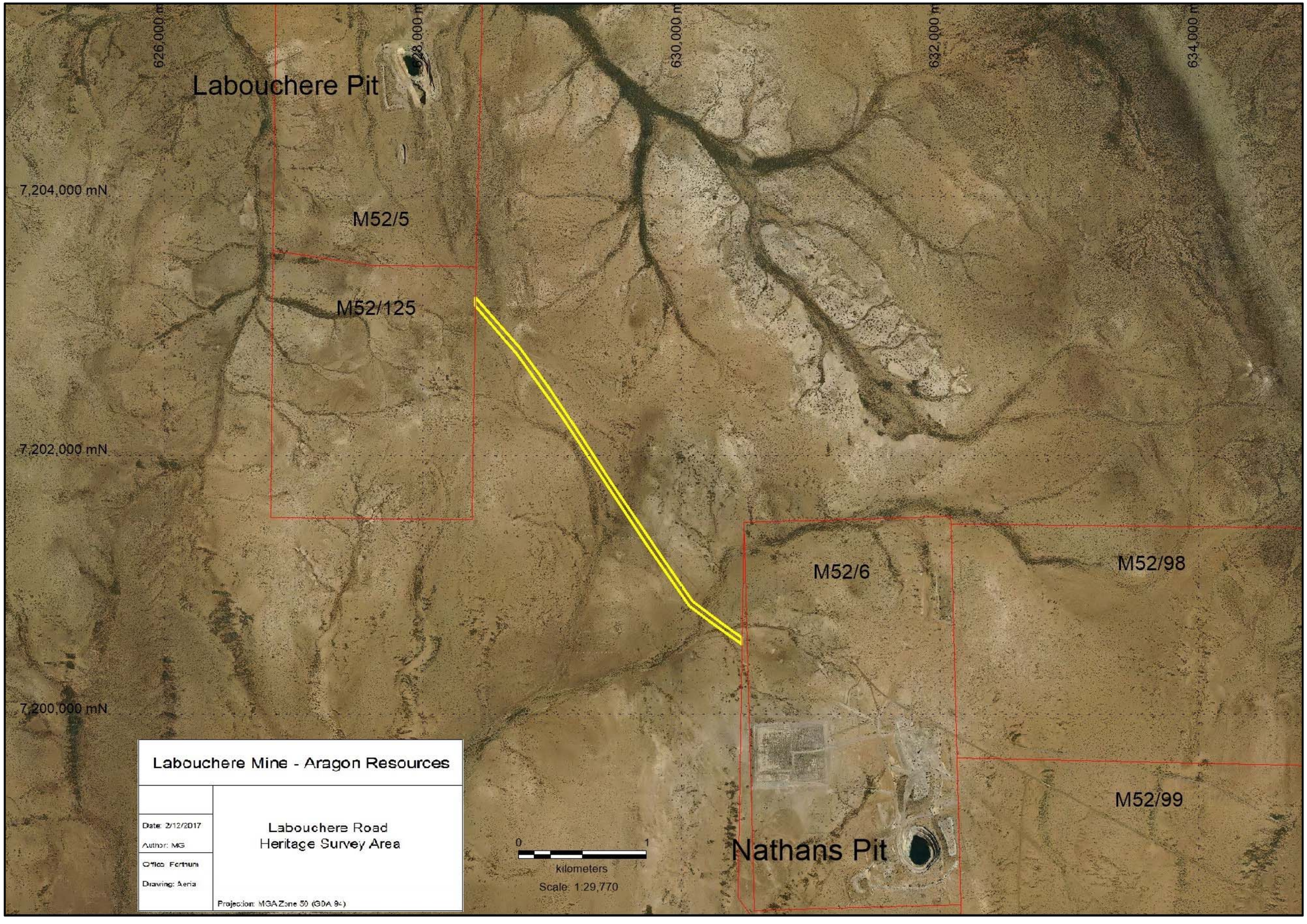
Plate 4: View east of the Horseshoe Mine Priority 1 survey area

Plate 5: View west of the Nathan's Pit Priority 1 survey area

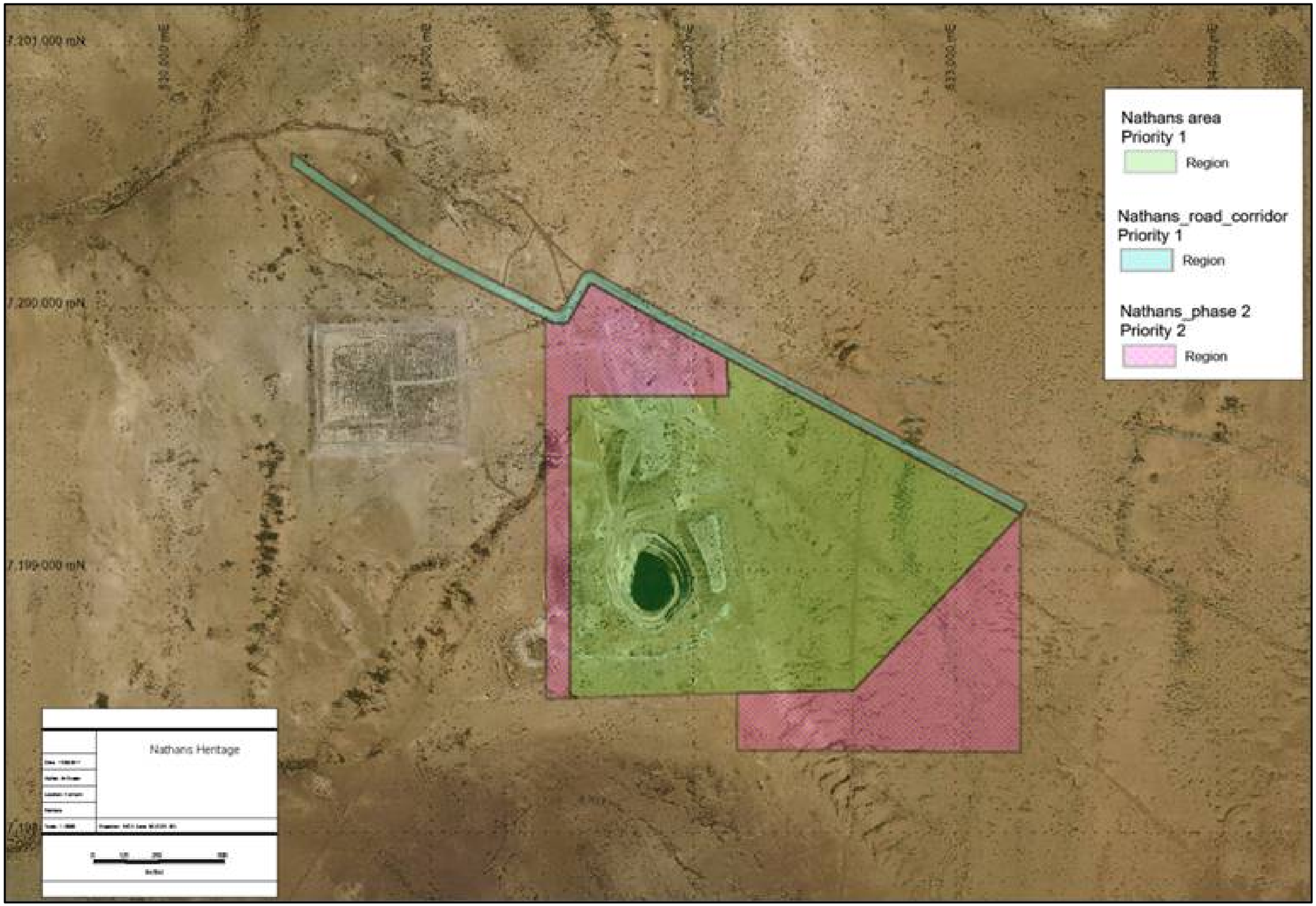
Map 1: Heritage survey area for the proposed Horseshoe Mine project



Map 2: Heritage survey area for the proposed Labouchere project



Map 3: Heritage survey area for the proposed Nathan's Road and Pit project



2 Heritage assessment method

The archaeological and ethnographic heritage survey was conducted to a site avoidance standard. The objective of site avoidance heritage surveys is to identify and record brief details of heritage places within the survey areas that may constitute Aboriginal sites as defined under s5 of the Act, to negotiate deviations around such places where possible, and to provide Aragon Resources with heritage management considerations for heritage values that would otherwise be impacted by the proposed development. As such, the site avoidance method of heritage assessment is designed to document Aboriginal heritage values to a standard sufficient to provide a preliminary understanding of the characteristics of heritage places and to allow the proponent to proceed with works that will not impact those places.

This includes accurate delineation of the spatial extent of heritage places using handheld global positioning systems (GPSs), justification of the recorded boundaries, and brief description of the heritage values of the places sufficient to convey the potential importance and significance of the place. However, site avoidance recording is insufficient to allow a full significance assessment to be made under s39 of the Act for consideration by the Aboriginal Cultural Materials Committee (ACMC).

Overviews of the procedures used during desktop and field-based research are provided below.

2.1 Legislative requirements

Under s17 of the Act, it is an offence to disturb an Aboriginal site without prior written permission to do so under s16 or s18 of the Act. This applies regardless of whether an Aboriginal site is registered. Heritage assessments of proposed development areas are conducted to identify the location and extent of sites and heritage places so that they can be appropriately managed in accordance with the legislative requirements of the Act. Outlines of the sections of the Act referenced in this report are provided in appendix 1.

2.2 Desktop assessment procedure

Prior to field work, a preliminary desktop assessment was undertaken to provide an overview of heritage research undertaken to date within the area. Desktop research focused on the identification of any registered Aboriginal sites and surveys within the area, which need to be considered in the heritage approval process for the project.

Desktop research for heritage values relies largely on the Register of Sites maintained by the Department of Aboriginal Affairs (DAA), which provides an indication as to the presence and nature of any heritage values previously recorded and registered within the area.

Prior to field work, the survey area boundaries are entered into the DAA's Aboriginal Heritage Inquiry System (AHIS) to ascertain whether any registered Aboriginal sites or other heritage places (OHPs) have been recorded within the area. Registered Aboriginal sites are those areas that have been assessed by the ACMC as constituting sites under the Act. OHPs include places for which data has been lodged with the DAA but is pending assessment by the ACMC, and stored data / not a site pertaining to heritage places and objects that have been assessed by the ACMC as not constituting registered Aboriginal sites.

The AHIS search is also utilised to ascertain whether any heritage assessments have previously been conducted within the application area and if any heritage reports containing information relevant to the application area have been registered with the DAA.

Following the AHIS search, relevant registered Aboriginal sites, OHP files and heritage reports held by the DAA are accessed and studied. Some of the information held by the DAA is not publically accessible due to file restriction, or due to temporary access suspension as a result of DAA administrative processes. In such cases, the inability to access information is noted in the heritage assessment results for the relevant sites / heritage places.

Unpublished material (heritage reports not registered with the DAA) available for review is also researched prior to field work and included in the heritage assessment results where relevant.

2.3 Field assessment procedure

As outlined above, the heritage assessment was conducted to site avoidance standard.

Before the start of the heritage survey, a briefing was conducted by the heritage consultants to provide the Traditional Owners with information about its purpose, scope, and method. Any places of interest known to or recognised by the Traditional Owners, including registered Aboriginal sites, were discussed, along with accessibility to and possible vantage points within the assessment areas. The heritage consultants sought confirmation from the Traditional Owners that they consented to participate in the heritage assessment and whether additional Traditional Owners, who may hold further knowledge of the area, needed to be consulted. The method utilised during field work was approved and endorsed by the Traditional Owners that participated in the field assessment.

Pedestrian transects were used to assess the survey area for cultural heritage values (Note that some survey areas were not assessed at all. These are set out at Table 2 below). Any heritage places identified were recorded to a site avoidance standard, which makes an assessment of whether they are considered likely to meet the criteria of a site under s5 of the Act. Detailed methods used to record different heritage values are provided in appendix 2.

The location, type, and lithology of any identified isolated objects comprising background archaeological material (BAM) during the assessment were also recorded.

Upon conclusion of the field trip a debrief was conducted to offer representatives of the Nharnuwangga Wajarri and Ngarlawangga Traditional Owner group the opportunity to discuss and comment upon the field method and the heritage places identified, including mitigation strategies and recommendations for heritage management within the area.

Plate 6: The survey team progress at the Horseshoe Mine Priority 1 survey area

Plate 7: The survey team progress at the Horseshoe Mine Priority 1 survey area

Plate 8: The survey team progress at the Nathan's Pit Priority 1 survey area

Plate 9: The survey team progress at the Labouchere survey area

2.4 Presentation and review of findings

Results are presented in formats tailored according to the classifications of findings. This ensures that sufficient information is provided in accordance with heritage approval requirements, and prevents the submission of any data superfluous to the requirements of the scope. Definitions of these are provided in the preamble of this report.

Outcomes of the heritage research are reviewed by the JJAC, prior to dissemination of results to Aragon Resources. The review process ensures that culturally sensitive information is appropriately indicated, and the recommendations discussed amongst the heritage team are made in accordance with the Traditional Owners' suggestions. This process provides Terra Rosa with feedback which is taken into account during the final editing of the report.

3 Heritage assessment results

Depending on the type of findings, the results of the desktop and field assessments are provided in a range of formats, as explained above in section 2.4. Table 2, below, presents a summary of the survey area assessment statuses at the end of the field trip.

Table 2: Heritage survey summary

Survey area	Assessment Type	Assessment status
Horseshoe Mine Priority 1	Archaeological and ethnographic site identification survey	Complete
Horseshoe Mine Priority 2	Archaeological and ethnographic site identification survey	Incomplete, unsurveyed
Labouchere	Archaeological and ethnographic site identification survey	Complete
Nathan's Pit Priority 1	Archaeological and ethnographic site identification survey	Incomplete, partially surveyed
Nathan's Pit Priority 2	Archaeological and ethnographic site identification survey	Incomplete, unsurveyed
Nathan's Road	Archaeological and ethnographic site identification survey	Complete

An overview of the registered Aboriginal sites, heritage places, and isolated objects identified during the assessment is provided in table 3, below (see section 3.2), with further detail subsequently provided. All registered Aboriginal sites and heritage places within the assessment area are illustrated in maps 4 and 5.

3.1 Limitations to the heritage assessment

The progress of the fieldwork was not impacted by any significant limitations.

3.2 Sites, places, and objects identified within the assessment area

The number of registered Aboriginal sites, potential sites, OHPs, and isolated objects identified within the assessment area during desktop and field-based research are listed in the table below.

Summaries of heritage places identified at the time of assessment are provided in section 3.5.

Isolated objects identified at the time of assessment were moved outside the survey area at the request of the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners.

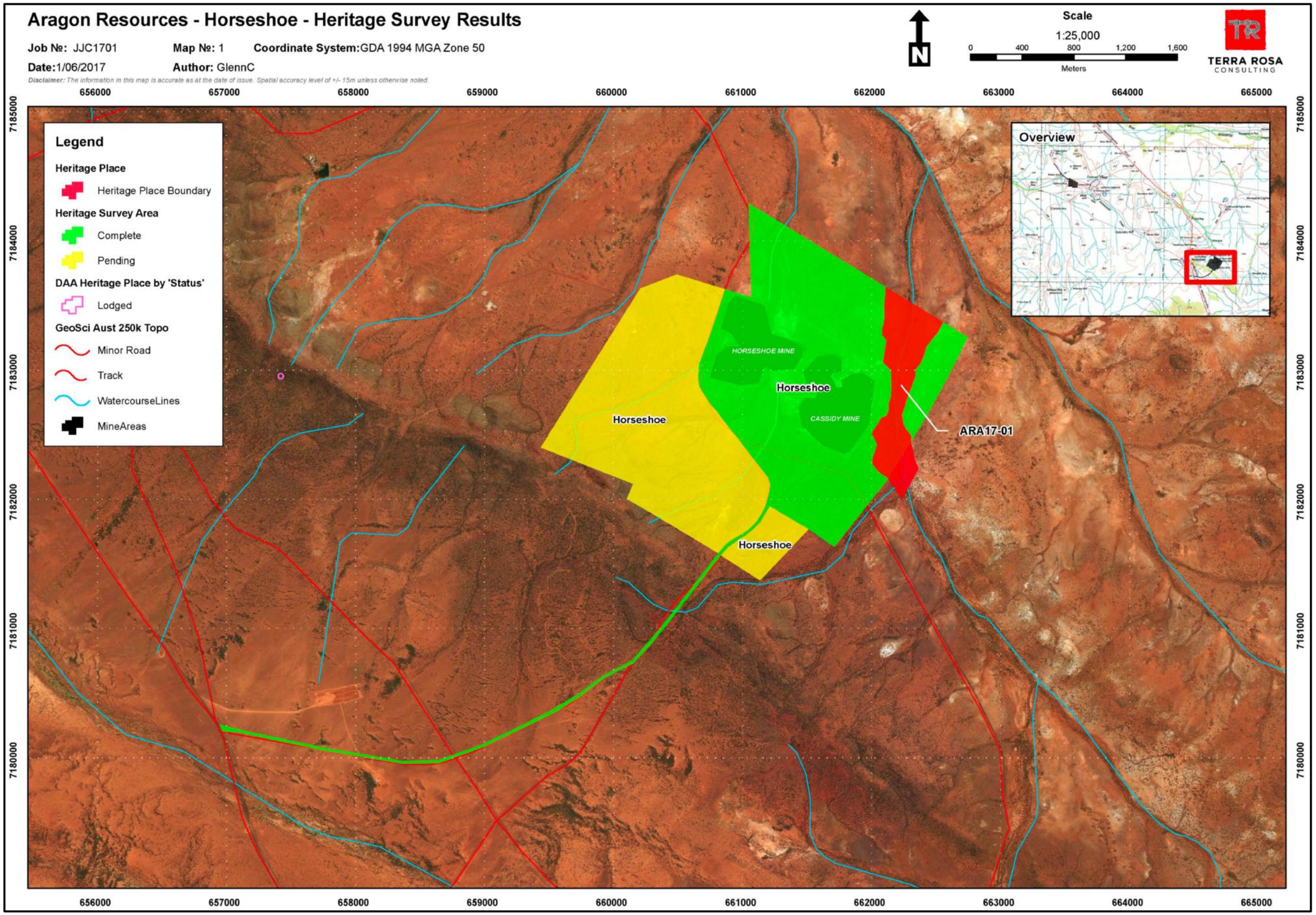
Table 3: Aboriginal sites, heritage places and objects identified within the assessment area

Classification of findings	Number identified	Survey Area	Place ID	Place type	HISF receipt no.	Comments
Registered Aboriginal sites ***see section 3.3***	0	Horseshoe Mine Priority 1	n/a	n/a	n/a	AHIS search revealed no previously registered Aboriginal sites within the survey area.
		Horseshoe Mine Priority 2				
		Labouchere				
		Nathan's Pit Priority 1				
		Nathan's Pit Priority 2				
		Nathan's Road				
DAA OHPs ***see section 3.4***	0	Horseshoe Mine Priority 1	n/a	n/a	n/a	AHIS search revealed no lodged or stored OHPs within the survey area.
		Horseshoe Mine Priority 2				
		Labouchere				

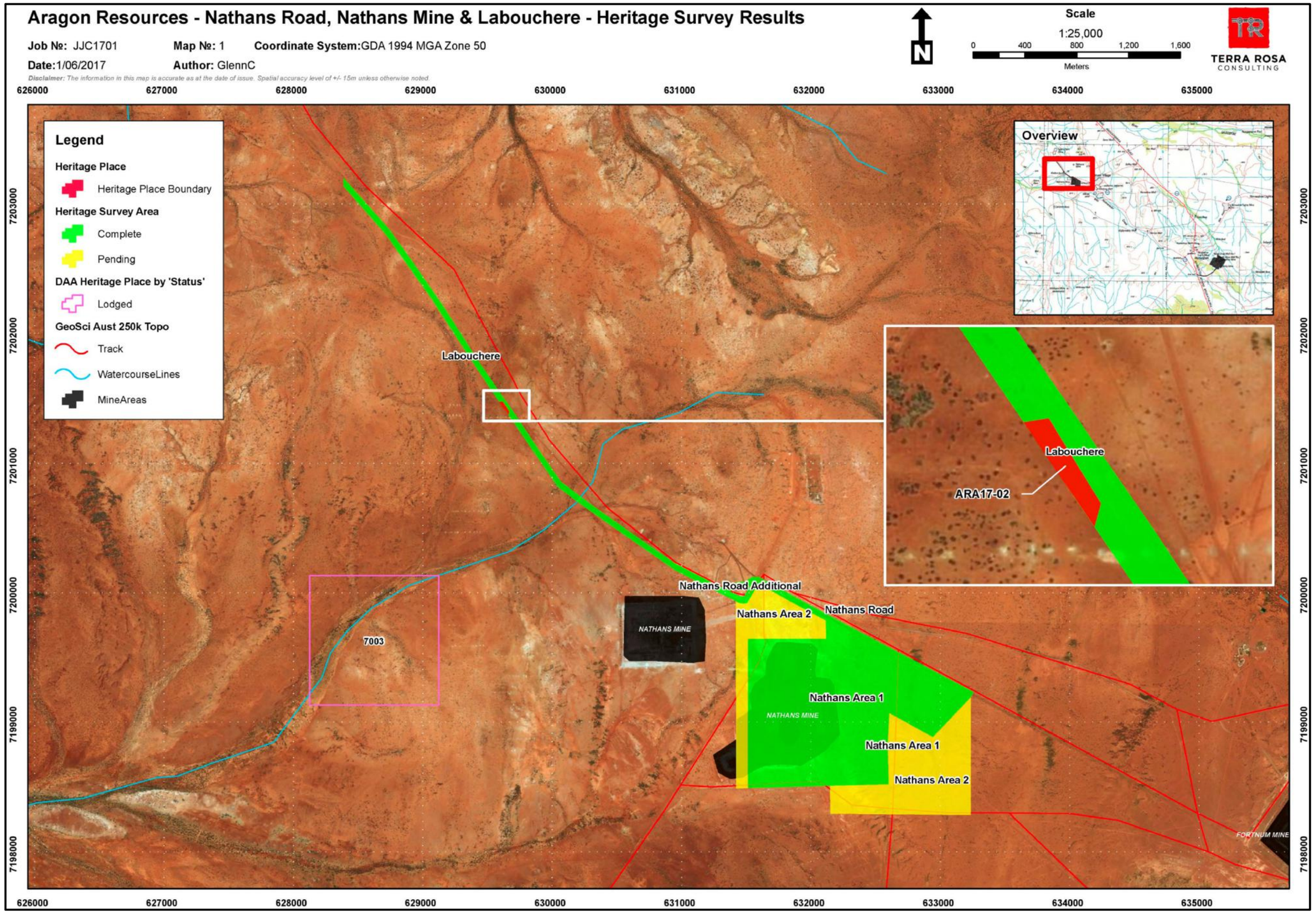
Classification of findings	Number identified	Survey Area	Place ID	Place type	HISF receipt no.	Comments
		Nathan's Pit Priority 1				
		Nathan's Pit Priority 2				
		Nathan's Road				
Heritage places ***see section 3.5***	1	Horseshoe Mine Priority 1	ARA17-01	Artefact scatter / water source	n/a	No HISF provided; heritage place recorded to site avoidance standard. Details in section 3.5.1
	n/a	Horseshoe Mine Priority 2	n/a	n/a	n/a	Area was not surveyed.
	1	Labouchere	ARA17-02	Artefact scatter / quarry	n/a	No HISF provided; heritage place recorded to site avoidance standard. Details in section 3.5.2
	0	Nathan's Pit Priority 1	n/a	n/a	n/a	Heritage survey of this area remains incomplete. However, no heritage places were located in the area that was surveyed.
	n/a	Nathan's Pit Priority 2	n/a	n/a	n/a	Area was not surveyed.
	0	Nathan's Road	n/a	n/a	n/a	No heritage places were located during the survey.

Classification of findings	Number identified	Survey Area	Place ID	Place type	HISF receipt no.	Comments
Isolated objects comprising BAM	0	Horseshoe Mine Priority 1, Horseshoe Mine Priority 2, Labouchere, Nathan's Pit Priority 1, Nathan's Pit Priority 2 and Nathan's Road	Not labelled	Background archaeological material	n/a	No HISF required

Map 4: Archaeological and ethnographic results within the Horseshoe Mine project area



Map 5: Archaeological and ethnographic results within the Labouchere, Nathan's Pit and Nathan's Road project areas



3.3 Summaries of registered Aboriginal sites

No registered Aboriginal sites were found to exist within the survey areas.

The absence of registered Aboriginal sites within the survey areas does not necessarily indicate an absence of heritage places or objects within the area. Any previous heritage assessments undertaken within the area may have lacked the scope to record and register identified heritage places or heritage objects. Alternatively, the lack of registered Aboriginal sites may be resultant of the area having not been subjected to heritage assessment.

3.4 Summaries of DAA OHPs

No lodged or stored DAA OHPs were found to exist within the survey areas.

As described in section 3.3, above, the absence of lodged or stored DAA OHPs within the survey areas does not necessarily indicate an absence of heritage places or objects within the area. Previous heritage assessments undertaken within the area may have lacked the scope to record identified heritage places or heritage objects and submit information for consideration by the ACMC. Alternatively, the survey areas may not have been previously subject to heritage assessment.

3.5 Summaries of heritage places

Summaries of the Two newly identified heritage places that were assessed under s5 of the Act are provided below.

3.5.1 ARA17-01 (artefact scatter / water source)

3.5.1.1 Description and Justification of the boundary

The site boundary for ARA17-01 was defined by the creek bank and the Horseshoe Mine spoil heap and associated disturbance on the western side. To the northwest the mid-storey vegetation line was used to define the boundary.

The northern site boundary was defined by the survey area boundary; as archaeological material was noted to continue north along the creek banks, this section of the boundary is considered to be open and will require further refinement in future in order to determine its extent to the north. Any future works proposed in this area should be planned to allow time to refine the open boundary margin.

The site boundary was defined on the eastern side by the change in gibber density and vegetation. While the southern boundary is defined by a pool identified by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners as 'Rosies Pool', it extends outside the survey area by 200 m. The southeastern boundary is also considered to be open, and will also require further refinement in future. The boundary and recording method for ARA17-01 was approved by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners.

3.5.1.2 Place condition

The central western portion of the site has been significantly affected by the Horseshoe Mine spoil heap and associated runoff. Channels have been created from spoil heap runoff which

has washed large amounts of sediment into the creek, and likely some archaeological artefacts too. There are several graded roads and tracks running through the site. Despite these disturbances, the northern portion the site is considered to be in very good condition, with archaeological material remaining largely in situ.

3.5.1.3 Place description

The site is located in the northeastern corner of the Horseshoe Mine Priority 1 survey area, and is a large medium density artefact scatter. There is a complex of pits, roads and spoil heaps on the western side of the site and runs along the boundary of the site. There is a large creekline with semi-permanent pools running through the centre of the site. The surrounding vegetation includes a mid-storey consisting of Mulga, Minirichie, and other Acacia species. Along the creekline there is an upper-storey of vegetation including Snappy Gums and a under-story of native grasses.

The cultural material identified during the site avoidance assessment of ARA17-01 includes artefactual material located on both sides of the creek; A large concentration of artefacts was identified to the north of the western side of the creek, and a medium sized concentration was identified in the south on both sides of the creek. The artefactual assemblage is comprised of macro blades, single platform cores, multiple platform cores, flakes, flake fragments, two basal grindstone fragments, one basal grindstone and three mullers. these were manufactured from chalcedony, chert, ironstone, mudstone, granite and quartz. While most appear to have been imported from elsewhere, the mudstone artefacts were likely made from raw materials sourced from the creek.

The presence of grinding material, in the mullers and basal grindstones, is evidence of subsistence strategies and indicates occupation from the mid to late Holocene when the use of such objects regionally increased in response to increased environmental pressures on food resources. There is some native grass along the creek bank and there was a large number of Acacia spp. which produce a seed or nut which can be ground to produce flour for making damper.

The Gascoyne River is located 26 km to the north of the survey area and this was a major travel route used for travelling by past Aboriginal people. The creekline that runs through the centre of the site is not a tributary of the Gascoyne, however it was stated by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners that this creekline was used to travel between the hills in the north and Peak Hill. The creek is highly significant and the semi-permanent pools which are the main reason that people were using this area. Nharnuwangga Wajarri and Ngarlawangga Traditional Owners Garry 'Cowboy' Robinson Snr and Leonard Smith Snr stated that one of the pools was named 'Rosie's Pool' and is where the women would stay whilst the men undertook initiation ceremonies at the hills further up the creek. The women would bathe their children in this pool and could have potentially done their own women's business in this area but this was not known for certain by Cowboy. Leonard Smith Snr's mother told him about the pool but she has since passed away. He was told that it was a very important place to her but no additional information was known.

ARA17-01 shows how past Aboriginal people opportunistically utilised the landscape while travelling through the country using creeklines.

3.5.1.4 Potential importance and significance

ARA17-01 is important and significant to the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners as it provides tangible evidence of how past Aboriginal people used and travelled through the landscape. The place is also of ethnographic interest to the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners present, who were able to provide information and stories of their family members living in the immediate area.

Site identification recording of ARA17-01 is required to enable a fair assessment of the importance and significance of the heritage place under s39 of the Act.

Plate 10: View northwest of the spoil heap within ARA17-01

Plate 11: Nharnuwangga Wajarri and Ngarlawangga Traditional Owners Garry Robinson Jnr, Leonard Smith Snr and Garry 'Cowboy' Robinson Snr with Terra Rosa Consultant Sunissa Brown discussing ARA17-01

Plate 12: View northwest of the creekline from within ARA17-01

Plate 13: Ironstone flake from within ARA17-01 (scale = 10 cm)

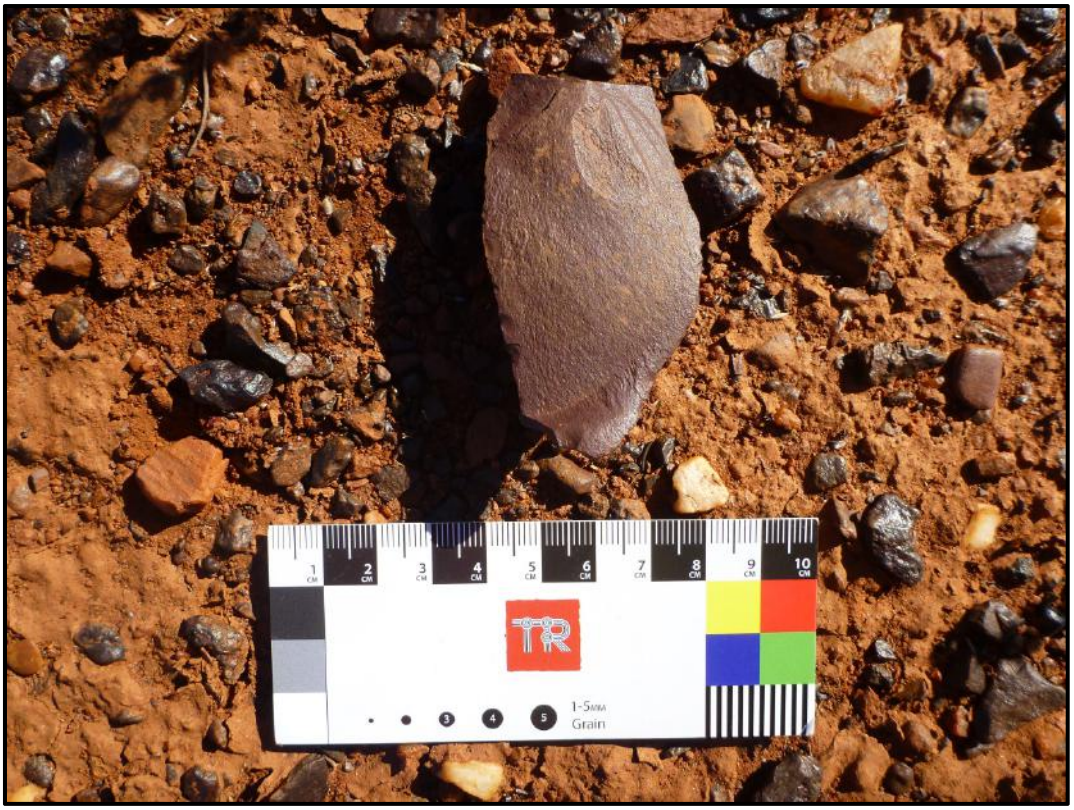


Plate 14: Quartz flake from within ARA17-01 (scale = 10 cm)

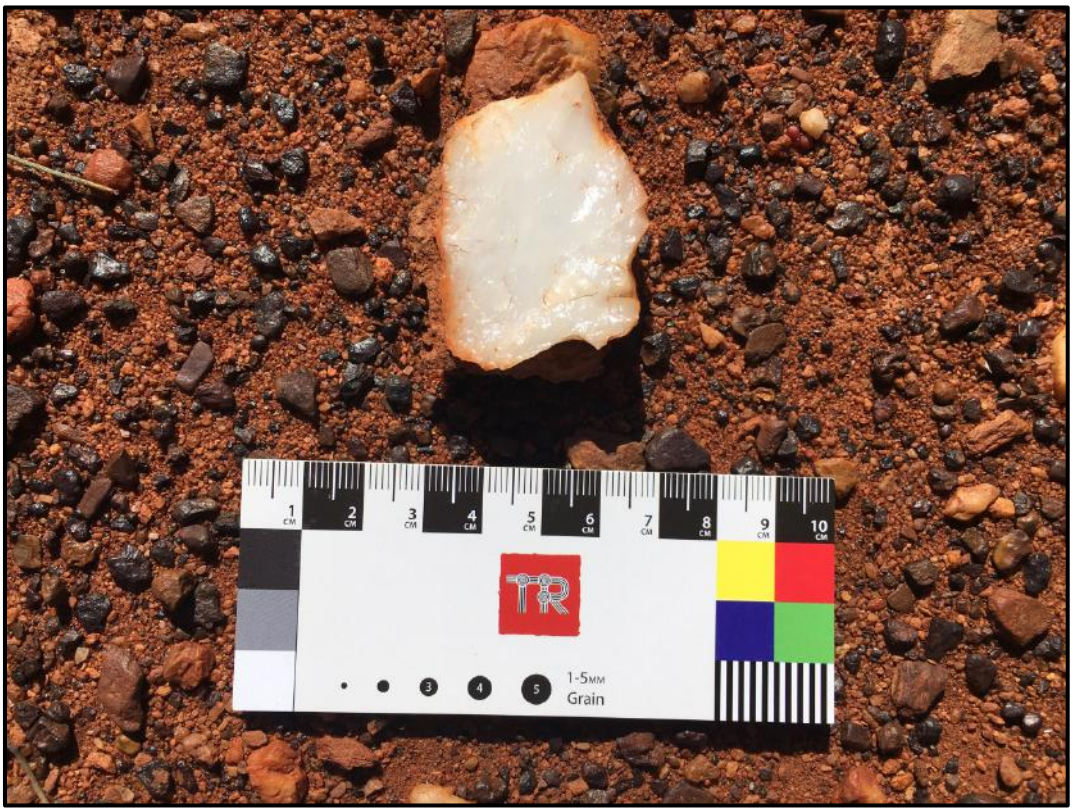


Plate 15: Dolerite macro blade from within ARA17-01 (scale = 10 cm)

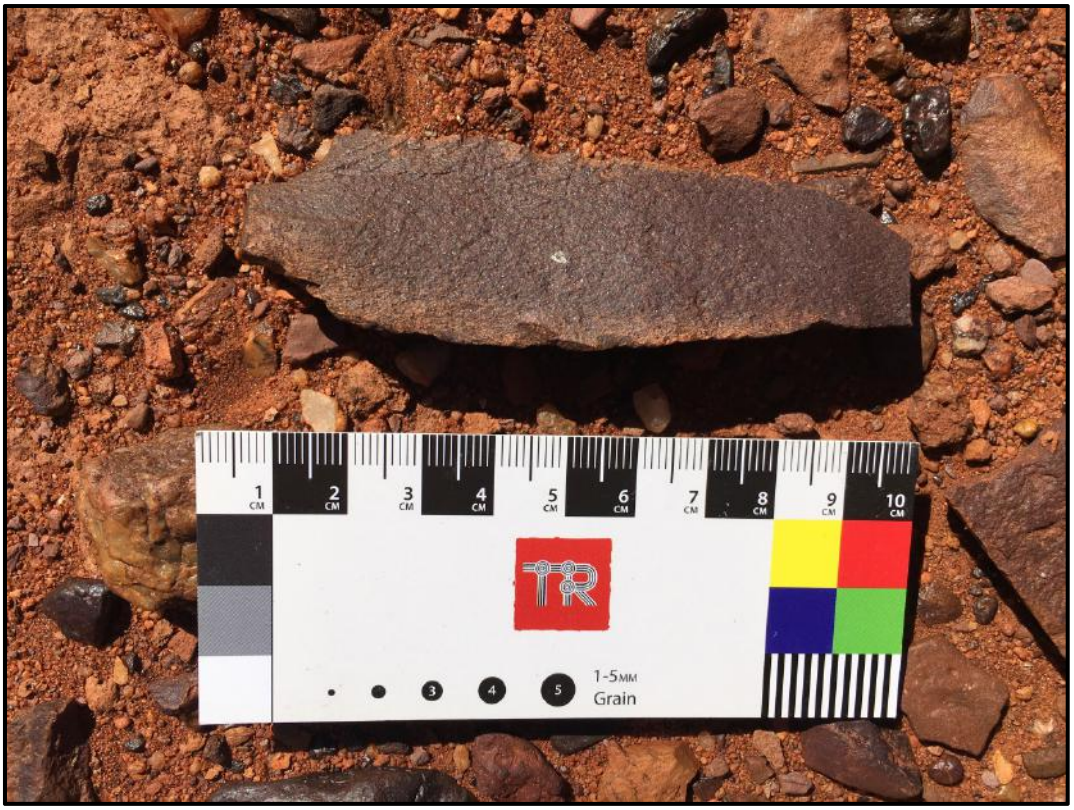


Plate 16: Mudstone basal grindstone fragment from within ARA17-01 (scale = 10 cm)

3.5.2 ARA17-02 (artefact scatter / quarry)

3.5.2.1 Description and Justification of the boundary

The northwestern and southeastern extents of the ARA17-02 site boundary are defined by extent of artefacts visible on the ground surface. The northeastern boundary for ARA17-02 is defined by an existing road and windrow, and by the boundary of the survey area in the southwest. Because of these arbitrary boundaries, both of these sections of the ARA17-02 boundary are considered to be open and will require further refinement in future as artefacts were noted to continue beyond the survey area. Any future works proposed in this area should be planned to allow time to refine the open boundary margins.

Only a small portion of the site is situated within the survey area. The boundary and recording method for ARA17-02 was approved by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners.

3.5.2.2 Place condition

The site has been divided by a 20 m wide road that runs through the centre of it. However northeastern and southwestern portions of the site appear to be in good condition; intact knapping floors and small sized artefacts indicate that there has been very little water disturbance through ARA17-02, and that the majority of the assemblage is likely to be in situ.

3.5.2.3 Place description

ARA17-02 is located in the central portion of the Labouchere survey area, and is a large, medium density artefact scatter. The survey area is located along a road that runs between the Labouchere and Nathan's Pits. The road is 20 m wide and has two sets of windrows. The vegetation within ARA17-02 consists largely of Mulla Mulla, Mulga, Minirichie and other Acacia species.

Artefacts were located on both sides of the road, with the majority of the assemblage being situated beyond the survey area. The artefactual assemblage is comprised of blades, blade fragments, single platform cores, multiple platform cores, core fragments, flakes and flake fragments.

The cores and core fragments found within ARA17-02 indicate that core preparation for blade and other tool production was being undertaken by the people who used the site. Some artefacts displayed differential levels of patination, indicating that there has been at least two occupations of this site.

A majority of the artefacts are made from white chert and a chalcedony obtained from sources within the site. These sources present as heat fractured cobbles eroding out of the ground, which has then been targeted for use by people as they have moved through the area. Nharnuwangga Wajarri and Ngarlawangga Traditional Owner Leonard Smith Snr stated that this material is important and that people would have specifically come to this site to collect it.

ARA17-02 shows how past Aboriginal people opportunistically utilized the landscape and raw materials while travelling through the country.

3.5.2.4 Potential importance and significance

ARA17-02 is important and significant to the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners as it provides tangible evidence of how past Aboriginal people used and travelled through the landscape.

Site identification recording of ARA17-02 is required to enable a fair assessment of the importance and significance of the heritage place under s39 of the Act.

Plate 17: View northeast of Nharnuwangga Wajarri and Ngarlawangga Traditional Owner Garry Robins Jnr from within ARA17-02

Plate 18: Chalcedony transversely broken flake from within ARA17-02 (scale = 10 cm)

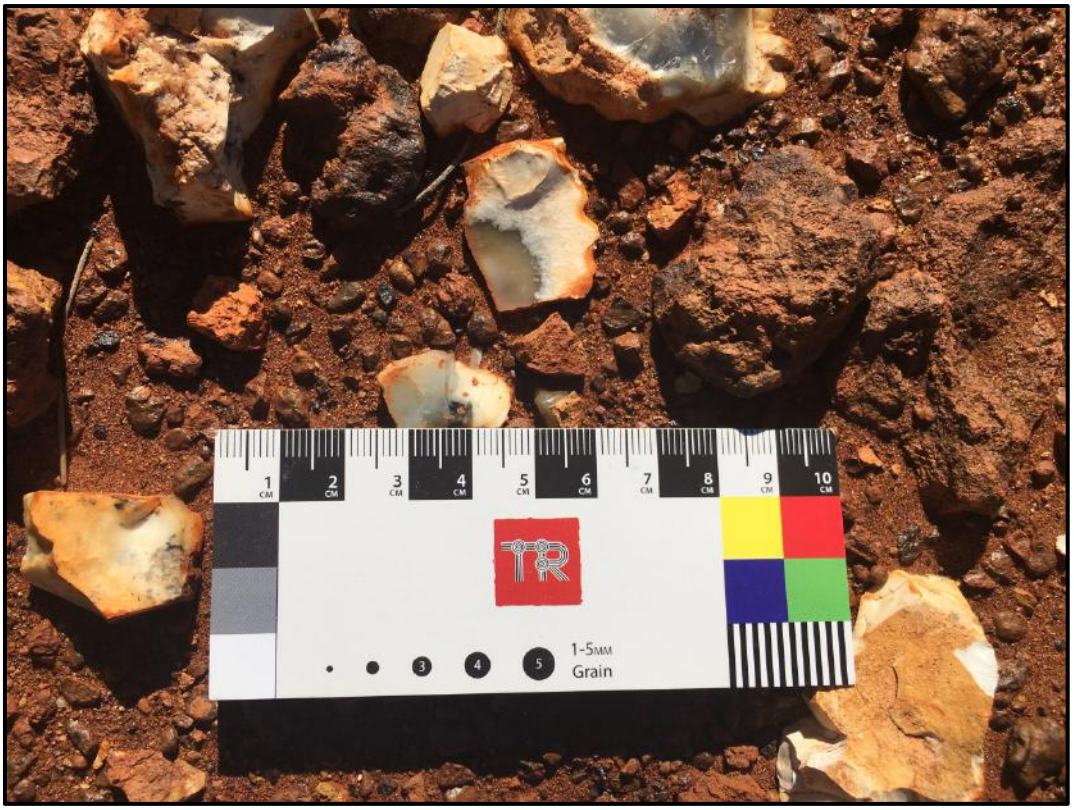


Plate 19: Quartz flake from within ARA17-02 (scale = 10 cm)

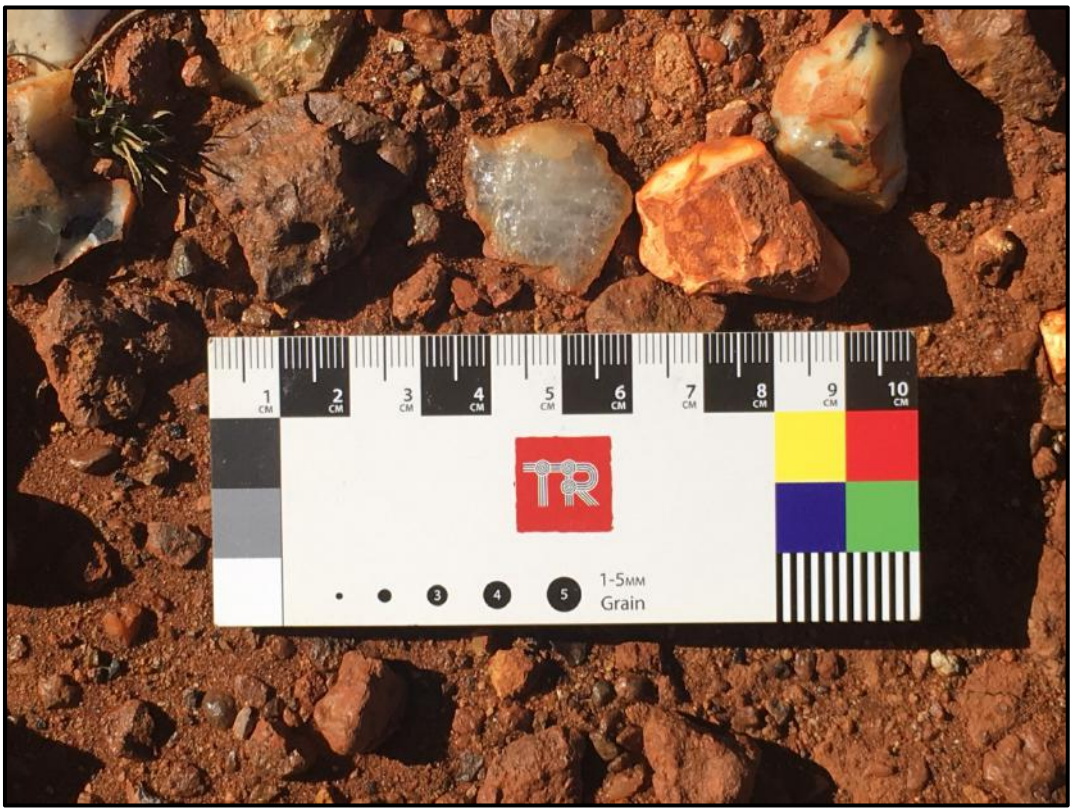


Plate 20: Raw material source from within ARA17-02 (scale = 10 cm)

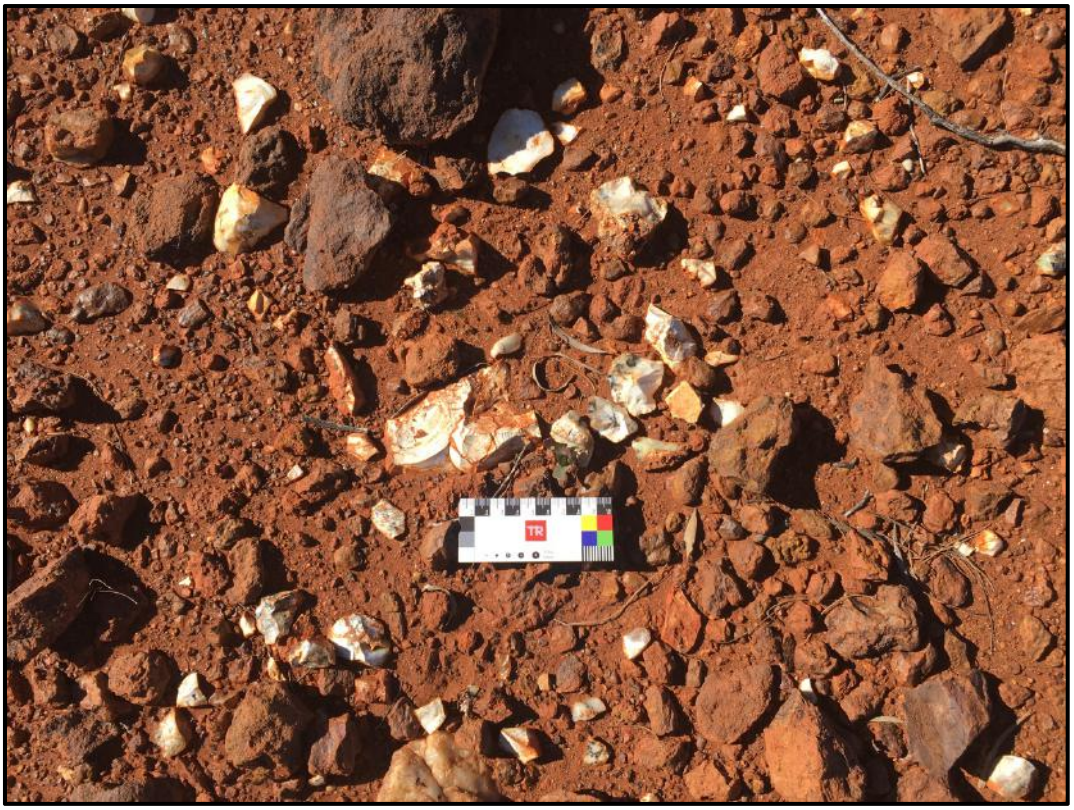
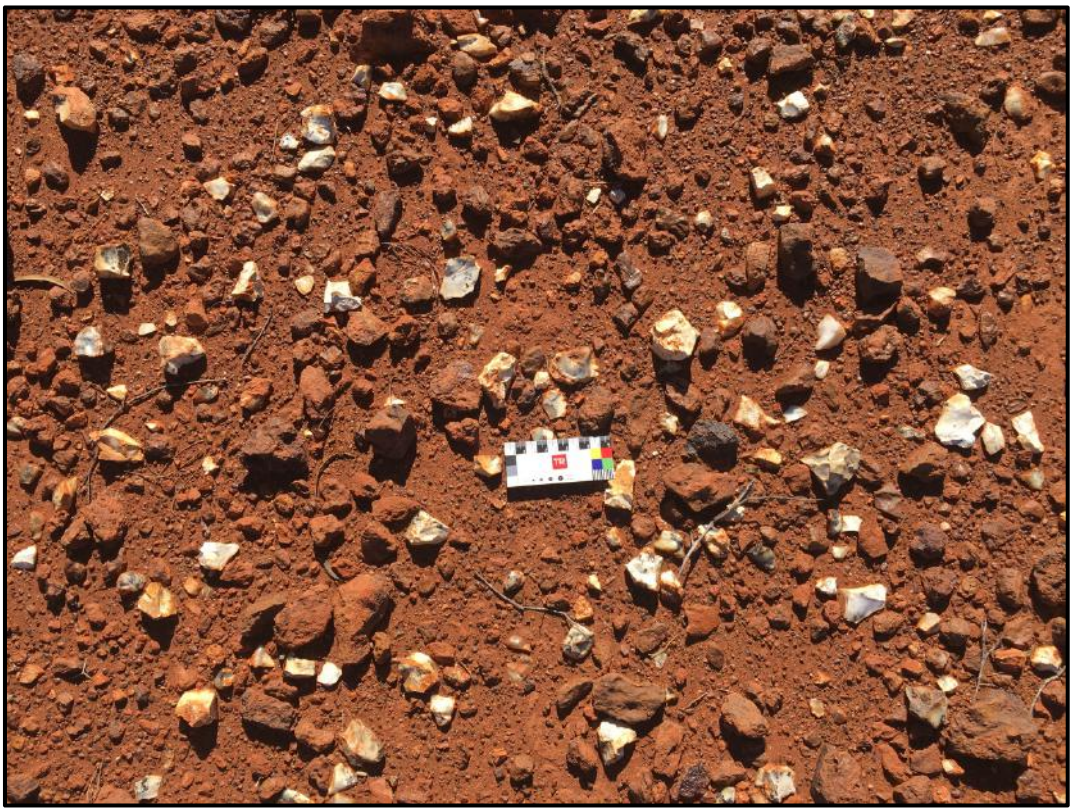


Plate 21: Knapping floor from within ARA17-02 (scale = 10 cm)



4 Cultural heritage management recommendations

Based on the archaeological and ethnographic assessment of the Horseshoe Mine, Labouchere, Nathan's Pit and Nathan's Road project areas and consultation with the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners, Terra Rosa has established the following heritage management recommendations for the project.

1 Aragon Resources is advised that beyond the boundaries of the heritage places, the surveyed areas within Horseshoe Mine, Labouchere, Nathan's Pit, and Nathan's Road are clear for the proposed works to proceed.

As a result of the heritage survey:

- No DAA registered Aboriginal sites were identified;
- No DAA OHPs were identified; and
- Two newly identified heritage places (ARA17-01 and ARA17-02) were recorded to site avoidance standard.

2 The Nharnuwangga Wajarri and Ngarlawangga Traditional Owners have requested that the Labouchere road is not graded beyond the windrows for the portion of the road that runs through the site ARA17-02.

ARA17-02 was located on both sides of the Labouchere road. It is advised that consent under s18 of the Act is attained if Aragon wishes to widen the road beyond the windrows in this section of the road.

3 All employees and contractors working within Horseshoe Mine, Labouchere, Nathan's Pit, and Nathan's Road should be made aware of the location and boundaries of all heritage places identified therein and are clearly instructed to restrict access and works to areas that Aragon Resources has clearance to utilise.

If Aragon Resources proposes to utilise areas in which heritage places have been identified, Aragon Resources is advised to consult with the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners and apply for Ministerial consent to disturb the areas under s18 of the Act.

Under s17 of the Act, it is an offence to disturb an Aboriginal heritage place without prior written permission to do so under s16 or s18 of the Act. Financial penalties may be applied against individuals or corporations who disturb a heritage place, whether that place is catalogued by the DAA or not.

To minimise any inadvertent impact to identified heritage places and any potential breaches of the Act, Aragon Resources should ensure that all employees and contractors working in the project area should be briefed on the location of all heritage places and are clearly instructed to restrict access and works to areas that Aragon Resources has clearance to utilise.

4 If Aragon Resources proposes to alter the type of works or to expand the program of works, either in size or scale, beyond that cleared during the heritage assessment, it is advised that further consultation with the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners should be undertaken prior to the commencement of works.

Aragon Resources is advised that only the areas subjected to heritage assessment are clear for the proposed works to proceed. Should the program of works expand in size or scale, or should Aragon Resources wish to conduct activities that differ to those discussed during field work, the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners will need to be engaged for further heritage assessment.

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Aboriginal Heritage Act 1972 (Western Australia), viewed 10 August 2012,

<http://www.austlii.edu.au/au/legis/wa/consol_act/aha1972164/>

Appendix 1 – Relevant sections of the Act

The below sections of the Act are referenced in the current report and included below for easy reference. A full copy of the Act is available online at http://www.austlii.edu.au/au/legis/wa/consol_act/aha1972164/.

s5 Application to places

This Act applies to —

a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;

b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;

c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State;

d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

s6 Application to objects

1) Subject to subsection (2a), this Act applies to all objects, whether natural or artificial and irrespective of where found or situated in the State, which are or have been of sacred, ritual or ceremonial significance to persons of Aboriginal descent, or which are or were used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people past or present.

2) Subject to subsection (2a), this Act applies to objects so nearly resembling an object of sacred significance to persons of Aboriginal descent as to be likely to deceive or be capable of being mistaken for such an object.

    a. This Act does not apply to a collection, held by the Museum under section 9 of the Museum Act 1969, which is under the management and control of the Trustees under that Act.

3) The provisions of Part VI do not apply to an object made for the purpose of sale and which —

    a. is not an object that is or has been of sacred significance to persons of Aboriginal descent, or an object so nearly resembling such an object as to be likely to deceive or be capable of being mistaken for the same; or

    b. is an object of the kind referred to in paragraph (a) that is disposed of or dealt with by or with the consent of the Minister.

s15 Report of findings

Any person who has knowledge of the existence of any thing in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual or ceremonial significance, cave or rock

paintings or engravings, stone structures or arranged stones, carved trees, or of any other place or thing to which this Act applies or to which this Act might reasonably be suspected to apply shall report its existence to the Registrar, or to a police officer, unless he has reasonable cause to believe the existence of the thing or place in question to be already known to the Registrar.

s17 Offences relating to Aboriginal sites

A person who –

a. excavates, destroys, conceals or in any way alters any Aboriginal site; or
b. in any way alters, damages, removes, destroys, conceals, or who deals with in a manner not sanctioned by relevant custom or assumes the possession, custody or control of any object on or under an Aboriginal site,

commits an offence unless he is acting with the authorisation of the Registrar under section 16 or of the Minister under section 18.

s39 Functions of the Committee

1. The functions of the Committee are —
    a. to evaluate on behalf of the community the importance of places and objects alleged to be associated with Aboriginal persons;
    b. where appropriate, to record and preserve the traditional Aboriginal lore related to such places and objects;
    c. to recommend to the Minister places and objects which, in the opinion of the Committee, are, or have been, of special significance to persons of Aboriginal descent and should be preserved, acquired and managed by the Minister;
2. In evaluating the importance of places and objects the Committee shall have regard to —
    1. any existing use or significance attributed under relevant Aboriginal custom;
    2. any former or reputed use or significance which may be attributed upon the basis of tradition, historical association, or Aboriginal sentiment;
    3. any potential anthropological, archaeological or ethnographical interest; and
    4. aesthetic values.
3. Associated sacred beliefs, and ritual or ceremonial usage, in so far as such matters can be ascertained, shall be regarded as the primary considerations to be taken into account in the evaluation of any place or object for the purposes of this Act.

Appendix 2 – Heritage place recording methods

Detailed below are the methods used by Terra Rosa to record the heritage places and values identified within the survey area. This includes how place boundaries are defined, which attributes are documented, and how an assessment of a place's importance and significance is made.

Definition of archaeological heritage places

Following thorough investigation, if a collection of objects were deemed to be of insufficient density or importance to constitute a heritage place under the meaning of the Act, artefacts were recorded as isolated objects comprising BAM.

For isolated objects, the location, artefact lithology, and typology were noted. Artefacts were then returned to their original location and orientation.

Artefacts were deemed to be isolated unless one or more of the following conditions existed:

- The heritage place displayed clear, purposive activity;
- The heritage place and its objects are considered to be relatively intact and in sufficient condition for an assessment of their importance and significance to be made;
- The material was identified in association with other heritage place elements; and
- The Traditional Owners requested that the material be recorded as a heritage place.

If the above conditions were met and the survey team assess the objects and/or features to constitute a heritage place under the meaning of s5 of the Act, the place and its constituent features were comprehensively photographed, and then recorded using the methods outlined below.

The methods employed during the heritage assessment within the survey areas were discussed with, and approved by, the attending Traditional Owner representatives.

Designation of archaeological heritage place boundaries

Archaeological heritage place boundaries were determined by a number of factors, including the extent and / or density of heritage features and objects, and / or natural features (e.g. creek banks or outcrop margins). All heritage place boundaries were checked with the Traditional Owners to ensure all important and significant cultural heritage values were sufficiently encompassed.

Boundaries were delineated in the field where possible, and recorded using a hand-held Garmin GPS unit. Where field-based delineation of boundaries was not feasible, heritage place extents are calculated using GIS determinations during assessment of field data in the office.

Definition of ethnographic heritage places and their boundaries

Pedestrian inspection of the survey areas was undertaken to identify all heritage places of ethnographic significance to the Traditional Owners, such as ritual, sacred and/or ceremonial sites, and other places of ethnographic interest. This included previously known places, and

places interpreted by the Traditional Owners as having significance based on their knowledge of traditional law and custom.

The boundaries for ethnographic heritage places were determined in consultation with the Traditional Owners, taking into account any specific physical, cultural and / or geographical attributes of the place, and the relationship between these and the surrounding environment. A hand-held Garmin GPS unit was used to capture boundary coordinates and the location of any significant features identified within the heritage places and surrounding area. As such, ethnographic heritage place boundaries are representative of the cultural knowledge held by the Traditional Owners present during the heritage assessment.

Ethnographic heritage place recording method

Following the identification of a place of ethnographic interest, the anthropologist conducted informal, semi-structured interviews with the Traditional Owners to establish whether the place was likely to meet the criteria under s5 of the Act. If a place was considered likely to be considered as an Aboriginal site under the Act, the anthropologist captured more comprehensive information in regard to the cultural values, importance and significance of the place. Interview questions were tailored to the context of the heritage place.

Information was recorded using hand-written notes, photography, heritage place plans, videography, and / or voice recording.

The interrelationships between places and any specific heritage management recommendations were then discussed and recorded for each place of ethnographic interest identified.

Assessing importance and significance

Site avoidance level recording is insufficient to allow a significance assessment to be made under s39 of the Act for consideration by the ACMC.

Artefact scatter recording method

Areas containing collections of artefacts in notably higher densities than the surrounding BAM were investigated as potential artefact scatters.

For site avoidance level recording, once a boundary was established (see above), a comprehensive description of the place and its associated heritage features and objects was produced. This included details and photos of environmental attributes along with any relevant and / or interesting archaeological features. The Traditional Owners were consulted, and their discussion regarding the cultural values of the place was recorded.

Appendix 3 – Regional background

Region and native title interests

The Nharnuwangga Wajarri and Ngarlawangga People hold native title over an area located within the Shires of Ashburton, Meekatharra and Upper Gascoyne (NNTT no. WCD 2000/001).

The Nharnuwangga Wajarri and Ngarlawangga determination area broadly extends from Turee Creek and Prairie Downs pastoral leases in the north (southwest of Newman); south to Doolgunna pastoral lease; west-southwest towards Landor; and northeast to Pingandy and Mininer pastoral leases. Their traditional lands include the Collier Range National Park (Reserve 35104).

Jidi Jidi Aboriginal Corporation is the registered Native Title Body Corporate for Nharnuwangga Wajarri and Ngarlawangga.

Biogeography and major Landforms

The Nharnuwangga Wajarri and Ngarlawangga determination area is located within the Gascoyne (GAS) biogeographic region, as described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell, 1995), more specifically within the Augustus subregion (GAS 3).

The Augustus subregional area is approximately 10,687,739ha (106,877 square kilometres). The bioregion has approximately 2.5% of its surface under some form of conservation tenure, 3.37% in Aboriginal reserves, and approximately 9.7% being other Crown reserves and Unallocated Crown Land (UCL). Pastoralism occupies nearly 85% of the region and mining also has considerable interests.

Broadly, Mulga (*Acacia* spp.) woodland with an understorey of *Triodia* spp. occurs on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland.

Much of the region is covered by a large sedimentary basin known as the Carnarvon Basin. The sedimentary Carnarvon Basin slopes gently towards the coast and is characterised by low relief, open drainage and large gently undulating sand plains. This contrasts strongly with the small area of Precambrian rocks in the north east of the Gascoyne, which has moderately high relief, a close dendritic drainage pattern and mature valley topography.

The north eastern part of the Gascoyne region is covered by Middle Proterozoic sandstone, shale and dolomite of the Bangemall Basin. These sediments of varying age, almost entirely marine in origin, have been subjected to low- grade metamorphism, folding and intrusion by numerous dolerite sills, which have a westerly regional dip.

The Augustus subregion (GAS 3) is summarised as consisting largely of rugged low Proterozoic sedimentary and granite ranges. There are extensive areas of alluvial valley-fill deposits, the Gascoyne River System provides the main drainage of this subregion, it is also the headwaters of the Ashburton and Fortescue Rivers.

The soils in the Gascoyne region have many features that are common to semi-arid soils elsewhere in Australia. Most obvious is the predominantly red colouration of the soil which is due to soil particles covered by oxides of iron.

The Department of Agriculture and Food (DAFWA) (2006), describe the Nharnuwangga Wajarri and Ngarlawangga Determination area as occurring within the Gascoyne Valley Zone (295), consisting of:

- Hardpan wash plains (with hills, stony plains and some calcrete plains and floodplains) on alluvial deposits over gneiss and volcanic rocks of the southern parts of the Gascoyne Complex and Edmund and Collier Basins.
- Red-brown hardpan shallow loams with red deep sands, red shallow sandy duplexes and red loamy earths and some red/brown non-cracking clays and stony soils.
- Mulga shrublands (with some Wanderrie grasses and Chenopods), located in the Upper Gascoyne between Landor Station and the Great Northern Highway.

Cultural landscape

The Nharnuwangga Wajarri and Ngarlawangga Native Title determination area is located in the boarder Midwest Region, which begins on the coast near Cervantes and ends just north of Exmouth, extending inland to Mt Magnet. The ethnographic record reflects a diversity of views regarding the traditional organisation of social and linguistic boundaries within the Midwest region, boundaries that have often been defined along the circumcision and subincision lines, which separated the Geraldton Coastal Region from Aboriginal groups further inland (Tindale 1974).

Embedded within these topographical features are Law, stories, Dreamtime pathways, ancestral spirits and traditional travel routes through country. Pathways travelled by the mythical beings who transformed the lands were called 'Dreaming tracks' and the maps people used to travel across the country were often depicted in songs. Thus, song-lines or stories tell the journeys of ancestral spirits that moulded the earth as they travelled across country, including mythical water snakes called *Bimara* (Green 2001; Shaw & Martin 2011).

Water resources

With Gascoyne climate being so arid, knowledge of reliable water sources was necessary for survival. Ethnographic and archaeological sites within the Nharnuwangga Wajarri and Ngarlawangga determination area are concentrated along major water sources such as the Gascoyne River, Murchison River and Ashburton River, including their various tributaries the Angelo River, Ethel River and Turee Creek. Nharnuwangga Wajarri and Ngarlawangga people traditionally utilised natural cavities forming in rocky outcrops, known as rock holes and gnamma holes. These were often covered over with a movable stone in order to protect the gathered water from evaporating and being contaminated. To this day, Yamatji people continue to maintain these water sources when encountered, often by cleaning them out and/or covering them up.

The Murchison River, Gascoyne River, and Ashburton River are highly culturally significant for a variety of groups throughout the Midwest and Gascoyne regions as they cover multiple native title boundaries. Multiple groups believe that the permanent water sources contain *Bimara*, or mythological water serpents that often bear the same name as the site it associated with (Kingsford 1982). *Bimara* are inherently linked to the 'Dreamtime' responsible for creating the landscape and water sources (Shaw & Martin 2011). Permanent water sources continue to be of high cultural importance, indicating the health of country, which in turn reflects the health of culture (Barber & Jackson 2011).

Natural resources

A myriad of faunal and botanical resources were readily available within the NWN determination area. The knowledge and use of various plants and animals continues to be passed on generationally among Traditional Owners. Exploitable wildlife and vegetation available within the region includes various types of *Kangaroo* and rock kangaroo, porcupines (echidnas), bird species including ducks and emu, *bungarra* (Goanna) and lizards (Shaw & Martin 2011).

Vegetation traditionally served a variety of purposes for Nharnuwangga Wajarri and Ngarlawangga people including modification into tools, food, and association with spiritual and cultural beliefs. Traditionally seeds, fruits and tuber vegetables were commonly collected and consumed as part of the diet, including bush tomato and *quandong* berries were also commonplace bush foods found throughout the region (ibid.).

Pastoral history

Pastoral settlement began in the Geraldton region the 1850's with expansion into the central parts of the Murchison occurring in the 1860's (Kingsford 1982), following legislative Council inducements to pastoralists to take up leases for the grazing of sheep and cattle. Stock routes along which drovers took cattle from the Ashburton and Pilbara to railheads at Mullewa and Meekatharra pass through the region (GDC. c. 2000).

Pastoralism comprises an important part of recent history for many of the groups in the Midwest, including the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners, with many elders holding living memories of the pastoral lifestyle.

Many Nharnuwangga Wajarri and Ngarlawangga Traditional Owners hold living memory of working on pastoral stations, often holding familial association with particular stations. Aboriginal people were engaged to undertake various tasks, often as station hands, stockmen and shearers, mostly in return for basic rations, stores and shelter. Women often served as domestic help. According to Biskup (1973), by 1910 all surviving full-Aboriginal people had all settled on stations or around towns, profoundly effecting traditional lifestyles and establishing strong connections with the pastoral industry.

Pastoral stations specifically associated with the Nharnuwangga Wajarri and Ngarlawangga Traditional Owners determination area include Bryah, Doolgunna, Kumarina, Landor, Milgun, Mingah Springs, Mount Clere, Mount Vernon, Mulgul, Tangadee, Three Rivers, Turee Creek, Woodlands, and Yarlarweelor.