Mesa H
Riparian Community Assessment

June 2016

Prepared for
Robe River Mining Co. Pty Ltd

astron

Report Reference: 14269-16-BISR-5Rev0_170804

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Revision Status

Rev	Date	Description	Author(s)	Reviewer
A	30/09/2016	Draft Issued for Client Review	D. Roocke J. Trainer J. Atkinson	R. Archibald
B	21/04/2017	Draft Issued for Client Review	D. Roocke J. Trainer J. Atkinson	R. Archibald
0	04/08/2017	Final Issued for Information	D. Roocke J. Trainer J. Atkinson	R. Archibald

Approval

Rev	Date	Issued to	Authorised by	
			Name	**Signature**
A	30/09/2016	P. Royce	S. Pearse	
B	21/04/2017	M. Brand	S. Pearse	
0	04/08/2017	M. Brand	S. Pearse	

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Abbreviations

Abbreviation	Definition
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
Astron	Astron Environmental Services
BAM Act	*Biosecurity and Agriculture Management Act 2007 (*State)
Biota	Biota Environmental Sciences
BOM	Bureau of Meteorology
DAFWA	Department of Agriculture and Food Western Australia (State)
DRF	Declared Rare Flora
EC	Electrical Conductivity
ecologia	ecologia Environment
EPA	Environmental Protection Authority (State)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESA	Environmentally Sensitive Areas
GDA94	Geocentric Datum of Australia 1994
GDE	Groundwater Dependent Ecosystem
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
MGA	Map Grid of Australia
MNES	Matters of National Environmental Significance (under the EPBC Act)
MGA94	Map Grid of Australia 1994
Parks and Wildlife	Department of Parks and Wildlife (State)
P	Priority
PEC	Priority Ecological Community
RNE	Register of the National Estate
sp.	Species (singular)
SRE	Short Range Endemic
The 'survey area'	Riparian Community project area
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
TPFL	Threatened and Priority Flora Database (administered by Parks and Wildlife)
TP List	Threatened and Priority Flora List (administered by Parks and Wildlife)
TV	Trigger Value
UWA	University of Western Australia
WAHerb	Western Australian Herbarium
WC Act	*Wildlife Conservation Act 1950* (State)
WoNS	Weeds of National Significance
WRM	Wetland Research & Management

Executive Summary

Rio Tinto on behalf of Robe River Mining Co. Pty Ltd is evaluating the potential development of the Mesa H deposit located adjacent to the Mesa J Operation. One aspect of the environmental assessment process for the Mesa H development under consideration is water management, as off-site discharge is likely to result in additional water being directed into the Robe River. In anticipation of potential impacts due to increased stream flow, Astron Environmental Services was commissioned to undertake a Level 2 flora and vegetation assessment and Level 1 vertebrate fauna and aquatic fauna assessment in the riparian community survey area which is 2,128 hectares in size.

Five vegetation associations were described within the survey area, none of which represent a Threatened Ecological Community or Priority Ecological Community. The dominant trees in the upper stratum of three vegetation associations represent potentially Groundwater Dependent Ecosystems. Vegetation condition broadly ranged from 'poor' to 'excellent'. Approximately 17 hectares (less than 1%) of the survey area was 'disturbed', the majority of which represented established tracks and rail infrastructure within the survey area. Other disturbances included small pockets of riparian vegetation being burnt within the past 10 years and grazing on alluvial plains and in drainage lines.

There were 124 plant species from 37 families and 82 genera recorded from sampling sites and opportunistically throughout the survey area. The families and genera recorded are typical of what would be expected in riparian vegetation of major drainage lines in the Pilbara. No Threatened taxa were recorded, however three Priority flora species, *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3, *Livistona alfredii* P4 and *Rhynchosia bungarensis* P4, were recorded within the Robe River and its tributaries. There were 23 weed species recorded within the sampling sites and opportunistically. None of the weed species recorded is listed as a declared pest for the Shire of Ashburton or a Weed of National Significance.

Two broad fauna habitat types were recorded in the survey area: Riverine and Drainage Line. The Riverine habitat is considered to be of high importance to fauna species providing a range of ecological values to a wide suite of species. Thirteen permanent pools (approximately 16.4 hectares) were recorded within the survey area in the Riverine habitat. These pools are considered a significant fauna habitat due to the refuge they provide to fish, amphibians and water fowl during dry times and the dense vegetation they support. The Drainage Line habitat is a commonly recorded habitat for the wider Pilbara region and considered to be of low to moderate value to a wide spectrum of fauna species. The survey area contains some of the most significant permanent pools in the area (such as Yeera Bluff) that are significant ecological features to the local fauna both up and downstream. The springs and pools of the Robe River that occur in the survey area are considered wetlands of sub-regional significance (Kendrick 2001).

The database searches and literature review results indicate that 318 vertebrate fauna have been previously recorded within 40 kilometres of the survey area, including six amphibian species, 102 reptile species, 160 bird species and 50 mammal species. Thirty-one terrestrial vertebrate fauna species, comprising two reptiles and 29 bird species were recorded within the survey area. This includes one conservation significant species, the Rainbow Bee-eater, which is listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*.

A total of 28 species of conservation significance, have been previously recorded in the vicinity of the survey area. Of these, six species were considered to have a 'high' likelihood of occurrence: the Pilbara Olive Python (Vu; S3), Rainbow Bee-eater (Mi; S5), Eastern Great Egret (Mi; S5), Northern Quoll (En; S2), Ghost Bat (Vu; S3) and Pilbara Leaf-nosed Bat (Vu; S3).

Based on the number of previous records of the Matter of National Environmental Significance species (Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat), the survey area and its surrounds potentially support locally significant populations. These species may be locally common, but their presence is restricted to areas of preferred habitat. Although the fauna habitats of the survey area do not support the caves and den sites these species shelter in, they do provide quality foraging habitat in close proximity to an abundance of suitable shelter. This feature is an important component to supporting the populations and presence of the Matter of National Environmental Significance species in the survey area and its surrounds.

As part of the aquatic ecosystems survey, 12 pools were sampled along the main channel of the Robe River. Sites included six potentially exposed sites adjacent to the predicted groundwater drawdown cone of depression and within the predicted surface extent of dewatering discharge; and six reference sites upstream of the Jimmawurrada Creek confluence. Water quality was highly variable amongst sites, with salinity levels ranging from fresh (592 µS/cm) to brackish (1,700 µS/cm), pH from circum-neutral (6.9) to slightly alkaline (7.9) and dissolved oxygen from hypoxic (14.5%) to supersaturated (134.9%).

Exceedances of the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand default trigger values for the protection of 95% of species in slightly-moderately disturbed tropical northern Australian systems were recorded for nitrogen nutrients (N-total, N-NO_x & N-NH_3) at most sites upstream (reference sites) and downstream (impact sites) of the Jimmawurrada-Robe confluence. Elevated background levels of N-NO_3 and N-NH_3 within the survey area are unsurprising, given that the Robe River catchment is already affected by current and historic pastoral practices, with groundwaters also appearing to be enriched.

A total of 81 microinvertebrate taxa were recorded from the survey area, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69 were recorded at upstream reference sites. The microinvertebrate fauna was generally typical of that commonly recorded from tropical/sub-tropical freshwater systems, comprising Protista, Rotifera, Copepoda, Cladocera (water fleas) and Ostracoda (seed shrimp), with species from the family Lecanidae dominating within the Rotifera. One microinvertebrate species listed for conservation significance, the copepod *Eodiaptomus lumholtzi* (International Union for Conservation of Nature Vulnerable) was recorded. The conservation listing of this species is considered in need of revision, because it now occurs at numerous locations across the Pilbara region.

A total of 59 taxa were recorded from hyporheic samples, the majority of which were species not specially adapted to groundwater environments (stygoxene). Of these 59 taxa, 8% were considered stygobitic (obligate groundwater inhabitants), 31% occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), and 2% possible hyporheic taxa. Stygobitic taxa collected included the amphipod *Nedsia* sp., the thermosbaenacean *Halosbaena tulki*, and the ostracods *Candonopsis* cf. *tenuis* and *Vestalenula marmonieri*. Of these, *Nedsia* sp. is considered to be a short range endemic species.

A total of 148 macroinvertebrate taxa were recorded from surface waters (117 from upstream reference sites, and 116 from downstream potentially exposed sites), with composition typical of freshwater systems throughout the world, being dominated by Insecta, in particular Diptera (true flies) and Coleoptera (aquatic beetles). One macroinvertebrate species listed for conservation significance, the Pilbara Pin Damselfly *Eurysticta coolawanyah* (International Union for Conservation of Nature: Near Threatened), was recorded at potentially exposed downstream sites.

A total of 3,515 individual fish, representing 11 species, were recorded in the survey area. True freshwater species included Western Rainbowfish, Spangled Perch, Pilbara Tandan (Eel-tailed Catfish), Fortescue Grunter, Barred Grunter, Terapontidae (Grunter) hybrids and Bony Bream. Estuarine/marine vagrant fish species included Milkfish, Tarpon/Ox-eye Herring, Mullet and Banded Scat/Striped Butterfish. The conservation listed Fortescue Grunter (*Leipotherapon aheneus*; International Union for Conservation of Nature Lower Risk/Near Threatened; P4) was the second most abundant fish species of the survey area.

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1 Introduction

1.1 Project Background

Rio Tinto, on behalf of Robe River Mining Co. Pty Ltd (the Proponent), is evaluating the potential development of the Mesa H deposit located adjacent to the Mesa J Operation and approximately 13 km to the south-west of the town of Pannawonica, Western Australia (Figure 1). A key component of the pre-feasibility and feasibility studies being undertaken is the environmental surveys which are required to inform the environmental assessment process for the potential development of the Mesa H deposit.

One aspect of the Mesa H development under consideration is water management involving mine dewatering, off-site discharge and processing/dust suppression water use. Groundwater abstraction has the potential to impact the groundwater levels in the vicinity of the Robe River and off-site discharge is likely to result in additional surplus water being directed into the Robe River. For this reason, biological surveys of the riparian vegetation along the relevant section of the Robe River (and tributaries such as portions of the Jimmawurrada Creek) are required.

Astron Environmental Services (Astron) was commissioned to undertake some of these environmental surveys. This report presents the outcome of a Level 2 vegetation and flora assessment of the Robe River riparian community, and also a Level 1 fauna assessment (Table 1). The survey area is 2,128 ha.

Astron commissioned Wetland Research & Management (WRM) to design and conduct a baseline sampling program encompassing aquatic ecosystems of the Robe River both upstream and downstream of the Mesa H development.

A vegetation and flora survey of previously unsurveyed sections of the Robe River was completed in June 2016. In addition to this, information pertaining to the riparian zone of three separate surveys which overlap the current survey area helped inform the vegetation and flora aspects of this assessment:

- Astron Environmental Services (2016a), '*Middle Robe and East Deepdale Level 2 Vegetation and Flora Assessment'*, unpublished report to Rio Tinto
- Astron Environmental Services (2016b), '*Mesa H Level 2 Vegetation and Flora Assessment'*, report in preparation for Robe River Mining Co. Pty Ltd
- Astron Environmental Services (2016c),'*Mesa H Riparian Vegetation Baseline Monitoring'*, report in preparation for Robe River Mining Co. Pty Ltd.

Table 1: Summary of Astron's Riparian Community Assessment.

Level of survey	Survey area size	Relevant regulatory guidance documents
Level 2 flora and vegetation assessment	2,128 ha	• Environmental Protection Authority (EPA) Position Statement No. 3 (Environmental Protection Authority 2002) • EPA Guidance Statement No. 51 (Environmental Protection Authority 2004a) • EPA & Parks and Wildlife Technical Guide (Environmental Protection Authority and Department of Parks and Wildlife 2015)

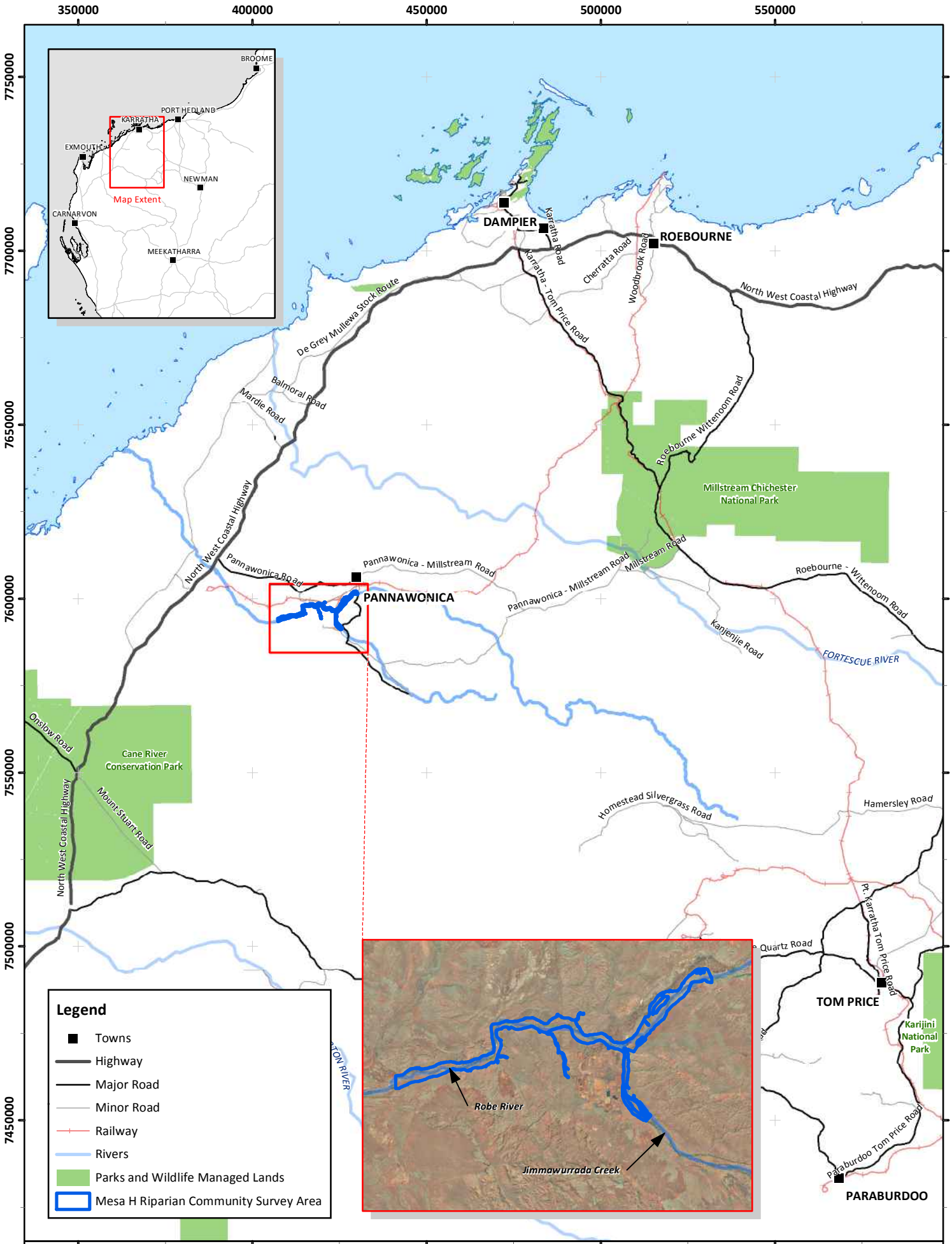
Level of survey	Survey area size	Relevant regulatory guidance documents
Level 1 fauna assessment	2,128 ha	• EPA Guidance Statement No. 56 (Environmental Protection Authority 2004b) • EPA and DEC Technical Guide (Environmental Protection Authority and Department of Environment and Conservation 2010)
Baseline Aquatic Survey	12 sites (6 upstream and 6 downstream of the proposed discharge point)	• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000) • EPA Guidance No. 20, Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (Environmental Protection Authority 2009) • EPA Position Statement No. 3 (Environmental Protection Authority 2002) • EPA Guidance Statement No. 56 (Environmental Protection Authority 2004b)

1.2 Scope and Objectives

The scope of the assessment includes determining the floristic composition and condition of the riparian vegetation, mapping vegetation communities and detailing fauna values along an approximate 28 km section of the Robe River and two of its tributaries. The objectives were to undertake a:

- desktop assessment, including database searches and literature review of available resources.
- vegetation and flora assessment, to include:
  - description of dominant vegetation types (with supporting photographs of each type with location data) including the dominant species and structure
  - the presence or likely presence of Threatened (Declared Rare) and Priority flora, and weeds
  - a list of the vascular plant species recorded within the survey area
- fauna and fauna habitat assessment, to include:
  - habitat assessment and photographs for any significant areas or sites observed that may be suitable for Matters of National Environmental Significance (MNES) species
  - the presence or likely presence of Threatened and Priority fauna
  - opportunistic sightings, species present and their significance
- baseline aquatic assessment, to include:
  - identification of baseline and future riverine monitoring sites, and where possible, inclusion of long-term monitoring sites established previously by Streamtec/the University of Western Australia (UWA)
  - semi-qualitative sampling for aquatic fauna and water quality to allow statistical comparison of any changes overtime
  - qualitative visual assessment of general habitat conditions at all sites

  - identification of all specimens to the lowest taxonomic level practicable
  - assessment of the conservation status of aquatic fauna recorded
  - report water quality data against the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) (2000) guidelines for freshwater ecosystems
  - discussion on the potential impacts of the development on aquatic ecosystems
  - preparation of a detailed technical report of all findings
- preparation of a final report which addresses the tasks outlined above, relevant contextual information, methodology, timing and limitations (WRM report displayed in full in Appendix A).



Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure 1: Survey Area Location

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Author: D. Roocke	Date: 05-04-2017
Drawn: W. An	Figure Ref: 14269-16-BIDR-1RevB_170406_Fig01

Datum: GDA 1994 - Projection: MGA Zone 50

0 10 20 30 40 50 Km

N

2 Environmental Context

2.1 Physical Environment

2.1.1 Climate

The climate of the Pilbara region of Western Australia is classified as arid tropical with two distinct seasons: a hot, wet summer (October – April) and a mild, dry winter (May – September) (Bureau of Meteorology 2016).

Based on long-term climatic data from the nearest Bureau of Meteorology (BOM) weather station at Pannawonica (Station 5069) (approximately 13 km north-east of the survey area), the mean annual rainfall since 1971 is 404 mm (Bureau of Meteorology 2016). The mean maximum daily temperatures range between 26.7°C and 41°C, and range above 30°C for much of the year (Figure 2) (Bureau of Meteorology 2016).

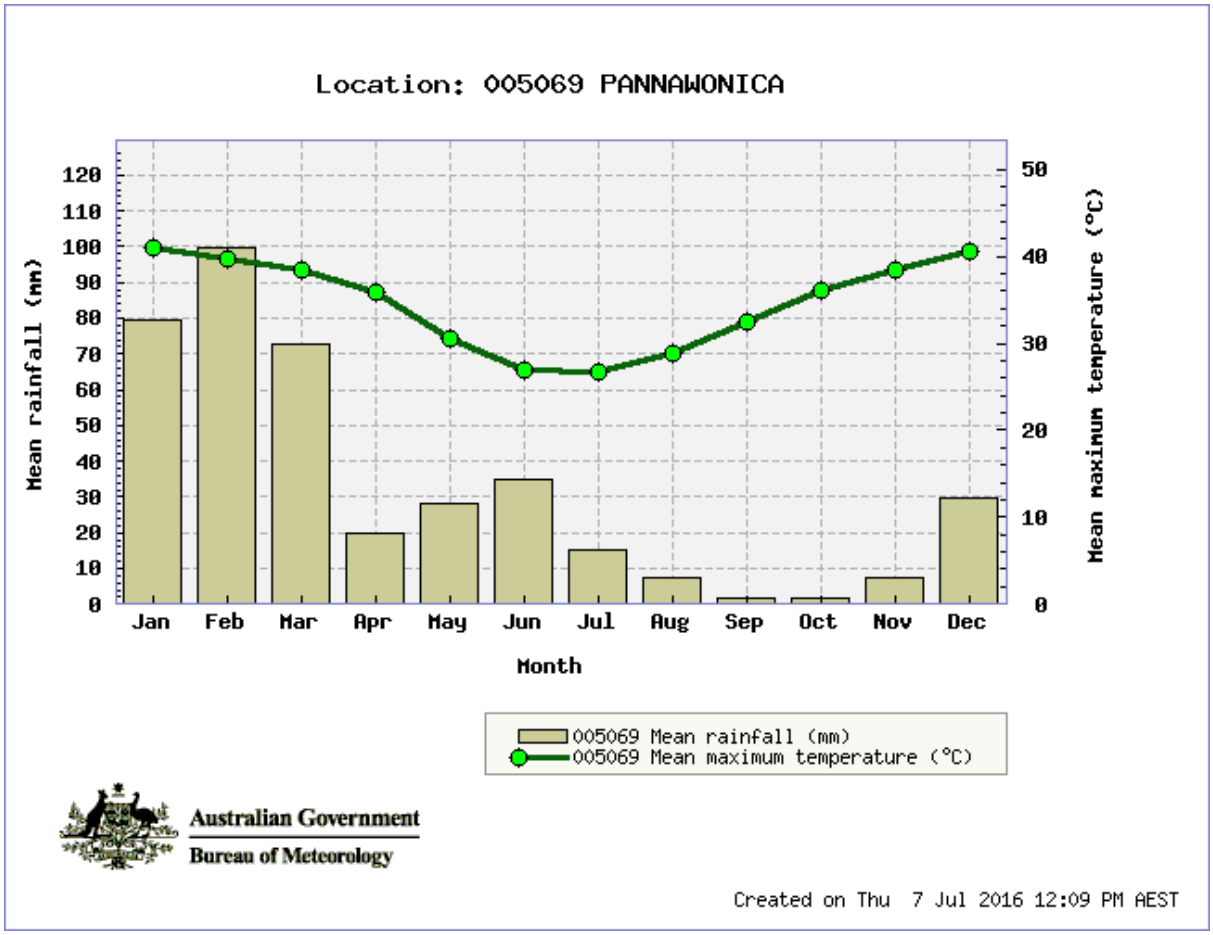

Figure 2: Climate data for Pannawonica (Station 5069). Mean annual rainfall data calculated from 1971-2016 and mean maximum temperature (calculated from 1971-2005) (Bureau of Meteorology 2016).

2.1.2 Geology and Soils

The survey area occurs on the Hamersley Basin which overlies the Archaean Pilbara Craton and comprises of mafic and felsic volcanics, shale, siltstone, sandstone and conglomerate, as well as dolomite and banded iron formation. The basin is extensively deformed from numerous tectonic events, resulting in extensive folding and faulting through the geological formations (van Vreeswyk

et al. 2004). The surface geology of the survey area is comprised of seven units (Stewart et al. 2008) as presented in Table 2. Geological mapping of the survey area and surrounds is presented in Figure B.1 (Appendix B).

Table 2: Geological units of the survey area.

Geological name	Label	Area within survey area (ha)
Marra Mamba Iron Formation: chert, ferruginous chert, jaspilite, banded iron formation, minor shale, siltstone, mudstone	Achm	184.9
Mount McRae Shale and Mount Sylvia Formation: interbedded shale, chert, banded iron-formation	Ashm	1.4
Jeerinah Iron Formation: shale, sandstone, siltstone, mudstone, dolomite, local microbanded chert, jaspilite, conglomerate; fine-grained massive rhyolite; mafic tuff with local accretionary lapilli and agglomerate; thin basalt/dolerite and andesitic basalt flows	Awfj	51.2
Robe Pisolite: pisolitic, oolitic and massive limonite, goethite and hematite deposits containing fossil wood fragments; iron ore	Czlr	107.2
Boolgeeda Iron Formation: fine-grained, finely laminated, dark-grey-brown to black flaggy iron-formation, minor chert, jaspilite, shale	Lchb	3.1
Woongarra Rhyolite: rhyolite, rhyodacite, rhyolitic volcaniclastic breccia and banded iron formation	Lfhw	40.5
Alluvium 38485: channel and flood plain alluvium; gravel, sand, silt, clay, locally calcreted	Qa	1730.3
Colluvium 38491: colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite	Qrc	9.3

The survey area is mapped as soil landscape zone 285 – Hamersley Plateaux in the Fortescue Province (Tille 2006). This soil unit is described as hills and dissected plateaux with some stony plains and hardpan wash plains on volcanic and sedimentary rocks. It is comprised predominately of stony soils with red shallow loams and some red-brown non-cracking clays and red loamy earths (Tille 2006). Some drainage habitats occur and these are characterised by sand, gravel, pebbles and stones (van Vreeswyk et al. 2004).

2.1.3 Surface Water and Hydrology

The Robe River is considered a seasonal watercourse and flows in an east-west orientation. A number of permanent pools in the river were observed within the survey area and have been previously reported in Kendrick (2001) as wetlands of subregional significance. Numerous creeks and smaller drainage lines stem from the main flow line. There are no regionally significant wetlands in proximity. A section of the survey area, represented as the northern extent of Jimmawurrada Creek, is within a Public Drinking Water Source Area, the Bungaroo Water Reserve (Department of Water 2008).

2.2 Biological Environment

2.2.1 Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation for Australia (IBRA version 7) divides the Australian continent into 89 bioregions and 419 subregions (Department of the Environment and Energy 2016a). The IBRA regions represent a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. The survey area occurs in the Pilbara Bioregion, of which 5% to 10% is represented in the national reserve system (Department of the Environment and Energy 2016b).

The biodiversity of the 53 subregions recognised in Western Australia was documented as part of a national audit to provide priorities for conservation action (Department of Conservation and Land Management 2002). The survey area occurs in two subregions, the Chichester and Hamersley subregions of the Pilbara region. The subregions are described in the audit as:

- Chichester PIL1 – undulating Archean granite and basalt plains include significant areas of basaltic ranges and plains support shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, and ranges comprise of *Eucalyptus leucophloia* tree steppes (Kendrick and McKenzie 2001). This subregion represents approximately 1% of the survey area.
- Hamersley PIL3 – dissected bold plateaux and ranges of flat lying of moderately folded sandstone and quartzite with vegetation described as Mulga low woodland over tussock grasses occurring on fine textured soils in valley floors, with scattered Snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001). This subregion represents 99% of the survey area.

2.2.2 Land Systems

Land systems of the Western Australian rangelands have been mapped and described by the Department of Agriculture and Food (DAFWA) outlining the distributions and providing comprehensive descriptions of biophysical resources, including soil and vegetation condition. A total of 102 land systems occur in the Pilbara bioregion covering 181,723 km^2, of which six occur in the survey area (Table 3). The layout of these land systems within the survey area is shown in Figure B.2 (Appendix B).

Table 3: Distribution of land systems within the survey area and Pilbara bioregion (van Vreeswyk et al. 2004).

Land system	Total area within Pilbara bioregion (ha)	Total area within survey area (ha)	Proportion within survey area (%)
Boolgeeda - stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands	961,847	0.04	<0.1
McKay - hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands	425,967	1.79	<0.1
Newman - rugged jaspilite plateaux, ridges and mountains with hard spinifex	1,994,339	38.30	<0.1
River - active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands	481,994	1859.92	<0.1
Robe - low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands	128,680	169.02	<0.1
Urandy - stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands	132,039	58.82	<0.1
TOTAL	**4,124,866**	**2,127.89**	<0.1

2.2.3 Pre-European Vegetation

Pre-European vegetation was mapped across the Pilbara region at a scale of 1: 1,000,000 (Beard 1975). The survey area is located in the Stuart Hills, Chichester Plateau and Hamersley Plateau physiographic units of the Fortescue Botanical District (Figure B.3, Appendix B). These physiographic units are described as:

Hamersley: a compact unit defined by the outcropping of jaspilite and dolomite, with some shale, siltstone and volcanics. Vegetation is described as:

- ranges – tree steppe of *Eucalyptus brevifolia* (likely to represent *E. leucophloia*) over *Triodia wiseana* hummock grasslands
- valley plains – mulga (*Acacia aneura* complex) low woodlands, or tussock grasslands on cracking clay soils
- basalt hills – mosaic of mulga low woodland and *Acacia pyrifolia* and *Triodia* species shrub steppe.

Chichester Plateau: this very long narrow unit forms a watershed between numerous rivers flowing north to the coast and the Fortescue drainage on the southern side. It is bounded for most of its northern length and at its western end by abrupt escarpments rising from the coastal plains, but the decent to the Fortescue is much less abrupt and more gradual. Vegetation is described as:

- high plains – *Acacia pyrifolia* - *Triodia* shrub steppe on hard alkaline red soils, changing to grass savannah on clay soils in the lower portions.

Stuart Hills: this unit consists mostly of plains, gently undulating pediplains extending out from Breakaways and residuals capped by Robe pisolites, and stony hills and steeply dissected pediments on fine-grained sandstone, shale and dolomite. Vegetation is described as:

- hills and plains – *Triodia wiseana* and *T. basedowii* hummock grasslands with sparse shrubs, particularly *Acacia bivenosa*
- drainage lines – *Corymbia hamersleyana* and *C. candida* occur occasionally, with *Senna* species and ephemerals
- major rivers – *Eucalyptus camaldulensis* and *Acacia citrinoviridis* along river and mulga low woodland on river flats and tributaries.

Six pre-European vegetation units, 82, 173, 603, 605, 609, 620 (Shepherd, Beeston, and Hopkins 2002), are associated with the survey area:

82: 'Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*',

173: 'Hummock grasslands, shrub steppe; kanji over soft spinifex and *Triodia wiseana* on basalt',

603: 'Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* over hard spinifex',

605: 'Hummock grasslands, shrub steppe; *Acacia pachycarpa* and waterwood over soft spinifex'

609: 'Mosaic: Hummock grasslands, open low tree steppe; bloodwood with sparse kanji shrubs over soft spinifex/Hummock grasslands, open low tree steppe; snappy gum over *Triodia wiseana* on a lateritic crust'

620: 'Hummock grasslands, shrub steppe; snakewood over soft spinifex'.

Table 4 summarises the current and pre-European extent of these six vegetation units in the Pilbara and the survey area.

Table 4: Extent of pre-European vegetation in the survey area (Government of Western Australia 2014).

Vegetation association	Mapping unit (Beard 1975)	Extent in survey area (ha)	Current extent in Pilbara bioregion (ha)	Pre-European extent (ha)	Proportion of pre-European extent remaining (%)
82	e16Lr t3Hi	402.6	2,550,899.0	2,563,583.2	99.5
173	a2Sr t1, 3Hi	81.4	1,747,677.6	1,752,420.9	99.7
603	a6Sb t3Hi	282.2	55,764.0	56,726.9	98.3
605	a5,11Sr t1Hi	259.3	114,115.9	114,115.9	100.0
609	e24Lr a2Sp t1Hi /e16Lr t3Hi	765.4	72,765.2	74,186.1	98.1
620	a11Sr t1Hi	337.0	15,539.4	15,539.4	100.0

2.3 State and Commonwealth Conservation Categories and Management

Commonwealth and State regulatory authorities maintain databases of the locations and conservation status of significant flora, fauna and ecological communities in Western Australia. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage MNES including listed flora, fauna and ecological communities.

These listed flora, fauna and ecological communities are allocated conservation categories, which are outlined in Tables C.1 and C.2 (Appendix C).

Ecological communities may be subject to processes that threaten to destroy or significantly modify it across much of its range. These communities are identified as Threatened Ecological Communities (TECs) and are listed at both Commonwealth level under the EPBC Act and State level by the Western Australian Minister for Environment (Table C.3, Appendix C). The Department of Parks and Wildlife (Parks and Wildlife) maintains a list of Priority Ecological Communities (PECs), which may also be under threat and are assigned one of four Priority rankings according to the criteria outlined in Table C.4 (Appendix C).

Under Western Australian legislation, all native flora is protected and it is an offence to 'take' protected flora. The *Wildlife Conservation Act 1950* (WC Act) also provides for native plant species to be specially protected when they are under identifiable threat of extinction, are rare, or otherwise in need of special protection (Department of Parks and Wildlife 2015a). Such specially protected flora is considered under the WC Act to be 'declared rare' (Threatened) (Table C.5, Appendix C). In addition, due to the diversity of Western Australia's flora, many species are known from only a few collections or locations, but have not been adequately surveyed. Such flora may be rare or threatened, but cannot be considered for declaration as Threatened flora until adequate surveys have been undertaken. These flora species are included on a supplementary conservation list managed by Parks and Wildlife called the *Priority Flora List*. Priority flora are categorised according to level of threat and other information and the conservation categories are described in Table C.6 (Appendix C).

Groundwater Dependent Ecosystems (GDEs) are often a focus of conditions applied through a Ministerial Statement. GDEs in the Pilbara play an important ecological role by providing essential habitat for species and a haven for biological diversity and productivity in an otherwise harsh, dry climate. Therefore, the vegetation comprised within GDEs may be considered locally significant.

2.4 Introduced Flora (Weeds)

Significant weed species are identified at both the state and national level. The Australian Weeds Strategy (Australian Weeds Committee 2012) identifies Weeds of National Significance (WoNS) which have the potential to impact primary industry and/or environmental and social values. The management of weeds in Western Australia is primarily regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Species listed under this act are allocated one of three declared pest categories which define the required level of management (Department of Agriculture and Food Western Australia 2016). Declared pest categories and listed weed species' priority ratings are presented in Table C.7 (Appendix C).

2.5 Land Use and Tenure

The survey area is located within the Shire of Ashburton, and is on two pastoral leases; Yalleen Station and Yarraloola Station. The local area is used for pastoralism, mineral exploration and mining activity.

The Millstream-Chichester National Park is the nearest conservation reserve to the survey area, located approximately 79 km to the north-east. The Cane River Conservation Park is located approximately 48 km to the south-west, Murujuga National Park is approximately 120 km north and Karijini National Park is approximately 180 km south-east of the survey area (refer to Figure 1).

3 Methodology

3.1 Desktop Assessment

3.1.1 Database Searches

A search for Environmentally Sensitive Areas (ESAs) in the vicinity of the survey area was conducted using the WA Atlas (Landgate 2016) and Register of the National Estate (RNE) spatial database (Department of the Environment and Energy 2008). Despite all references to the RNE being removed from Commonwealth legislation in 2012, current State regulations (*Environmental Protection (Clearing of Native Vegetation) Regulations 2004*) declare any area registered on the RNE as an ESA (Department of the Environment and Energy 2016c).

In addition, database searches were conducted to identify listed conservation significant ecological communities, and flora and fauna species within, or in close proximity to, the survey area. Search results are presented in Appendix D and details are summarised in Table 5. Conservation categories for ecological communities and flora are presented in Appendix C. Introduced flora species were compared to the DAFWA list to determine if any have been listed as declared pests (Department of Agriculture and Food Western Australia 2016) and the WoNS list (Australian Weeds Committee 2012). Introduced flora categories are also presented in Appendix C.

Table 5: Database searches requested.

Database name	Date search results received	Search focus	Search area
Vegetation & Flora			
Protected Matters Search Tool (Department of the Environment and Energy 2016d)	25/07/2016	Matters of National Environmental Significance flora	50 km radius from the approximate Mesa H Level 2 Vegetation and Flora (Astron Environmental Services 2016b) survey area centre point, defined by the coordinates: 21°44'11 S, 116°11'50 E
Threatened and Priority Ecological Communities database (Department of Parks and Wildlife 2015b)	05/10/2015	Listed Threatened and Priority Ecological Communities	20 km radius surrounding the Mesa H Level 2 Vegetation and Flora (Astron Environmental Services 2016b) survey area boundary (shapefiles provided)
Threatened and Priority Flora Database (TPFL) (Department of Parks and Wildlife 2015c)	29/09/2015	Threatened and Priority flora	20 km radius surrounding the Mesa H Level 2 Vegetation and Flora (Astron Environmental Services 2016b) survey area boundary (shapefiles provided)
Threatened and Priority Flora Species List (TP list) (Department of Parks and Wildlife 2015d)			
Western Australian Herbarium flora (Department of Parks and Wildlife 2015e)			

Database name	Date search results received	Search focus	Search area
NatureMap (Department of Parks and Wildlife 2016a)	25/07/2016	Terrestrial flora of conservation significance	40 km radius from the approximate Mesa H Level 2 Vegetation and Flora (Astron Environmental Services 2016b) survey area centre point, defined by the coordinates: 21°44'11 S, 116°11'50 E
Terrestrial Fauna			
NatureMap (Department of Parks and Wildlife 2015f)	22/09/2015	Terrestrial fauna and fauna of conservation significance	40 km radius from the approximate Mesa H Level 2 Fauna (Astron Environmental Services 2016d) survey area centre point, defined by the coordinates: 21°44'47 S, 116°12'02 E
Threatened and Priority Fauna Database (Department of Parks and Wildlife 2015g)	30/09/2015	Threatened and Priority fauna species	20 km radius from the approximate Mesa H Level 2 Fauna (Astron Environmental Services 2016d) survey area centre point defined by the coordinates: -21.738899, 116.205782 (MGA50, GDA94)
Protected Matters Search Tool (Department of the Environment 2015)	21/09/2015	Threatened and Priority fauna species	40 km buffer from the approximate Mesa H Level 2 Fauna (Astron Environmental Services 2016d) survey area centre point defined by the coordinates: -21.738899, 116.205782 (MGA50, GDA94)
BirdLife Australia (Birdlife Australia 2015)	30/09/2015	Bird species	1 degree from the approximate Mesa H Level 2 Fauna (Astron Environmental Services 2016d) survey area centre point defined by the coordinates: -21.74617, 116.20118 (MGA50, GDA94)

3.1.2 Vegetation and Flora

The 30 PECs listed by Parks and Wildlife for the Pilbara region (Department of Parks and Wildlife 2016b) were reviewed to determine if any were analogous with ecological communities recorded in the survey area.

Prior to conducting the field surveys, aerial imagery was interpreted to identify potential habitat types. The conservation significant flora species returned from the database searches were then categorised according to the criteria in Table 6 for potential occurrence within the survey area.

Table 6: Pre-survey criteria used to assess the likely presence of conservation significant flora in the survey area.

Likelihood of occurrence	Pre-survey
Likely	Species previously recorded within the survey area or within 10 km of the survey area and suitable habitat appears to be present in the survey area
Potential	Species previously recorded within 10 km to 20 km of the survey area and/or suitable habitat appears to be present in the survey area
Unlikely	No suitable habitat appears to be present in the survey area

Following the field surveys, the conservation significant flora species identified during the desktop assessment as having the highest potential to occur within the survey area, yet were not recorded during the current survey, were again assessed to determine their likelihood of occurrence within the survey area. Post-field survey likelihood of occurrence was primarily based on validating the presence (and thorough inspection) of suitable habitats within the survey area, combined with life form, habitat and flowering information for each flora species.

3.1.3 Literature Review

3.1.3.1 Vegetation and Flora

Vegetation and flora surveys which have recently been commissioned by Rio Tinto and that are within the vicinity of the survey area are presented in Figure E.1 (Appendix E). The data and results from three reports have also been incorporated into this assessment:

- Middle Robe and East Deepdale Level 2 Vegetation and Flora Assessment (ecologia Environment 2013)
- Mesa H Level 2 Vegetation and Flora Assessment (Astron Environmental Services 2016b)
- Mesa H Riparian Vegetation Baseline Monitoring (Astron Environmental Services 2016c).

A further five surveys previously commissioned by Rio Tinto between 2003 and 2012 provided contextual information appropriate for this riparian survey area, and were supplied to Astron and reviewed as part of the desktop assessment:

- Mesa J Tail Track Extension Vegetation, Flora and Fauna Survey (Astron Environmental Services 2011)
- Mesa J Extension Vegetation, Flora and Fauna Assessment (Biota Environmental Sciences 2003)
- A Vegetation and Flora Survey of the Proposed Mesa A Transport Corridor, Warramboo Deposit and Yarraloola Borefield (Biota Environmental Sciences 2006a)
- Baseline Flora and Vegetation Assessment of Robe Valley Mesas (Mesas B, C, D, E, F, H and I) (Biota Environmental Sciences 2011a)
- Greater Bungaroo Flora and Vegetation Survey (Biota Environmental Sciences 2012).

Ecologia (2013) presents Phase 1 vegetation and flora data for Astron (2016a) and does not contain the final results for that survey, therefore was not considered in this assessment to avoid duplication of information. Additional vegetation and flora surveys have previously been commissioned by Rio

Tinto within the vicinity of the survey area, however did not contain landforms and vegetation analogous to riparian communities, therefore were not used for contextual information.

3.1.3.2 Terrestrial Fauna

Terrestrial fauna surveys have previously been commissioned by Rio Tinto within the vicinity of the survey area and supplied to Astron for the desktop assessment. The reports reviewed as part of the fauna aspects of this assessment include:

- Mesa J Tail Track Extension Vegetation, Flora and Fauna Survey (Astron Environmental Services 2011)
- Mesa H Level 1 Flora, Vegetation and Fauna Assessment (Astron Environmental Services 2014)
- Mesa H Level 2 Fauna Assessment (Astron Environmental Services 2016d)
- Bungaroo Iron Ore Mine and Infrastructure Project, Level 2 Fauna Survey (Astron Environmental Services 2016e)
- Middle Robe and East Deepdale Level 2 Fauna Assessment (Astron Environmental Services 2016f)
- Yarraloola Targeted Fauna Survey (Biologic Environmental Survey 2014)
- Fauna Habitats and Fauna Assemblage of Mesa A and Mesa G (Biota Environmental Sciences 2005)
- Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo (Biota Environmental Sciences 2006b)
- Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonica (Biota Environmental Sciences 2007)
- Mesa G Baseline Fauna Survey (Biota Environmental Sciences 2009)
- Greater Bungaroo Seasonal Fauna Survey (Biota Environmental Sciences 2010a)
- Robe Valley Mesas Fauna Survey (Biota Environmental Sciences 2011b)
- Middle Robe and East Deepdale Flora, Vegetation, Vertebrate and Invertebrate Fauna Survey (ecologia Environment 2013).

3.1.3.3 Aquatic Ecosystems

Numerous aquatic ecological surveys have been undertaken within the vicinity of the survey area and were used for the desktop assessment. A more comprehensive description of the aquatic surveys and studies are provided in Appendix A. The reports reviewed as part of the aquatic aspects of this assessment include:

- Streamtec/UWA, annual sampling of Robe River pools (Dobbs and Davies 2009; Streamtec 1996-2014)
- Pilbara Biological Survey: An arid zone awash with diversity: patterns in the distribution of aquatic invertebrates in the Pilbara region of Western Australia (Pinder et al. 2010)
- Fish fauna of the inland waters of the Pilbara (Morgan and Gill 2004)
- API Aquila: Baseline Aquatic Ecosystem Surveys (Wetland Research & Management 2009)

- HD1: Pilbara Regional Aquatic Surveys Wet & Dry 2011 Sampling (Wetland Research & Management 2013)
- HD1: Pilbara Regional Aquatic Surveys Wet & Dry 2015 Sampling (Wetland Research & Management 2016)
- Mesa A/Warramboo Yarraloola Borefield Development: Baseline Stygofauna Assessment (Biota Environmental Sciences 2006c)
- West Pilbara Iron Ore Project Stygofauna Assessment (Biota Environmental Sciences 2010b)
- Bungaroo South: Subterranean Fauna Assessment (Bennelongia Environmental Consultants 2013)
- Exploring the relationship between sampling efficiency and short-range endemism for groundwater fauna in the Pilbara region, Western Australia (Eberhard et al. 2009)
- Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity (Halse et al. 2014).

3.2 Field Survey

The flora field survey was undertaken concurrently with the riparian monitoring survey from 26 May to 7 June 2016 (Astron Environmental Services 2016c). Six other field surveys have also assessed parts of the survey area (Table 7). Applicable data from all seven field surveys has been included to inform the riparian community vegetation and flora assessment. The Level 1 fauna survey was undertaken on 8 May 2016. Habitat assessment data and mapping from the Mesa H fauna survey and Middle Robe and East Deepdale fauna survey (Astron Environmental Services 2016d, 2016f) were used for areas that overlapped with the current survey area. The baseline aquatic ecosystem survey was completed between 28 April and 7 May 2016. The scientists and the dates of the surveys are listed in Table 7.

Table 7: Field survey timing and personnel.

Component	Survey dates	Field personnel
Middle Robe and East Deepdale Level 2 Vegetation and Flora Assessment – Phase 1	15 to 27 June 2015	Janelle Atkinson (Flora permit SL011215; Declared Rare Flora (DRF) 141-1415) Daniel Roocke (Flora permit SL011212; DRF 142-1415) Dr Kellie McMaster (Flora permit SL011404) Linda Vaughan (Flora permit SL011214)
Middle Robe and East Deepdale Level 2 Vegetation and Flora Assessment – Phase 2	21 September to 3 October 2015	Janelle Atkinson (Flora permit SL011215; DRF 141-1415 Daniel Roocke (Flora permit SL011212; DRF 142-1415)
Mesa H Level 2 Vegetation and Flora Assessment – Phase 1	23 to 30 October 2014	Janelle Atkinson (Flora permit SL010911; DRF 107-1516) Daniel Roocke (Flora permit SL010827; DRF 139-1314) Alice Bott (Flora permit SL011640); DRF 140-1314)
	24 September to 4 October 2015	Natalie Cadd (Flora permit SL011621; DRF 170-1415) Dr Kellie McMaster (Flora permit SL011404)
Mesa H Level 2 Vegetation and Flora Assessment – Phase 2	27 April to 14 May 2016	Janelle Atkinson (Flora permit SL011617, DRF 141-1415) Daniel Roocke (Flora permit SL011627, DRF 131-1516) Linda Vaughan (Flora permit SL011631) Dr Kellie McMaster (Flora permit SL011810)

Component	Survey dates	Field personnel
	19 to 22 July 2016	Janelle Atkinson (Flora permit SL011617), DRF 141-1415 Daniel Roocke (Flora permit SL011627), DRF 131-1516
Level 2 Riparian Community Vegetation and Flora Survey	26 May to 7 June 2016	Janelle Atkinson (Flora permit SL011617; DRF107-1415) Daniel Roocke (Flora permit SL011627; DRF 131-1516)
Middle Robe and East Deepdale – Level 2 Fauna Assessment	15 to 28 June 2015	Matthew Love Matthew Johnston Ray Lloyd Frances Leng
	17 to 27 August 2015	Matthew Love Matthew Johnston Ray Lloyd John Trainer
Mesa H Level 2 Fauna Assessment	24 September to 3 October 2015	Matthew Johnston John Trainer
	27 April to 9 May 2016	Matthew Love John Trainer
Level 1 Riparian Community Fauna Survey	8 May 2016	Matthew Love John Trainer
Mesa H Baseline Aquatic Ecosystem Survey	28 April to 7 May 2016	Adam Harman Emma Thillainath Fintan Angel

3.2.1 Weather

Daily weather observations recorded from Mesa J were used to describe local rainfall and temperatures preceding the surveys (Figure 3). Rainfall in the second half of 2015 was 28% below average with 45 mm recorded for the 6 month period. Above average rain was recorded in January 2016, although only 30 mm was recorded from February to March compared to the mean of 192 mm for the corresponding period. The months of May, June and July 2016 recorded above average rainfall with a total of 137 mm, which is 60 mm more than the long term mean. The mean maximum temperatures between May 2015 and July 2016 were generally slightly higher than the long-term averages, ranging between 27.0°C and 43.1°C (Figure 3).

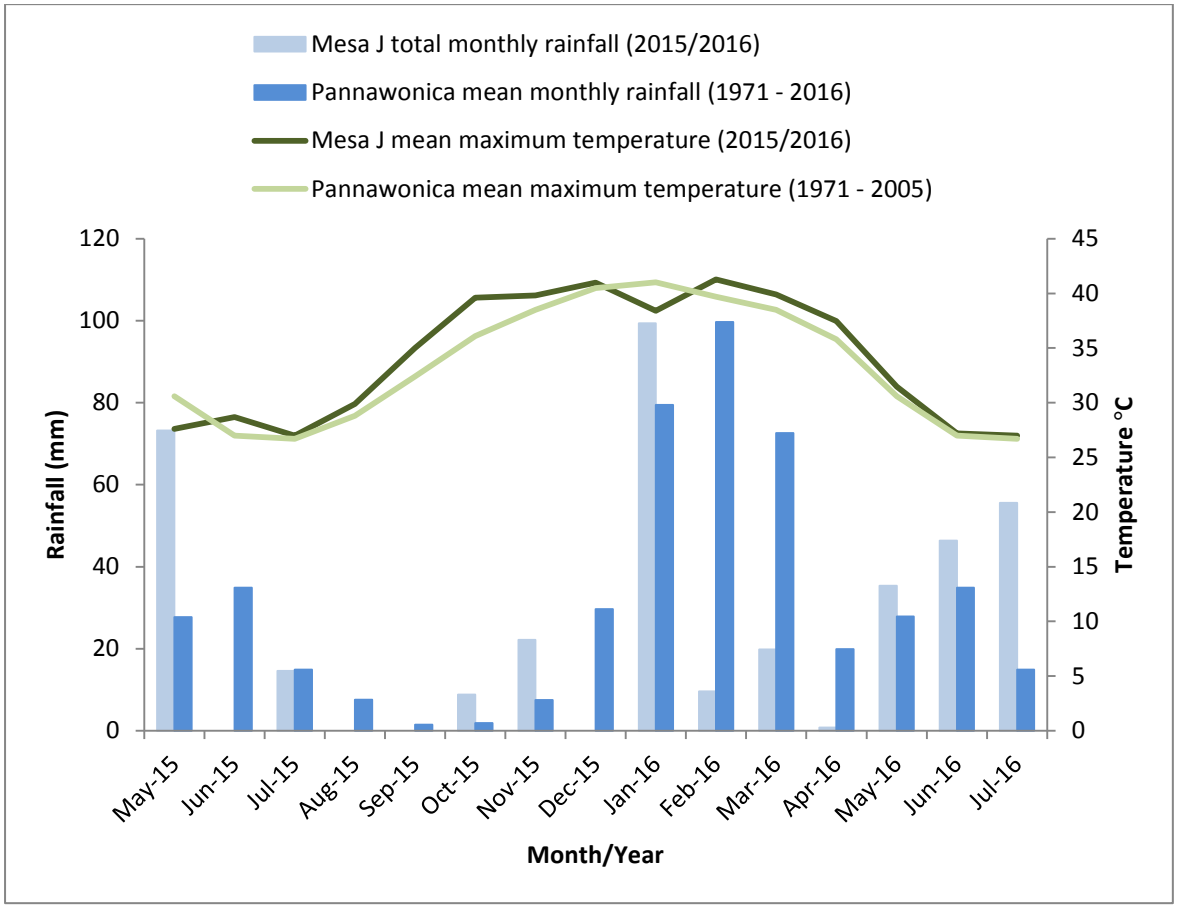

Figure 3: Pannawonica mean monthly rainfall (1971 – 2016) and Mesa J total recorded rainfall (2015 - 2016), and Pannawonica mean monthly maximum temperatures (1971 – 2005) and Mesa J mean monthly maximum temperatures from May 2015 to July 2016. Mesa J data provided by Rio Tinto (2016a). Pannawonica data from Bureau of Meteorology (2016).

3.2.2 Vegetation and Flora Assessment

The vegetation and flora field surveys were undertaken in accordance with the requirements outlined in the Environmental Protection Authority (EPA) (Environmental Protection Authority 2002, 2004a; Environmental Protection Authority and Department of Parks and Wildlife 2015) and Rio Tinto policy and guidance documents.

Information acquired during the desktop assessment assisted in the design of the field surveys. Pre-survey planning involved the examination of 1:10,000 scale aerial photography to identify potential landforms, habitat and vegetation types. It also involved a review of the flora and vegetation assessments previously completed within the Robe River and adjacent to Mesa H for context and to identify data gaps. Proposed quadrat locations were identified prior to the field surveys according to the replicates supporting previous vegetation mapping (Astron Environmental Services 2016a, 2016c).

Data from 28 current and previous sampling sites, representing 27 quadrats and one relevé, was collected (Table 8). Four quadrats were previously sampled as part of the Middle Robe and East Deepdale study (Astron Environmental Services 2016a). Sixteen sampling sites had a single season of survey only. Vegetation associations were aligned with those described in the Mesa H Level 2 Vegetation and Flora Assessment (Astron Environmental Services 2016b).

Table 8: Survey effort for existing and newly installed quadrats and relevés occurring within the survey area.

Author; project; phase of survey	Number of sites	Name of sites
Astron Riparian Community Assessment (current survey) 1 phase	7 quadrats	MH379, MH381, MH384, MH385, MH387, MH388, MH389
Astron Mesa H Level 2 Flora and Vegetation Survey (Astron Environmental Services 2016b) 2 phase	7 quadrats 1 relevé	MH43, MH44, MH203, MH204, MH303, MH321, MH332, MH337r
Astron Mesa H Level 2 Flora and Vegetation Survey (Astron Environmental Services 2016b) 1 phase	9 quadrats	MH354, MH363, MH373, MH392, MH393, MH394, MH397, MH398, MH401
ecologia (2013)and Astron Middle Robe and East Deepdale (2016a) 2 phase	3 quadrats	E07, E09, E20
Astron Middle Robe and East Deepdale (2016a) 1 phase	1 quadrat	AM215

Quadrats were positioned by measuring a square of 50 m by 50 m in suitable terrain, or dimensions measuring 2,500 m^2 where necessary. The four corners of the quadrats were permanently marked with fence droppers and the following information was collected at each quadrat:

- Location – coordinates measured using a handheld GPS (MGA50, GDA94).
- Recorder and date – personnel involved in sampling that location and the survey date.
- Species – representative vascular plant species present. The inventory of associated species was more comprehensive for a quadrat location, with each flora species present recorded; at relevés the species most typical of the vegetation unit and represented at that location were recorded. Species that could not be identified in the field were collected for later identification at the Astron herbarium or Western Australian Herbarium (WAHerb).
- Weeds – the coordinates and density of any introduced flora.
- Foliar cover – the percentage cover was estimated for each flora species.
- Vegetation description – vegetation was described according to the Aplin (1979) modification of the vegetation classification system of Specht (1970) (Table F.1, Appendix F) and the National Vegetation Information System, level 5 (Department of the Environment and Energy 2016e). At this level, vegetation is described to 'association' where up to three dominant genera for each of the upper, middle and ground strata are categorised based on dominant growth form, cover and height.
- Vegetation condition – assessed according to the vegetation condition classification adapted from Trudgen (1988) (Table F.2, Appendix F).
- Habitat – a broad description of the surrounding landscape based on landform, topography and soil.
- Photographs – a representative photograph was taken of each quadrat.
- Disturbances – records of any obvious disturbances such as fire, tracks or grazing.
- Geology – rock type and abundance.
- Soil – including colour and texture.

Quadrat and relevé locations are presented in Figure G.1 (Appendix G).

3.2.3 Vegetation Description and Mapping

Vegetation was described and mapped to be consistent with the descriptions and mapping previously conducted in and adjacent to the survey area (Astron Environmental Services 2016c). Results from the sections of riparian landform within the survey area that had already undergone assessment were incorporated into the data. Vegetation units were described and mapped using the data collected from quadrats, and followed the same convention as that previously used; the vegetation association code is described according to the initials of the dominant flora species defining the community.

3.2.3.1 Vegetation Condition Mapping

Vegetation condition was mapped according to vegetation association boundaries throughout the survey area, using a combination of quadrat data, opportunistic observations and the mean condition rating for each vegetation association. Vegetation condition was rated at each survey site using the five point Trudgen (1988) scale, and then applied to the whole vegetation association polygon in which it was mapped. A mean condition rating was calculated for each vegetation association using the data collected from survey sites and this was applied to any polygons not already attributed with a rating.

3.2.4 Targeted Flora Survey

Previously recorded conservation significant flora records (Astron Environmental Services 2016a, 2016b; Biota Environmental Sciences 2003, 2006a, 2011a; Department of Parks and Wildlife 2015c, 2015d, 2015e) and associated habitat preference information were used to identify vegetation associations and habitat within the survey area that have the potential to support conservation significant flora. The habitats and vegetation associations considered to have the potential to support conservation significant flora were located within the survey area from 1:10,000 colour aerial imagery and on-ground observations.

Population information for conservation significant flora was captured electronically using ArcPad (Esri) on a handheld device. The information recorded included population size, density, landform, soil and reproductive characteristics.

3.2.5 Terrestrial Fauna

3.2.5.1 Habitat Assessment

Data from 10 current and previous fauna habitat assessments located in the survey area were collected. Seven habitat assessments were previously sampled as part of the Mesa H fauna study (Astron Environmental Services 2016d) and one habitat assessment was previously sampled as part of the Middle Robe and East Deepdale fauna study (Astron Environmental Services 2016f) (Table H.1, Appendix H). The locations are shown in Figure H.1 (Appendix H) and the following information was collected at each site:

- Location – coordinates measured using a handheld GPS (GDA94).
- Recorder and date – personnel involved in undertaking the fauna habitat assessment and the survey date.
- Habitat/landform – position in the landscape - major fauna habitat types were described based on the landform and vegetation.
- Vegetation type – a broad description of vegetation type and structure.

- Soils – a brief description of soil type.
- Microhabitat – presence of specific microhabitat features, e.g. leaf litter, logs, burrows, rocky outcrops, rock crevices, hollows, permanent or semi-permanent water.
- Condition – habitat condition was assessed based on the presence of anthropogenic (human-induced) disturbances, and using the condition ratings suggested by Thompson and Thompson (2010) (Table F.3, Appendix F).
- Disturbance – any disturbance such as clearing, fire, weeds, flooding, vehicular, machinery, tracks or grazing.
- Photographs – a representative photograph was taken of each habitat assessment site.

The information derived from the fauna habitat assessments was used to delineate fauna habitats throughout the survey area, which were then mapped accordingly. In sections of the survey area that overlap with other recent fauna surveys the data from fauna habitat assessments and the fauna habitat mapping was used to ensure consistency between projects.

3.2.5.2 Active Foraging

Active searches were undertaken throughout the survey area in microhabitats suitable for ground-dwelling reptiles and mammals. Active searches included the following:

- searching and recording scats, tracks and other traces
- turning over rocks and logs and peeling off bark
- raking soil and leaf litter
- searching around water bodies.

3.2.6 Aquatic Ecosystem

A total of 12 pools were sampled along the main channel of the Robe River. Sites included six potentially exposed sites adjacent to the predicted groundwater drawdown cone of depression and within the predicted surface extent of dewatering discharge; and six reference sites upstream of the Jimmawurrada Creek confluence. Reference sites upstream of Mesa H were selected to serve as the "control" for potentially impacted sites. Surveys conducted in April/May 2016 are part of the benchmark or "before" phase against which to assess any future changes following mine development. A more comprehensive description of aquatic survey methodology is provided in Appendix A.

3.2.6.1 Water Quality

At each site, pH, dissolved oxygen and temperature were measured in situ using hand-held Wissenschaftlich-Technische-Werkstätten field meters. Water depth was measured using a graduated pole. Undisturbed water samples were collected for laboratory analyses of major ions, alkalinity, dissolved metals, nutrients and total suspended solids. Water samples for nitrogen and phosphorus nutrient and dissolved metal analyses were filtered in the field through 0.45 µm nitrocellulose filters. Samples were stored refrigerated or frozen for a maximum of 10 days prior to transport on ice to analytical laboratories at ChemCentre, Bentley, together with chain-of-custody forms.

Water quality data were compared against default ANZECC/ARMCANZ (2000) guidelines (trigger values) for the protection of freshwater ecosystems. Default trigger values (TVs) for 95% aquatic

species protection were considered more appropriate than default TVs for 99% protection, given that the Robe River catchment in the vicinity of current mining developments is already slightly to moderately disturbed by historic mining and pastoral practices (Strategen Environmental Consultants 2006). In accordance with ANZECC/ARMCANZ (2000), the default 99% TVs were applied to bioaccumulating metals such as selenium. For metals and nutrients, dissolved concentrations (0.45 µm filtered samples) were compared to the default TVs. Filtered concentrations were considered a better reflection of the fraction that may be bioavailable. By contrast, comparison of the default TVs to the total metal or total nutrient concentration may overestimate the risk to the environment (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000).

3.2.6.2 Microinvertebrates

Microinvertebrate samples were collected from each site by gentle sweeping over an approximate 15 m distance with a 53 µm mesh plankton net. Care was taken not to disturb the benthos (bottom sediments) during sampling. Samples were preserved in 70% ethanol and sent to Dr Russell Shiel at the University of Adelaide, South Australia, for processing. Dr Shiel is a world authority on microfauna, with extensive experience in fauna survey and impact assessment across Australasia, including the Pilbara.

Microinvertebrate samples were processed by identifying the first 200 to 300 individuals encountered in an agitated sample decanted into a 125 mm^2 gridded plastic tray, with the tray then scanned for additional missed taxa also taken to species, and recorded as 'present'. Specimens were identified to the lowest taxon possible, i.e. species or morphotypes. Abundance data were reported as log_{10} scale abundance classes (i.e. 1 = individual, 2 = 2 to 10 individuals, 3 = 11 to 100 individuals, 4 = 101 to 1000 individuals, 5 = >1000 individuals). Where specific names could not be assigned, vouchers were established. These vouchers are held by Dr Shiel at the University of Adelaide, South Australia.

3.2.6.3 Hyporheos

At each site, hyporheic sampling was conducted using the Karaman-Chappuis method (Delamare Deboutteville 1960). This involved digging a hole approximately 20 cm deep and 40 cm diameter in alluvial gravels in dry streambed adjacent to the water's edge, allowing the hole to infiltrate with water, and sweeping the water column with a modified 110 µm mesh plankton net. The water column was swept immediately after the hole had filled, and again after approximately 30 minutes, once other sampling had been conducted.

Samples were preserved in 70% ethanol and returned to the laboratory for processing. Any aquatic fauna present was removed from samples by sorting under a low power dissecting microscope. In-house expertise was used to identify the majority of hyporheic taxa using available published keys and through reference to the established voucher collections held by WRM. External specialist taxonomic expertise was sub-contracted to assist with Chironomidae (Dr Don Edward, UWA) and micro-crustacea (Dr Russell Shiel, University of Adelaide).

3.2.6.4 Macroinvertebrates

Macroinvertebrate sampling was conducted with a 250 µm mesh pond net. All meso-habitats were sampled, including trailing riparian vegetation, woody debris, open water column and benthic sediments with the aim of maximising the number of species recorded. Each sample was washed through a 250 µm sieve to remove fine sediment, while leaf litter and other debris were carefully washed in the sieve and removed by hand. Samples were then preserved in 70% ethanol. In the

laboratory, macroinvertebrates were removed from samples by sorting under a low power dissecting microscope.

Collected specimens were identified to the lowest practicable level (typically genus or species) and enumerated to $\log_{10}$ scale abundance classes (i.e. 1 = individual, 2 = 2 to 10 individuals, 3 = 11 to 100 individuals, 4 = 101 to 1000 individuals, 5 = >1000 individuals). In-house expertise was used to identify invertebrate taxa using available published keys and through reference to the established voucher collections held by WRM. External specialist taxonomic expertise was sub-contracted to assist with Chironomidae (Dr Don Edward, UWA).

3.2.6.5 Fish

A number of fish sampling methods were used at each site in order to collect as many species and individuals as possible. Methods included electrofishing, seine nets and gill nets. Electrofishing is an extremely useful and efficient sampling tool in rivers with clear, low salinity, slow flow water. All meso-habitats within a maximum 40 m reach were shocked with the intention of recovering as many species/individuals as possible. Shocking was not continuous, but targeted areas of optimum habitat, whereby the operator would shock, move to a new habitat before shocking again, and so prevent fish being driven along in front of the electrical field.

Duplicate 30 m multi-panel gill nets were set at each site where there was sufficient depth of water. Each net consisted of six 5 m panels, with panels increasing in size from 1 inch to 6 inch stretched mesh size. At each sampling location, two nets were set for approximately 2.5 hours. Nets were checked frequently to avoid fish deaths. Catch from the duplicate nets were combined to form one replicate sample from each sampling location.

Smaller species and juveniles were sampled by beach seine (10 m net, with a 2 m drop and 6 mm mesh) deployed in shallow areas where there was little vegetation or large woody debris. Typically, two seine hauls were made at each location to maximise the number of individuals caught.

All fish were identified in the field, measured for standard length, and then released alive. Fish nomenclature followed that of Allen *et al.* (2002). Fish measurements provided information on the size structure, breeding and recruitment of fish populations.

3.3 Taxonomy and Nomenclature

Plant specimens that were not identified in the field were later identified in Perth by Astron Botanists Janelle Atkinson, Natalie Cadd and Daniel Roocke. Each of these botanists has worked extensively in the Pilbara and is very familiar with the flora of the region. The assigned nomenclature is consistent with the current listing of scientific names recognised by the WAHerb and was used for the species list and associated species information collected. Where specimens had inadequate descriptive material to allow confident identification, they were assigned a 'sp.' (species) epithet, indicating that identification could not be confirmed beyond genus level. Data from each quadrat was entered into a customised database.

3.4 Limitations

Following completion of the desktop assessment and field survey, a review of any limitations that may affect a complete assessment of the data collected was conducted. The limitations listed in Table 9 are based on those suggested as considerations in Guidance Statement No. 51 (Environmental Protection Authority 2004a) and Guidance Statement No. 56 (Environmental Protection Authority 2004b).

Table 9: Statement of limitations.

Potential limitation	Degree of limitation	Statement regarding potential limitations
(i) Sources of information and availability of contextual information. Is the region well documented?	No limitation	Broad-scale contextual information is available from Van Vreeswyk et al. (2004), IBRA (Kendrick 2001; Kendrick and McKenzie 2001) and Beard (1975) mapping. Numerous consultants' reports have been completed within a 50 km radius of the survey area.
(ii) Scope. The level of survey and detail required to undertake the survey. Was there adequate time to complete the survey to the desired standard?	No limitation	The assessment incorporates data from current and previous vegetation, flora, fauna and aquatic systematic surveys from the survey area. As such, the level of detail and scope of this study is deemed adequate.
(iii) Proportion of biota collected and identified. Was the survey sampling, timing and intensity considered adequate? Was the survey conducted at what was considered an appropriate time of the year for plant identification? Were any taxonomic groups considered to be under-represented?	Minor limitation	The seasonal conditions for field surveys conducted in October 2014 (Astron Environmental Services 2014), September-October 2015 and April-May 2015 (Astron Environmental Services 2016b) were considered dry, with below average rainfall in the months preceding. The seasonal conditions for the July 2015 survey, trip 2 of Phase 2 (Astron Environmental Services 2016b), were considered excellent, following substantial rainfall in the three months preceding. Despite unfavourable seasonal conditions for many surveys, the specimens collected were generally of reasonable quality with flowering and fruiting material available; few specimens were unable to be confidently identified to species level. Most taxonomic groups expected within the survey area were well represented, and floristic richness was considered reasonable given the seasonal conditions. Only opportunistic fauna records were undertaken during the Level 1 fauna assessment; as such many of the reptiles and mammals inhabiting the survey area were not recorded. Due to the recent biological surveys that have been conducted in and around the survey area the faunal assemblage is well known. The aquatic sampling was timed to correspond with recessional flow conditions at the end of the wet (April-May) season. It was considered that the end of the wet season would be a more ecologically important time of year to sample, as biological diversity would be expected to be at its highest. Inherent physical sampling deficiencies are acknowledged as a barrier to sampling aquatic fauna,

Potential limitation	Degree of limitation	Statement regarding potential limitations
		and in particular fish. For example, fish catch rates may have been hindered by the abundance of aquatic vegetation (macrophytes and algae) which physically obstructed seine and gill nets at some sites. This was somewhat compensated for by the use of a back-pack electrofisher, which generates a pulsed direct electrical current to draw fish out from under such habitat.
(iv) Completeness. Is there further work which may be required i.e. was the relevant area fully surveyed?	No limitation	The survey area was considered adequately surveyed to compile a representative list of species, (including conservation significant and introduced species), as well as describe and map vegetation and habitats at a level appropriate for possible future management decisions.
(v) Mapping reliability. Were the aerial photographs, satellite images and site maps available considered adequate to fully understand the area surveyed? Was the mapping generated considered to have a high degree of reliability?	No limitation	Colour aerial photography at a scale of 1:10,000 was used to locate the survey area and to assist in navigation and delineation of vegetation and habitat boundaries. The aerial photography was of good resolution and, in general, accurately represented ground conditions.
(vi) Timing. When was the survey conducted in terms of season, rainfall and severe weather events? Was the survey conducted at an appropriate time for access, observation of the optimal suite of species and for flora the identification of flowering and fruiting species?	Minor limitation	The flora surveys were conducted at what would normally be considered the optimal time for both dry and post-wet season surveys in the Pilbara. During the first post-wet season survey of 2016 (Astron Environmental Services 2016b), quadrat species richness was lower than might be expected. Due to the range of surveys informing this assessment, and the variety of conditions involved, the total floristic diversity was in line with what may be expected. The majority of flora species had adequate identification material present. The rainfall in the three months preceding the fauna survey was well below average. This was evident in the lack of surface water present specifically in the Riverine habitats. This is likely to reduce the number of waterbirds recorded. Due to the range of surveys informing this assessment, and the variety of conditions involved, the total fauna diversity is well known. As stated above, the aquatic sampling was timed to correspond with recessional flow conditions at the end of the wet (April-May) season as this would be a more ecologically important time of year to sample, as biological diversity would be at its highest.
(vii) Disturbance. Had the survey area been impacted by any disturbance which may have limited the survey, i.e. fire, flood,	No limitation	A history of pastoral activity and cattle grazing was evident within the survey area. Uprooted mature *Eucalyptus* and *Melaleuca* trees, and associated debris provided evidence of flood waters flowing

Potential limitation	Degree of limitation	Statement regarding potential limitations
accidental human intervention?		through the river after significant rainfall. Small sections of the survey area had been burnt within five years, although this did not compromise the vegetation mapping for these locations. Two small areas of stressed riparian vegetation were noted within the Robe River, where mature trees had senesced. Vehicle tracks were abundant in open areas of the Robe River where shingle substrate supported very sparse vegetation. None of these disturbances limited the outcomes of this survey.
(viii) Intensity. In retrospect, was the intensity considered to be adequate?	No limitation	The intensity of the survey was considered adequate to compile a representative species list for flora, fauna and aquatic components and to map the vegetation and fauna habitats of the survey area. The vegetation mapping was completed to association level with adequate quadrat replication achieved. The intensity of the survey was adequate to conduct targeted flora searches in potential habitat for likely and potential Priority flora species.
(ix) Resources. Were the appropriate tools and materials available to complete the task effectively?	No limitation	Resources were adequate to complete the survey and all appropriate tools and materials required to complete the task were available.
(x) Access. Were there any factors limiting access to the survey area?	No limitation	Much of the survey area was able to be accessed by vehicle; areas that were unable to be reached by vehicle were accessed and traversed by foot.
(xi) Experience. Were personnel undertaking the field survey and plant identification trained and/or experienced in undertaking the required tasks?	No limitation	The scientists responsible for undertaking the field surveys have considerable experience in conducting biological surveys in the Pilbara. The identification of specimens brought back from the field was conducted by scientists with extensive experience.

4 Results

4.1 Desktop Assessment

4.1.1 Vegetation and Flora

No State or Commonwealth listed TECs are known to occur within or adjacent to the survey area (Department of the Environment and Energy 2016d; Department of Parks and Wildlife 2015b).

Two PECs, '*Triodia sp. Robe River assemblages of mesas of the West Pilbara*' P3 and '*Four plant assemblages of the Wona Land System*' P1, have been previously recorded within 50 km of the Mesa H (Astron Environmental Services 2016b) survey area (Department of Parks and Wildlife 2016b) (Figure I.1, Appendix I). Several mapped occurrences of '*Triodia sp. Robe River assemblages of mesas of the West Pilbara*' are located between approximately 16 km and 19 km south-west of the Mesa H survey area (Astron Environmental Services 2016b). The '*Four plant assemblages of the Wona Land System*' PEC is mapped as occurring approximately 21 km north-east of the Mesa H (Astron Environmental Services 2016b) survey area (Department of Parks and Wildlife 2015b).

The Parks and Wildlife TPFL (Department of Parks and Wildlife 2015c) and WAHerb (Department of Parks and Wildlife 2015e) database searches indicated that no species listed as Threatened have been recorded within 20 km of the Mesa H (Astron Environmental Services 2016b) survey area. The Parks and Wildlife TP List (Department of Parks and Wildlife 2015d), which is searched according to place names rather than coordinates, listed two Threatened species: *Lepidium catapycnon* T and *Thryptomene wittweri* T. Since receiving the TP List database search results, *L. catapycnon* has been removed from the Threatened flora list and is currently listed as P4 (Western Australian Government 2015). A review of recorded specimens of *T. wittweri* T, held by the WAHerb (Western Australian Herbarium 1998-2016), indicates that the closest occurrence of this species to the survey area is approximately 270 km to the south-east. In addition, this species has not been identified during previous surveys conducted within, or in close proximity to, the survey area (Astron Environmental Services 2011, 2016a, 2016b; Biota Environmental Sciences 2003, 2006a, 2011a, 2012).

Fourteen Priority flora species have been previously recorded within 20 km of the Mesa H (Astron Environmental Services 2016b) survey area (Table J.1, Appendix J) (Department of Parks and Wildlife 2015c, 2015d, 2015e, 2015f). Of these, two are P1, four are P2, six are P3 and two are P4 status. The pre-survey desktop assessment indicated that two of the listed Priority flora species were considered likely to occur within the riparian community survey area; a further six were considered to have the potential to occur (Table J.1, Appendix J).

4.1.1.1 Literature Review

Results of the literature review indicate that no TECs have been previously recorded within, or in the vicinity of, the survey area (Astron Environmental Services 2011, 2016a, 2016b; Biota Environmental Sciences 2003, 2006a, 2011a, 2012). Vegetation representing the PEC '*Triodia sp. Robe River assemblages of mesas of the West Pilbara*' was recorded within close proximity to the Robe River and adjacent to the riparian community survey area (Astron Environmental Services 2016a, 2016b) (Table 10). This PEC occurred in association with mesa landforms, where either *Acacia pruinocarpa* or *Acacia citrinoviridis* occurred in conjunction with *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3.

Results of the literature review identified eight currently listed Priority flora species as having been previously recorded within, or within close proximity to, the survey area: *Pentalepis trichodesmoides* subsp. *hispida* P2, *Eragrostis surreyana* P3, *Gymnanthera cunninghamii* P3, *Indigofera* sp. Bungaroo

Creek (S. van Leeuwen 4301) P3, *T.* sp. Robe River (M.E. Trudgen et al. 12367) P3, *Livistona alfredii* P4, *Ptilotus mollis* P4 and *Rhynchosia bungarensis* P4 (Table 10) (Astron Environmental Services 2016a, 2016b, 2016c; Biota Environmental Sciences 2003, 2006a, 2011a, 2012).

Of these species, *R. bungarensis* P4, was recorded in the greatest number of surveys, and species such as *P. trichodesmoides* subsp. *hispida* P2 and *P. mollis* P4 were recorded from non-riparian landforms (Astron Environmental Services 2016a, 2016b, 2016c; Biota Environmental Sciences 2003, 2006a, 2011a, 2012) (Table 10).

Table 10: Summary of relevant vegetation and flora surveys which overlap the current survey area.

Survey parameter	Astron Environmental Services (2016a)	Astron Environmental Services (2016b)	Astron Environmental Services (2016c)	Biota Environmental Sciences (2012)	Astron Environmental Services (2011)	Biota Environmental Sciences (2011a)	Biota Environmental Sciences (2006a)	Biota Environmental Sciences (2003)
Survey Location	Middle Robe and East Deepdale	Mesa H	Mesa H riparian monitoring	Greater Bungaroo	Mesa J	Robe Valley Mesas	Mesa A, Warramboo, Yarraloola	Mesa J
Survey area size (ha)	11,816	4,930	N/A	8,765	79	9,494	Not specified	~300
Survey focus	Two phase Level 2	Two phase Level 2	Riparian vegetation baseline monitoring	Two phase Level 2	Level 1	Baseline vegetation and flora	Baseline vegetation and flora	Single phase Level 2
Survey timing	June and September/October 2015	October 2014, September 2015, May and July 2016	June 2016	July 2009 and June 2011	June 2011	October 2010	7 surveys between July 2004 and September 2005	September 2003
Seasonal conditions	Excellent	Dry - Average	Average	Excellent	Excellent	Dry	Excellent (all surveys)	Dry
Survey effort (quadrats/relevés/transects)	106 quadrats 13 relevés	138 quadrats 16 relevés	21 transects	37 quadrats	9 relevés	51 quadrats 2 relevés	50 quadrats	10 quadrats
Total vegetation associations mapped	37	38	N/A	16	9	50	72	10
Conservation significant ecological communities recorded	1 PEC	1 PEC	N/A	0	0	1 PEC	0	0
Total species recorded	399	310	118	284	73	221	437	119
Conservation significant flora species recorded (currently listed)	6	3	1	3	0	3	1	1

Survey parameter	Astron Environmental Services (2016a)	Astron Environmental Services (2016b)	Astron Environmental Services (2016c)	Biota Environmental Sciences (2012)	Astron Environmental Services (2011)	Biota Environmental Sciences (2011a)	Biota Environmental Sciences (2006a)	Biota Environmental Sciences (2003)
Eragrostis surreyana P3				✓				
Gymnanthera cunninghamii P3	✓							
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) P3	✓	✓		✓				
Livistona alfredii P4	✓							
Pentalepis trichodesmoides subsp. *hispida* P2	✓							
Ptilotus mollis P4						✓		
Rhynchosia bungarensis P4	✓	✓	✓			✓	✓	✓
Triodia sp. Robe River (M.E. Trudgen et al. 12367) P3	✓	✓		✓		✓		✓ (undescribed at the time of survey)

4.1.2 Environmentally Sensitive Areas

No ESAs occur within or adjacent to the survey area. The nearest ESA is the Duck Creek Gorge Area, located approximately 78 km south (Landgate 2016). The Millstream-Chichester National Park is the nearest conservation reserve to the survey area, located approximately 79 km to the north-east. The Murujuga National Park is approximately 120 km north and Karijini National Park is approximately 180 km south-east of the survey area.

Springs and pools of the Robe River are listed as 'Wetlands of Subregional Significance' in Kendrick (2001). These springs and pools occur from 40 km east of Pannawonica, downstream to North West Coastal Highway. The significant wetlands are described as 'running spring ecosystems with large deep permanent pools and consist of seasonal and irregular rivers and streams, and freshwater springs, oases and rock pools' (Kendrick 2001).

4.1.3 Terrestrial Fauna

The database searches and literature review results indicate that 318 vertebrate fauna have been previously recorded within 40 km of the survey area, including six amphibian species, 102 reptile species, 160 bird species (including one introduced bird species) and 50 mammal species (including 10 introduced mammal species) (Table K.1-K.4, Appendix K). Of these, 28 species are of conservation significance, including three reptile species, 16 bird species and nine mammal species. Of these, six species were considered to have a 'high' likelihood (inclusive of those previously recorded within the survey area), nine species were considered to have a 'moderate' likelihood and 13 were considered to have a 'low' likelihood of occurrence (Table L.1, Appendix L). This is based on their respective ecology, habitats considered likely to be present and any previous records from historic survey and database records.

4.1.3.1 Literature Review

Previous surveys undertaken for Rio Tinto in the vicinity of the survey area recorded 12 conservation significant vertebrate fauna species: Northern Quoll (*Dasyurus hallucatus),* Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Ghost Bat (*Macroderma gigas*), Western Pebble-mound Mouse (*Pseudomys chapmani*), Eastern Great Egret (*Ardea modesta*), Rainbow Bee-eater (*Merops ornatus*), Wood Sandpiper (*Tringa glareola*), Common Sandpiper (*Actitis hypoleucos*), Sharp-tailed Sandpiper (*Calidris acuminata*), Pilbara Olive Python (*Liasis olivaceus barroni*), Blind Snake (*Anilios ganei*) and Lined Soil-crevice Skink (*Notoscincus butleri*) (Table 11).

Table 11: Summary of literature review results from terrestrial fauna surveys conducted within the vicinity of the survey area.

Author (year)	Survey area size (ha)	Survey level	Survey timing	Survey effort	Conservation significant vertebrate fauna recorded
Astron (2011)	Mesa J Mine 78.63 ha	Level 1	June 2011	Desktop survey and site reconnaissance.	*Merops ornatus* (Rainbow Bee-eater)
Astron (2014)	Mesa H 2,582 ha	Level 1	October 2014	Targeted searches of suitable habitat, motion sensor cameras and SM2 acoustic bat call recorders were used to detect the presence of conservation significant fauna species.	*Dasyurus hallucatus* (Northern Quoll) *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Ardea modesta* (Eastern Great Egret) *Merops ornatus* (Rainbow Bee-eater)
Astron (2016e)	Bungaroo 9,795 ha	Level 2 (dual phase)	May - June 2015 August 2015	Habitat assessments, eight trapping sites, avifauna censuses at each trapping site, foot traverses, targeted searches for both vertebrates and short range endemic (SRE) invertebrates, and the use of motion sensitive cameras and SM2BAT ultrasonic bat detectors.	*Dasyurus hallucatus* (Northern Quoll) *Liasis olivaceus barroni* (Pilbara Olive Python) *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Notoscincus butleri* (Lined Soil-crevice Skink) *Anilios ganei* (Blind Snake) *Merops ornatus* (Rainbow Bee-eater)
Astron (2016f)	Middle Robe and East Deepdale 11,816 ha	Level 2 (dual phase)	June 2015 August 2015	Habitat assessments, 15 trapping sites, avifauna censuses at each trapping site, foot traverses, targeted searches for both vertebrates and SRE invertebrates, and the use of motion sensitive cameras and SM2BAT ultrasonic bat detectors.	*Dasyurus hallucatus* (Northern Quoll) *Liasis olivaceus barroni* (Pilbara Olive Python) *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Notoscincus butleri* (Lined Soil-crevice Skink) *Ardea modesta* (Eastern Great Egret) *Merops ornatus* (Rainbow Bee-eater)

Author (year)	Survey area size (ha)	Survey level	Survey timing	Survey effort	Conservation significant vertebrate fauna recorded
Biologic (2014)	Yarraloola Size not stated	Level 1	December 2013	A Level 1 targeted survey for Northern Quolls, Pilbara Olive Pythons and Pilbara Leaf-nosed Bats.	*Dasyurus hallucatus* (Northern Quoll) *Liasis olivaceus barroni* (Pilbara Olive Python) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat) *Merops ornatus* (Rainbow Bee-eater)
Biota (2005)	Mesa A and G, near Pannawonica 1,305 ha	Level 2 (single phase)	May 2004	Ten trapping sites utilising various combinations of pitfall traps (both PVC tubes and 20 L buckets), Elliott traps and/or funnel traps. Avifauna censuses at each trapping site and Anabat echolocation recordings.	*Dasyurus hallucatus* (Northern Quoll) *Macroderma gigas* (Ghost Bat)
Biota (2006b)	Mesa A Transport Corridor and Warramboo 7,045 ha	Level 2 (dual phase)	April - May 2005 July - August 2005	Ten trapping sites, including pits (buckets and PVC tubes), medium sized Elliotts and funnels. Harp traps targeting bat species, avifauna census at each trapping site and targeted searches for both vertebrates and SRE invertebrates.	*Notoscincus butleri* (Lined Soil-crevice Skink) *Macroderma gigas* (Ghost Bat) *Pseudomys chapmani* (Western Pebble-mound Mouse)
Biota (2007)	Bungaroo Trial Pit and Transport Corridor to Mesa J Size not stated	Level 2 (dual phase)	March 2005 June 2006	Sixteen trapping sites, avifauna census, harp traps targeting bat species, and targeted searches for both vertebrates and SRE invertebrates.	*Dasyurus hallucatus* (Northern Quoll) *Notoscincus butleri* (Lined Soil-crevice Skink) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Tringa glareola* (Wood Sandpiper)

Author (year)	Survey area size (ha)	Survey level	Survey timing	Survey effort	Conservation significant vertebrate fauna recorded
Biota (2009)	Mesa G Size not stated	Level 2 (single phase)	August 2009	Six trapping sites, avifauna census, harp traps and echoloaction recordings targeting bat species, and targeted searches for both vertebrates and SRE invertebrates.	*Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat)
Biota (2010a)	Greater Bungaroo 8,765 ha	Level 2 (dual phase)	August 2009 March 2010	Trapping at 14 locations, avifauna census, harp traps and echoloaction recordings targeting bat species, and targeted searches for both vertebrates and SRE invertebrates.	*Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Macroderma gigas* (Ghost Bat) *Notoscincus butleri* (Lined Soil-crevice Skink) *Merops ornatus* (Rainbow Bee-eater)
Biota (2011b)	Robe Valley 9,354 ha	Level 2 (single phase)	October 2010	Trapping at 18 locations, avifauna census, harp traps and echoloaction recordings targeting bat species, and targeted searches for both vertebrates and SRE invertebrates.	*Dasyurus hallucatus* (Northern Quoll) *Macroderma gigas* (Ghost Bat) *Notoscincus butleri* (Lined Soil-crevice Skink) *Merops ornatus* (Rainbow Bee-eater)
ecologia Environment (2013)	Middle Robe and East Deepdale 6,092 ha	Level 2 (single phase)	September 2012	Eight fauna trapping sites, avifauna censuses, targeted searches for vertebrate fauna and SRE invertbrates and Anabat echolocation recordings.	*Dasyurus hallucatus* (Northern Quoll) *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) *Ardea modesta* (Eastern Great Egret) *Actitis hypoleucos* (Common Sandpiper) *Calidris acuminata* (Sharp-tailed Sandpiper) *Tringa glareola* (Wood Sandpiper) *Merops ornatus* (Rainbow Bee-eater)

4.1.4 Aquatic Fauna

Numerous aquatic ecological surveys have been undertaken within the vicinity of the survey area and were used for the desktop assessment and literature review. A more comprehensive description of the aquatic surveys and studies are provided in Appendix A. A summary of previously recorded species of conservation significance and/or scientific interest are presented in Table 12.

Table 12: Summary of literature review results from aquatic surveys conducted within the vicinity of the survey area.

Species	Common name	Conservation / scientific value	Occurrence within 100 km of survey area	Likelihood of occurrence within the survey area	Occurrence elsewhere
Microinvertebrates					
Lecane noobjupi	Rotifer	WA endemic	Nyeetbury Spring, Red Hill Creek	High, in surface waters	Weeli Wolli Creek, Marillana Creek, Coondiner Creek, Mindy Mindy Creek, Kalgan Creek and Un-named Creek, DeGrey River. Also in south-west Western Australia
Paracyclops sp. 6	Copepod (micro-crustacean)	Pilbara endemic	Chalyarn Pool	High, in surface waters	20+ locations Pilbara-wide
Vestalenula matildae	Ostracod (micro-crustacean)	Pilbara endemic	Chalyarn Pool	High, in surface waters	Various systems of the Ashburton River, DeGrey River, Fortescue River and Sherlock River.
Hyporheos					
Paramelitidae spp.	Stygobitic amphipods	Stygobitic SREs	Yalleen Pool, Red Hill Creek, Mungarathoona Creek.	High in ground-waters and hyporheos	Unknown given family level identification
Melitidae spp.	Stygobitic amphipods	Stygobitic SREs	Bores across the Robe River catchment area	High in ground-waters; Low-moderate in hyporheos	Unknown given family level identification
Haptolana yarraloola	Stygobitic isopod	Stygobitic SRE	Bores in the lower Robe River catchment area – Mesa A/ Warramboo/ Yarraloola	Low	Recently described species; known only from Mesa A/ Warramboo/ Yarraloola bores
Kagalana tonde	Stygobitic isopod	Stygobitic SRE	Bores in the lower Robe River catchment area – Mesa A/ Warramboo/ Yarraloola	Low	Recently described genus and species; elsewhere known from Cane River and Hardey River catchments

Species	Common name	Conservation / scientific value	Occurrence within 100 km of survey area	Likelihood of occurrence within the survey area	Occurrence elsewhere
Pilbarophreatoicus platyarthricus	Stygobitic isopod	Stygobitic SRE	Chalyarn Pool, Nyeetbury Spring, bores in the Robe River catchment area	High in ground-water and hyporheos	Weeli Wolli Creek, Coondiner Creek, Bobswim Pool (Ashburton River)
Pygolabis sp.	Stygobitic isopod	Stygobitic SRE	One undescribed species known from the Robe River catchment	High in ground-water and hyporheos	Uncertain. Members of this genus restricted to either Fortescue, Ashburton or Robe catchment groundwater and hyporheos
Tainisopus sp.	Stygobitic isopod	Stygobitic SRE	Nyeetbury Spring	Low-moderate; only known from Nyeetbury Spring hyporheos	Unknown given genus level identification
Parabathynellidae spp.	Stygobitic syncarids	Stygobitic SREs	Unknown given genus level identification	High in ground-waters; Low-moderate in hyporheos	Unknown given genus level identification
Macroinvertebrates					
Hemicordulia koomina	Pilbara Emerald Dragonfly	IUCN, Near Threatened	Robe River pools, Red Hill Creek	High in surface waters	Fortescue River, Coondiner Creek; now known to be widespread throughout the Pilbara, though infrequently collected
Eurysticta coolawanyah	Pilbara Pin Damselfly	IUCN, Near Threatened	Chalyarn Pool, Robe River pools, Yalleen Pool	High in surface waters	Ashburton River (Bobswim Pool); Kalgan Creek, Coondiner Creek, Fortescue River; now known to be widespread throughout the Pilbara, though infrequently collected
Ictinogomphus dobsoni	Pilbara Tiger Dragonfly	Pilbara endemic; restricted distribution	Chalyarn Pool, Robe River pools, Red Hill Creek	High in surface waters	Fortescue, Ashburton, Yule, DeGrey and Sherlock Rivers
Nannophlebia injibandi	Pilbara Archtail Dragonfly	Pilbara endemic; restricted distribution	Robe River pools, Red Hill Creek	Low-Moderate in surface waters	Fortescue River catchment, but uncommonly collected
Agriocnemis kunjina	Pilbara Wisp Damselfly	Pilbara endemic; restricted distribution	Robe River Pools, Yalleen Pool	Low-Moderate in surface waters	Millstream, Harding River, Tanberry Creek; rarely collected

Species	Common name	Conservation / scientific value	Occurrence within 100 km of survey area	Likelihood of occurrence within the survey area	Occurrence elsewhere
Haliplus halsei	Aquatic beetle	Pilbara endemic; relatively new to science	Chalyarn Pool, Myannore Creek	Low-Moderate in surface waters	Uncommonly collected from ephemeral systems and claypans, e.g. the Fortescue Marsh and Coondiner Pool
Haliplus pilbaraensis	Aquatic beetle	Pilbara endemic; relatively new to science	Red Hill Creek	Low-Moderate in surface waters	Uncommonly collected from ephemeral systems and claypans, e.g. the Fortescue Marsh and Coondiner Pool
Sternopriscus pilbaraensis	Diving beetle	Pilbara endemic; restricted distribution	Red Hill Creek	Moderate in surface waters	A range of systems across the Pilbara, fairly commonly collected
Tiporus tambreyi	Diving beetle	Pilbara endemic; restricted distribution	Chalyarn Pool, Robe River pools, Red Hill Creek	Moderate-High in surface waters	A range of systems across the Pilbara, very commonly collected
Tiporus lachlani	Diving beetle	Pilbara endemic; restricted distribution	Red Hill Creek	Low-Moderate in surface waters	A range of systems across the Pilbara, infrequently collected
Laccobius billi	Aquatic beetle	Pilbara endemic; restricted distribution	Mungarathoona Creek, Red Hill Creek	Low-Moderate in surface waters	Yule River and Fortescue River
Fish					
Leiopotherapon aheneus	Fortescue Grunter	IUCN Near Threatened; P4	Robe River pools, Mungarathoona Creek, Red Hill Creek	High in surface waters	Fortescue River (below Fortescue Marsh); Ashburton River

4.2 Field Survey

4.2.1 Vegetation

There were five vegetation associations described within the survey area, which are summarised in Table 13. Some modifications were made to the vegetation association boundaries and descriptions from Astron (2016b) during this assessment to assist in amalgamating the vegetation associations between the previous and current survey areas. There was 16.9 ha of disturbance within the survey area. Vegetation association mapping is provided in Figure M.1 (Appendix M) and the data collected from each quadrat is presented in Appendix N.

Table 13: Vegetation associations recorded for the survey area.

Vegetation associations and descriptions	Sites	Vegetation condition	Total area (ha)	Representative photograph
Es *Euphorbia schultzii* scattered herbs **Associated species:** *Acacia trachycarpa, Petalostylis labicheoides, Hybanthus aurantiacus, Argemone ochroleuca* subsp. *ochroleuca*	MH388, MH394, MH397, MH398, E09 (Astron Environmental Services 2016a)	Very good - Excellent	114.2	 **Plate 1: Vegetation representing Es – facing south-east from GPS co-ordinate 411162mE and 7594904mN (MGA Zone 50).**

Vegetation associations and descriptions	Sites	Vegetation condition	Total area (ha)	Representative photograph
AtrPl *Acacia trachycarpa*, *Petalostylis labicheoides* tall open scrub **Associated species:** *Acacia ancistrocarpa, A. bivenosa, A. pyrifolia*, *Euphorbia schultzii, Ptilotus astrolasius, Tephrosia rosea* var. Fortescue Creeks (M.I.H Brooker 2186), *Triodia wiseana*, *T. epactia*	MH389, MH203, MH321, MH354 (Astron Environmental Services 2016a)	Very good - Excellent	796.1	 **Plate 2: Vegetation representing AtrPl – facing south-east from GPS co-ordinate 410478mE and 7594630mN (MGA Zone 50).**

Vegetation associations and descriptions	Sites	Vegetation condition	Total area (ha)	Representative photograph
MaEcCv *Melaleuca argentea, Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Cyperus vaginatus* scattered sedges to very open sedgeland **Associated species:** *Acacia trachycarpa, *Cenchrus ciliaris, Eucalyptus victrix, *Passiflora foetida subsp. hispida, Petalostylis labic*heoides, *Rhynchosia bungarensis* P4*, Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186), *Typha domingensis* and *Vigna lanceolata*	MH381, MH385, MH387, MH204, MH332, MH337r, MH363, AM215 (Astron Environmental Services 2016a)	Very good - Excellent	527.4	 **Plate 3: Vegetation representing MaEcCv – facing south-east from GPS co-ordinate 413079mE and 7595454mN (MGA Zone 50).**

Vegetation associations and descriptions	Sites	Vegetation condition	Total area (ha)	Representative photograph
EcEvAtrApyPlTw *Eucalyptus camaldulensis* subsp. *refulgens* woodland over *E. victrix* low woodland over *Acacia trachycarpa, A. pyrifolia* var. *pyrifolia, Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* scattered hummock grasses **Associated species:** *Acacia ancistrocarpa, A. bivenosa, A. colei, *Cenchrus ciliaris, *C. setiger, Cyperus vaginatus, Eulalia aurea, Euphorbia schultzii, Melaleuca argentea, M. glomerata, Tephrosia rosea* var. Fortescue Creeks (M.I.H. Brooker 2186)	MH43, MH44, MH303, MH373, MH379, MH384, E07, E09 (Astron Environmental Services 2016a)	Poor – Very Good	620.5	 **Plate 4: Vegetation representing EcEvAtrApyPlTw – facing south-east from GPS co-ordinate 410331mE and 7594931mN (MGA Zone 50).**

Vegetation associations and descriptions	Sites	Vegetation condition	Total area (ha)	Representative photograph
EvAtrTwCspp *Eucalyptus victrix* low open woodland over *Acacia trachycarpa* tall open shrubland over *Triodia wiseana* open hummock grassland and **Cenchrus* spp. very open tussock grassland **Associated species:** *Acacia bivenosa, A. pyrifolia var. pyrifolia, Boerhavia coccinea, Gossypium robinsonii, Rhynchosia minima, Triumfetta appendiculata and Waltheria indica*	MH392, MH393, MH401	Good	52.9	 **Plate 5: Vegetation representing EvAtrTwCspp – facing south-east from GPS co-ordinate 424829mE and 7592502mN (MGA Zone 50).**

4.2.1.1 Vegetation Condition

Vegetation in the survey area ranged from 'poor' to 'excellent' (Trudgen 1988) condition (Table 14; Figure O.1, Appendix O). Indications of multiple disturbances such as pastoral and mining activity, flood waters uprooting mature trees (Plate 6) and extensive vehicle tracks throughout the open shingle landform were evident. Weed proliferation was extensive in areas of deeper soils, and often in conjunction with evidence of cattle grazing and mining activities. Less than 17 ha (1% of the survey area) was mapped as 'disturbed'.

Occasional patches of mature *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* trees were noted to be in a deteriorating condition. Evidence of fire in the vicinity of a permanent water hole approximately 9 km downstream of Mesa J may be attributed to the stressed vegetation (Plate 7); however, there was no indication of fire in a separate location of unhealthy trees that was 1 km further downstream.

Plate 6: Debris and uprooted trees from flood waters in the main channel.

Plate 7: Stressed trees, exhibiting fire damage within the Robe River.

Table 14: Vegetation condition recorded for the survey area, based on the Trudgen (1988) scale.

Vegetation condition	Total mapped area within the survey area (ha)
Excellent	124.2
Very Good	1,169.5
Good	717.2
Poor	100.1
Disturbed	16.9

4.2.1.2 Conservation Significance of Vegetation

No TECs or PECs were recorded in the survey area.

Vegetation which may be considered indicator species for a GDE was consistently recorded within the survey area. *Melaleuca argentea* and *E. camaldulensis* subsp. *refulgens* are the dominant upper stratum species of MaEcCv and while *E. camaldulensis* subsp. *refulgens* and/or *E. victrix* are the dominant upper stratum species of EcEvAtrApyPlTw and EvAtrTwCspp. *Melaleuca argentea* is considered an obligate phreatophyte and therefore highly dependent on groundwater, while *E. camaldulensis* subsp. *refulgens* and *E. victrix* are facultative phreatophytes and use groundwater

opportunistically during periods of drought or some life stages. Vegetation association MaEcCv is likely to be most reliant on groundwater.

4.2.2 Flora

There were 124 plant species from 37 families and 82 genera recorded in the survey area. The dominant plant family was Fabaceae, with 23 species confirmed, while *Acacia* was the most frequently recorded genus (Table 15). A species list and a site by species matrix for the survey area are presented, respectively, in Tables P.1 and P.3 (Appendix P).

Table 15: Families and genera with the greatest number of taxa in the survey area.

Family	Number of taxa
Fabaceae	23
Poaceae	20
Malvaceae	17
Genus	**Number of taxa**
Acacia	9
Ptilotus	8
Euphorbia	5

4.2.2.1 Conservation Significant Flora

No State or Commonwealth listed Threatened flora were recorded, or are likely to occur, within the survey area.

Targeted searches in potential habitat within the survey area identified three state-listed Priority flora species (Table 16). Detailed location information and abundance data for each recorded occurrence, along with representative photographs of each species, are presented in Tables Q.1-Q.2 (Appendix Q). Conservation significant flora locations, for both this survey and previous surveys, are also mapped in Figure Q.1.A (Appendix Q).

Triodia sp. Robe River (M.E. Trudgen et al. MET 12367) P3 was recorded at three locations within the survey area. Typically, *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3 occurs along rocky slopes and crests of hills, occasionally also occurring within rocky drainage gullies. *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3 has previously been recorded in close proximity to the survey area (Biota Environmental Sciences 2003, 2011a).

One individual of *L. alfredii* P4 (Millstream Fan Palm) was recorded in a broad section of the Robe River, during the Middle Robe and East Deepdale survey (Astron Environmental Services 2016a). *Livistona alfredii* P4 has not been previously recorded within a 20 km radius of the survey area (Astron Environmental Services 2011; Biota Environmental Sciences 2003, 2006a, 2011a, 2012; Department of Parks and Wildlife 2015c, 2015d, 2015e).

Rhynchosia bungarensis P4 was recorded in the survey area, typically occurring in the Robe River. *Rhynchosia bungarensis* P4 was generally recorded from densely shaded vegetation in the river channels, under *E. camaldulensis* subsp. *refulgens* and *M. argentea* woodlands and forests. *Rhynchosia bungarensis* P4 has previously been recorded within the survey area and also adjacent to and in close proximity to the survey area (Biota Environmental Sciences 2003, 2006a, 2011a).

Table 16: Conservation significant flora recorded in the survey area.

Species	Vegetation association/s	Source data		
		Astron 2016a	Astron 2016b	Astron 2016c
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367) P3	MaEcCv, EvAtrTwCspp	✓	✓	
Livistona alfredii P4	EcEvAtrApyPlTw	✓		
Rhynchosia bungarensis P4	MaEcCv, AtrPl, Es, EcEvAtrApyPlTw	✓	✓	✓

4.2.2.2 *Post-survey Likelihood of Occurrence of Conservation Significant Flora*

Following the surveys, and with greater understanding of the soils and habitats of the survey area, four priority flora species, *Euphorbia australis* var. *glabra* P2, *Stylidium weeliwolli* P2, *E. surreyana* P3 and *I.* sp. Bungaroo Creek (S. van Leeuwen 4301) P3 are considered to have potential to occur but were not recorded. These species have been previously recorded in close proximity to the survey area and suitable habitat for all species was identified within the survey area. None of these species would be restricted to the survey area if present, as indicated by the voucher records listed with the WAHerb (Western Australian Herbarium 1998-2016). Survey effort, as shown by tracklog traverses within the survey area, is presented in Figure R.1 (Appendix R).

4.2.2.3 *Introduced Flora*

Weed diversity in the survey area is considered high with 23 weed species recorded. Species and abundance details are summarised in Table 17.

**Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy) is listed as a declared pest under the BAM Act, however it is excluded for the Shire of Ashburton (Department of Agriculture and Food Western Australia 2016). The remaining recorded weeds are not listed as declared pests under the BAM Act, or as a WoNS (Australian Weeds Committee 2012). The recorded locations within the survey area and a description of each weed are presented in Tables Q.3 and Q.4 (Appendix Q).

Table 17: Introduced flora species (weeds) recorded in the survey area.

Species	Family	Source data		
		Astron 2016a	Astron 2016b	Astron 2016c
**Aerva javanica* (Kapok Bush)	Amaranthaceae	✓	✓	✓
**Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)	Papaveraceae	✓	✓	✓
**Bidens bipinnata* (Bipinnate Beggartick)	Asteraceae		✓	
**Cenchrus ciliaris* (Buffel Grass)	Poaceae	✓	✓	✓
**Cenchrus setiger* (Birdwood Grass)	Poaceae	✓	✓	✓
**Chloris barbata* (Purpletop Chloris)	Poaceae	✓	✓	
**Citrullus colocynthis* (Colocynth)	Cucurbitaceae	✓	✓	✓
**Cynodon dactylon* (Couch Grass)	Poaceae	✓	✓	✓
**Datura leichhardtii* (Native Thornapple)	Solanaceae	✓		

Species	Family	Source data		
		Astron 2016a	Astron 2016b	Astron 2016c
**Echinochloa colona* (Awnless Barnyard Grass)	Poaceae	✓	✓	✓
**Euphorbia hirta* (Asthma Plant)	Euphorbiaceae	✓	✓	✓
**Flaveria trinervia* (Speedy Weed)	Asteraceae	✓		
**Lactuca serriola* (Prickly Lettuce)	Asteraceae	✓	✓	
**Malvastrum americanum* (Spiked Malvastrum)	Malvaceae	✓	✓	✓
**Melochia pyramidata*	Malvaceae			✓
**Ocimum basilicum* (Basil)	Lamiaceae		✓	
**Passiflora foetida* subsp. *hispida* (Stinking Passion Flower)	Passifloraceae	✓	✓	✓
**Phoenix dactylifera* (Date Palm)	Arecaceae		✓	
**Rumex vesicarius* (Ruby Dock)	Apocynaceae	✓	✓	
**Setaria verticillata* (Whorled Pigeon Grass)	Poaceae	✓	✓	✓
**Solanum nigrum* (Black Berry Nightshade)	Solanaceae	✓	✓	✓
**Sonchus oleraceus* (Common Sowthistle)	Asteraceae	✓	✓	✓
**Vachellia farnesiana* (Mimosa Bush)	Fabaceae	✓	✓	✓

4.2.3 Fauna

4.2.3.1 Fauna Habitats

Two broad fauna habitat types were recorded in the survey area: Riverine and Drainage Line. The habitats are described in Table 18 and mapping is presented in Figure H.1 (Appendix H). Habitat assessments undertaken during the survey are detailed in Table H.1 (Appendix H).

A significant level of disturbance was recorded during the fauna survey; tracks, pastoralism and weed infestation. The majority of Drainage Line and Riverine habitats were generally in 'good' condition due to weed infestation spread through pastoralism; some areas were also heavily impacted from grazing and therefore the introduction and spread of Buffel Grass (Thompson and Thompson 2010).

Riverine habitat is considered to be of high importance to fauna species providing a range of ecological values to a wide suite of species. This habitat type in the survey area was often narrow linear isolated pockets of riparian vegetation which is usually denser, taller and more diverse than the adjacent Drainage Line habitat. The vegetation was complex and diverse and provided a range of micro niches for fauna species to exploit such as shelter and foraging. There were also a significant number of permanent and semi-permanent water bodies providing drinking opportunities to a range of species along with attracting prey for predators. This habitat supports conservation listed fauna species such as the Rainbow Bee-eater and Fortescue Grunter and acts as foraging sites for Ghost Bats and Pilbara Leaf-nosed Bats.

Thirteen permanent pools (approximately 16.4 ha) were recorded within the survey area in the Riverine habitat (Figure H.1, Table H.2, Appendix H). The area of these pools expands during times of inundation and periodically flood with the advent of cyclones. Due to the dry conditions leading up

to the survey, surface water had contracted back to these permanent pools, some of which are groundwater fed (Dobbs and Davies 2009). These pools are considered a significant fauna habitat due to the refuge they provide to fish, amphibians and water fowl during dry times and the dense vegetation they support.

Drainage Line habitat is a commonly recorded habitat for the Pilbara region and considered to be of low to moderate value to a wide spectrum of fauna species. The Drainage Line habitat typically exhibits a moderate diversity of microhabitats, with some tree hollows and woody debris (logs and leaf litter). However, within the survey area this habitat was generally devoid of vegetation when compared to Riverine, with less dense and less complex vegetation associations. There were some locations with water bodies, albeit less significant and less permanent, and would likely be seasonally inundated during large rainfall events only. Conservation listed species including the Rainbow Bee-eater and Lined Soil-crevice Skink may occur in this habitat.

Table 18: Terrestrial fauna habitat types recorded in the survey area.

Habitat type	Extent in survey area (proportion)	Broad habitat description	Vegetation description	Habitat condition	Value (broad faunal assemblage and MNES species)	Representative photos	
Riverine	397.5 ha (18.7%)	Densely vegetated riparian zones of the Robe River often with permanent and semi-permanent water bodies on stony soils	*Eucalyptus camaldulensis* and *Melaleuca argentea* open forest over *Acacia* tall open shrubland over mixed open herbland and open hummock grassland.	Good to High Quality	High value to a wide spectrum of fauna species that are likely to reside in Riverine habitats. Moderate value to target MNES species as they are likely to traverse and forage within this habitat type.		
Drainage Line	1,713.6 ha (80.5%)	Broad open valley floor of the Robe River on stony soils	*Eucalyptus camaldulensis* or *Corymbia hamersleyana* woodland over *Acacia* tall open shrubland over mixed open herbland and *Triodia wiseana* hummock grassland.	Disturbed to Good Quality	Moderate value to a wide spectrum of fauna species that are likely to reside in Drainage habitats. Low value to target MNES species as they do not provide significant refugia or shelter.		

Habitat type	Extent in survey area (proportion)	Broad habitat description	Vegetation description	Habitat condition	Value (broad faunal assemblage and MNES species)	Representative photos	
Disturbed	16.9 ha (0.8%)	Cleared areas from mining and pastoralism activities	N/A	Highly Degraded	Little value as fauna habitat.	No picture available	No picture available

4.2.4 Terrestrial Vertebrate Fauna Species

Thirty-one terrestrial vertebrate fauna species, comprising two reptiles and 29 bird species were recorded within the survey area (Table 19). This includes one conservation significant species; the Rainbow Bee-eater which is listed as Migratory under the EPBC Act and Schedule 5 under the WC Act (Appendix L).

Table 19: Terrestrial fauna species recorded during the survey.

Species name	Common name
Reptiles	
Ctenophorus caudicinctus	Ring-tailed Rock Dragon
Heteronotia binoei	Bynoe's Gecko
Birds	
Anas superciliosa	Pacific Black Duck
Aythya australis	Hardhead
Tachybaptus novaehollandiae	Australasian Grebe
Phaps chalcoptera	Common Bronzewing
Eurostopodus argus	Spotted Nightjar
Phalacrocorax varius	Pied Cormorant
Pelecanus conspicillatus	Australian Pelican
Ardea novaehollandiae	White-faced Heron
Ardea pacifica	White-necked Heron
Haliastur sphenurus	Whistling Kite
Fulica atra	Eurasian Coot
Platycercus zonarius zonarius	Australian Ringneck
Cacatua sanguinea	Little Corella
Chrysococcyx basalis	Horsfield's Bronze Cuckoo
Merops ornatus	Rainbow Bee-eater
Malurus lamberti assimilis	Variegated Fairy-wren
Gerygone fusca	Western Gerygone
Smicrornis brevirostris	Weebill
Ptilotula penicillatus	White-plumed Honeyeater
Lichmera indistincta	Brown Honeyeater
Pomatostomus temporalis	Grey-crowned Babbler
Colluricincla harmonica	Grey Shrike-thrush
Pachycephala rufiventris	Rufous Whistler
Rhipidura albiscapa	Grey Fantail
Rhipidura leucophrys leucophrys	Willie Wagtail
Grallina cyanoleuca	Magpie-lark
Corvus orru	Torresian Crow
Acrocephalus australis	Australian Reed Warbler
Neochmia ruficauda subclarescens	Star Finch (Western)

4.2.5 Conservation Significant Terrestrial Vertebrate Fauna Recorded

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater (Mi; S5) is one of the most common and widespread birds in Australia and was a commonly recorded species during bioregional surveys in the Pilbara (Burbidge, Johnstone, and Pearson 2010). The species winters from the Gascoyne north to Indonesia, moving south mainly in late September and early October and north from February to April (Johnstone and Storr 1998). Rainbow Bee-eaters tend to prefer lightly wooded, preferably sandy country near water (Johnstone and Storr 1998).

The Rainbow Bee-eater was recorded during the field survey at five locations throughout the survey area in both the Riverine and Drainage Line habitats (Figure L.1, Appendix L). Sixteen previous records of this species were made within the survey area (Astron Environmental Services 2014, 2016d, 2016f; Biota Environmental Sciences 2011b; Department of Parks and Wildlife 2015g; ecologia Environment 2013) and numerous records exist in the vicinity of the survey area (Astron Environmental Services 2011, 2016e, 2016f; Biologic Environmental Survey 2014; Biota Environmental Sciences 2010a; ecologia Environment 2013).

4.2.5.1 Conservation Listed Species Potentially Occurring in the Survey Area

Five species, the Pilbara Olive Python (Vu; S3), Eastern Great Egret (Mi; S5), Northern Quoll (En; S2), Ghost Bat (Vu; S3) and Pilbara Leaf-nosed Bat (Vu; S3) have been previously recorded in the survey area and were considered to have a high likelihood of occurring (Table L.1, Appendix L).

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python (VU; S3) prefers escarpments, deep gorges, water holes and rock piles associated with permanent pools in rocky areas in the ranges of the Pilbara region (Pearson 1993; Wilson and Swan 2010). Microhabitat preferences of the Pilbara Olive Python are under rock piles, on top of rocks or under spinifex (Tutt et al. 2004). Individuals spend the cooler winter months within caves and rock crevices away from water sources. In the warmer summer months the pythons are found to move around widely, usually in close proximity to water and rock outcrops (Wilson and Swan 2010). A population is known to exist along the Robe River near Pannawonica (Biota Environmental Sciences 2007). There have been three Pilbara Olive Pythons previously recorded within the survey area in the Riverine habitat (Astron Environmental Services 2016d, 2016f) (Figure L.1, Appendix L). This species occurs within the Riverine habitats particularly in the sites that contain semi-permanent and permanent water. The Pilbara Olive Python has been previously recorded in the vicinity of the survey area (Astron Environmental Services 2016e, 2016f; Biologic Environmental Survey 2014).

Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret (Mi; S5) is an inland wetland specialist often seen wading in a range of wetlands from lakes, rivers and swamps to estuaries (Johnstone and Storr 1998). Eastern Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in small groups. This species has been previously recorded within the survey area in the Riverine habitat (Astron Environmental Services 2014) and in the vicinity of the survey area (Astron Environmental Services 2014, 2016f; ecologia Environment 2013) (Figure L.1, Appendix L). The Eastern Great Egret is likely to be present at permanent pools within the Riverine and Drainage Line habitats of the survey area.

Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll (EN; S2) occurs in a variety of habitats (Oakwood 2008) but is commonly found in open lowland savannah forest and rocky escarpments. Rocky areas are a particularly important zone for quolls in the Pilbara as these areas retain water and provide a diversity of microhabitats. These areas also tend to have greater floristic diversity and productivity resulting in greater prey density compared to non-rocky areas. These rocky areas also provide refuge from feral cats, fire and livestock (Hill and Ward 2010) and provide breeding potential (Department of the Environment 2013).

The Northern Quoll has previously been recorded for the survey area and within the general vicinity (Astron Environmental Services 2014, 2016d, 2016e, 2016f; Biologic Environmental Survey 2014; Biota Environmental Sciences 2005, 2007, 2011b; ecologia Environment 2013). Within the survey area the Northern Quoll has been recorded at nine locations, in the Riverine habitat type (Astron Environmental Services 2016d, 2016f) (Figure L.1, Appendix L). The Riverine and Drainage Line habitats of the survey area do not contain the rocky habitats this species requires for its den/shelter sites. However, these habitats are likely to be used as foraging sites, in particular when in close proximity to breakaways or gorges.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

Pilbara Leaf-nosed Bats (VU; S3) are known to require deep caves characterised by high levels of humidity and stable temperatures (Churchill 2008). This is a result of their limited ability to conserve heat and water (Armstrong 2001; Churchill 1991). Caves deep enough to create this environment are relatively uncommon in the Pilbara, with only 20 to 25 roost sites being known (R. Bullen 2014, pers. comm. 20 Oct 2014). Foraging habitat for the Pilbara Leaf-nosed Bat is diverse and includes riparian vegetation, hummock grassland, and sparse tree and shrub savannah (Duncan, Baker, and Montgomery 1999). Pilbara Leaf-nosed Bats have also been recorded flying over small watercourses amongst granite boulder terrain, over pools and low shrubs in ironstone gorges, and above low shrubs and around pools in gravelly watercourses with *Melaleuca leucadendron*, such as in Barlee Range Nature Reserve (Armstrong 2001). In the Pilbara this bat species has been observed in *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *E. camaldulensis* along the creeks (Armstrong 2001; Churchill 1991).

The Pilbara Leaf-nosed Bat has previously been recorded in the survey area at seven different locations (Astron Environmental Services 2014, 2016f) (Figure L.1, Appendix L) and within the general vicinity (Astron Environmental Services 2014, 2016d, 2016e, 2016f; Biota Environmental Sciences 2009, 2010a; ecologia Environment 2013). The habitats of the survey area lack the caves required as roost sites for this species. The complex vegetation of the Riverine and Drainage Line habitats provide ideal foraging habitat, especially in areas surrounding permanent water sources.

Ghost Bat (*Macroderma gigas*)

The preferred habitat of Ghost Bats (VU; S3) is considered to be rocky gorges and breakaways that support caves and crevices used as maternity roosts. The Ghost Bat uses different natural formations for various purposes and for groups to persist they generally require habitats that provide:

- a selection of roosting opportunities with night roosts or feeding sites, day roosts and at least one deep cave with characteristics of a maternity roost
- nearby gullies and gorges with vegetation of vertical complexity (diverse vegetation heights and density) and presence of water that would attract prey species

- a productive foraging area within a 5 km to 10 km radius, usually including a good quality riparian drainage line.

The Ghost Bat has been previously recorded within the vicinity of the survey area from past fauna surveys (Astron Environmental Services 2014, 2016e, 2016f; Biologic Environmental Survey 2014; Biota Environmental Sciences 2005, 2006b, 2009, 2010a, 2011b). Within the survey area Astron (2014) has previously recorded the presence of Ghost Bats at a single location (Figure L.1, Appendix L). The habitats of the survey area lack the caves required as roost sites for this species, although the complex vegetation of the Riverine and Drainage Line habitats provides ideal foraging habitat, especially in areas surrounding permanent water sources.

Other Potential Conservation Significant Species

Of the potentially occurring conservation significant fauna species, nine species were not found in the survey area but were all considered to have a moderate likelihood of occurrence: Fork-tailed Swift (Mi; S5), Cattle Egret (Mi; S5), Letter-winged Kite (P4), Australian Painted Snipe (EN; S2), Common Sandpiper (Mi; S5), Sharp-tailed Sandpiper (Mi; S5), Wood Sandpiper (Mi; S5), Common Greenshank (Mi; S5) and Oriental Pratincole (Mi; S5) (Table L.1, Appendix L). Suitable habitat is present for these species within the survey area; however, these species are either seasonal migrants and/or only present at certain times of the year or cryptic species such as Australian Painted Snipe and Oriental Pratincole, making individuals difficult to record during fauna surveys.

An additional 13 species not found in the survey area were considered to have a low likelihood of occurrence due to lack of suitable habitats (Table L.1, Appendix L).

4.3 Aquatic Ecosystem

This section contains a summary of results from the aquatic baseline survey completed by WRM. For more detail on this component refer to Appendix A.

4.3.1 Water Quality

Water quality was highly variable amongst sites, with salinity levels ranging from fresh (592 µS/cm) to brackish (1,700 µS/cm), pH from circum-neutral (6.9) to slightly alkaline (7.9) and dissolved oxygen from hypoxic (14.5%) to supersaturated (134.9%). There were no obvious longitudinal gradients in water quality parameters upstream or downstream of the Mesa H development.

Exceedances of ANZECC/ARMCANZ (2000) default TVs for the protection of 95% of species in slightly-moderately disturbed tropical northern Australian systems were recorded for nitrogen nutrients (N-total, N-NO_x and N-NH_3) at most sites upstream and downstream of the Jimmawurrada-Robe confluence. The majority of heavy metal analytes, with the exception of dissolved zinc at RRU5 and RRD3, did not exceed ANZECC/ARMCANZ (2000) default 95% TV s in the survey area.

4.3.2 Microinvertebrates

A total of 81 microinvertebrate taxa were recorded from the survey area, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69 were recorded at upstream reference sites. There were no significant differences in total mean microinvertebrate taxa richness between reference and potentially exposed sites, nor was there any significant difference in richness of any of the major microinvertebrate groups (protists, rotifers, micro-crustaceans) between these reaches.

One microinvertebrate species listed for conservation significance, the calanoid copepod *Eodiaptomus lumholtzi* (International Union for Conservation of Nature (IUCN) Vulnerable), was recorded at potentially exposed site RRD6.

4.3.3 Hyporheic Fauna

A total of 59 taxa were recorded from hyporheic samples, the majority of which were species not specially adapted to groundwater environments (stygoxene). Of these 59 taxa, 8% were considered stygobitic (obligate groundwater inhabitants), 31% occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), and 2% possible hyporheic taxa.

Stygobitic taxa collected included the amphipod *Nedsia* sp., the thermosbaenacean *Halosbaena tulki*, and the ostracods *Candonopsis* cf. *tenuis* and *Vestalenula marmonieri*. Of these, *Nedsia* sp. is considered a SRE species. *Nedsia* sp. was collected from sites potentially exposed to dewatering discharge (RRD1 – 4), as well as upstream reference sites (RRU3, RRU4 & RRU6).

4.3.4 Macroinvertebrates

A total of 148 macroinvertebrate taxa were recorded from surface waters (117 from upstream reference sites, and 116 from downstream potentially exposed sites). One macroinvertebrate species listed for conservation significance, the Pilbara Pin Damselfly *Eurysticta coolawanyah* (IUCN Near Threatened), was recorded at potentially exposed downstream sites RRD3 and RRD4.

4.3.5 Fish

A total of 3,515 individual fish, representing 11 species, were captured, measured and released in the survey area. True freshwater species included Western Rainbowfish, Spangled Perch, Pilbara Tandan (Eel-tailed Catfish), Fortescue Grunter, Barred Grunter, Terapontidae (Grunter) hybrids and Bony Bream. Estuarine/marine vagrant fish species included Milkfish, Tarpon/Ox-eye Herring, Mullet and Banded Scat/Striped Butterfish, the majority of which were recorded at the downstream reach. The conservation listed Fortescue Grunter (*Leiopotherapon aheneus*; IUCN Lower Risk/Near Threatened; P4) was the second most abundant fish species of the survey area, recorded at all sites both upstream and downstream of the proposed Mesa H development.

4.3.6 Aquatic Species of Conservation Significance

During the aquatic survey, four species of conservation significance were recorded in the survey area. These records are summarised in Table 20 and the locations shown in Appendix A.

Table 20: Aquatic fauna species of conservation significance recorded during the survey.

Species	Common name	Conservation Value	Occurrence within the Mesa H survey area	Occurrence elsewhere
Microinvertebrates				
Eodiaptomus lumholtzi	Calanoid copepod	IUCN Vulnerable	RRD6	Koodaderi Spring, Homestead Tributary, Mindy Mindy Creek, Cane River, Northern Territory and Queensland
Stygobitic/SRE invertebrates				
Nedsia spp.	Stygobitic amphipod	Potential short range endemic (data deficient)	RRD1 – 4, RRU3, RRU4 and RRU5	Uncertain, possibly bores within the Yarraloola area
Macroinvertebrates				
Eurysticta coolawanyah	Pilbara Pin Damselfly	IUCN Near Threatened, Pilbara endemic	RRD3 and RRD4	Widespread throughout the Pilbara, though infrequently collected
Fish				
Leiopotherapon aheneus	Fortescue Grunter	IUCN Near Threatened, P4, Pilbara endemic	All sites	Robe River catchment, Fortescue River (below Fortescue Marsh); Ashburton River

5 Discussion

5.1 Overview of Survey Area

The Robe River supports extensive woodlands of *M. argentea* and *E. camaldulensis* subsp. *refulgens* (River Red Gum) over sedges in the main channels, and is surrounded by sparely vegetated shingle beds and tall shrublands of *Acacia trachycarpa* and *Petalostylis labicheoides*. Tributaries of the river exhibited deeper soils supporting higher vegetation density at the shrub and grass stratum. *Eucalyptus camaldulensis* subsp. *refulgens* and *E. victrix* woodlands, mixed *Acacia* shrubs and **C. ciliaris* and **C. setiger* tussock grasses were common to these drainage lines which flow into the Robe River.

5.2 Vegetation

Five vegetation associations were mapped within the survey area. No vegetation community that represent a Commonwealth or State listed TEC or PEC was recorded within the survey area.

The majority of vegetation within the survey area was considered to be in 'very good' condition, but ranged from 'poor to 'excellent'. There was a relatively high diversity and abundance of weeds, although this is typical of drainage systems in the Pilbara bioregion. Vegetation of the Robe River typically occurs on shingle rock and occasionally soft sand where weed species such as **A. ochroleuca* subsp. *ochroleuca* (Mexican Poppy), **Cenchrus* species (spp.) (Buffel and Birdwood Grasses), and **Passiflora foetida* subsp. *hispida* (Stinking Passion Flower) contribute to a decline in vegetation condition.

A number of permanent and semi-permanent pools (Plate 8 and 9) occur in the survey area and are typically fringed by vegetation association EcMaCv dominated by *M. argentea* and *E. camaldulensis* var. *refulgens*. These vegetation associations are consistent with the vegetation that typically occurs along minor and major channels within the River land system. The River land system accounts for 2.3% of the Pilbara, and the river channels constitute 20% of this area (van Vreeswyk et al. 2004). Vegetation association EcMaCv is considered a GDE due to the dominant species being *M. argentea* and *E. camaldulensis* var. *refulgens*. *Melaleuca argentea* and *E. camaldulensis* var. *refulgens*, and therefore the vegetation they occur within, may be sensitive to changes in water depth and availability.

Plate 8: Permanent water fringed by *Melaleuca argentea*.

Plate 9: Permanent water supporting *Typha domingensis*.

5.3 Flora

The suite of flora species recorded was considered typical of what may be expected in the area (Beard 1975; Payne, Mitchell, and Holman 1988). Rainfall in the weeks preceding four of the seven field surveys informing this assessment was below average. It is likely that some annual and herbaceous species would have been more widespread but were not observed during the below average seasonal conditions experienced during some surveys. Despite this, specimens generally had adequate material to allow for confident identification.

Areas considered 'likely' or 'potential' habitat for Threatened or Priority flora were targeted and searched. Three Priority flora species were recorded within the survey area: *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3, *L. alfredii* P4 and *R. bungarensis* P4.

Occasional small clusters of *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3 were recorded in the survey area. These were generally the outer extent of a larger population that extended into the riparian zone beyond its favoured habitat of rocky slopes, hillcrests and ledges of mesas. Thirty-eight records of *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3 are listed at the WAHerb, with a known range of approximately 175 km (Western Australian Herbarium 1998-2016). Rio Tinto holds 3,443 records consisting of more than 238,000 *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) P3 individuals, with a geographical distribution spanning from Mesa A in the west to Mettawandy, a range of approximately 150 km (Rio Tinto Iron Ore 2016b).

One *L. alfredii* P4 (Millstream Fan Palm) individual was recorded within the Robe River in the Middle Robe and East Deepdale survey area (Astron Environmental Services 2016a). There is no other record of this species in close proximity to the survey area (Astron Environmental Services 2011; Biota Environmental Sciences 2003, 2006a, 2011a, 2012; Department of Parks and Wildlife 2015d, 2016a). There are 13 vouchered specimens for this species at the WAHerb (Western Australian Herbarium 1998-2016), the majority of which are associated with the Fortescue River in the Millstream Chichester National Park, but also extend to Cape Range and Duck Creek near Mount Brockman. Three hundred and fifty-nine individuals of *L. alfredii* P4 are listed on the Rio Tinto database (Rio Tinto Iron Ore 2016b), all of which are approximately 75 km south-east of the survey area.

Rhynchosia bungarensis P4 was recorded throughout the Robe River system, often in sheltered positions under the canopy of *Eucalyptus* and *Melaleuca* woodlands and where mesa landforms were immediately adjacent to the river. *Rhynchosia bungarensis* P4 has previously been recorded from within the survey area (Biota Environmental Sciences 2003, 2006a, 2011a). Seventy records of this species are listed at the WAHerb, with a known range of approximately 545 km (Western Australian Herbarium 1998-2016). The Rio Tinto database lists 10,865 individuals from 1,134 locations, distributed between Mesa A in the west, to Yandi, with a known range of approximately 360 km (Rio Tinto Iron Ore 2016b).

Although some *E. australis* were recorded from the survey area, the specimens observed had hairs on the leaf laminae differentiating them from the priority form. Given the small habit (≤10 cm) and often frequent occurrence of *E. australis*, not all individuals were observed and there is potential that *E. australis* var. *glabra* P2 occurred but was not recorded. *Euphorbia australis* var. *glabra* P2 has previously been recorded from Jimmawurrada Creek, but more typically occurs in the vicinity of Tom Price (Western Australian Herbarium 1998-2016).

Stylidium weeliwolli P2 is a delicate annual species that is difficult to observe when not in flower and may not have been present, should it occur, due to the low rainfall prior to the surveys. *Stylidium*

weeliwolli P2 has previously been recorded in the vicinity of the survey area; however, this location may be erroneous given the unsuitable habitat at the locality.

The small annual tussock grass *E. surreyana* P3 is unlikely to occur during dry conditions and would be difficult to observe post-rainfall if occurring among a grass-dominated lower stratum (such as **Cenchrus* spp. tussock grassland). *Eragrostis surreyana* has previously been recorded in Jimmawurrada Creek (Western Australian Herbarium 1998-2016), which runs through the eastern side of the survey area.

Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301) P3 was recorded within 100 m of the Riparian Community survey area (Astron Environmental Services 2016b). It is possible this species occurs within the survey area, given that suitable habitat is present.

Weed diversity and abundance in the survey area was considered high, with 23 species recorded. **Ocimum basilicum* (Basil) is rarely recorded species in the Pilbara bioregion, with the only record on Florabase being at the junction of the Pannawonica Road and North West Coastal Highway. No other weed species recorded represents a range extension or were atypical to a survey of this scale in the Robe Valley.

5.4 Terrestrial Fauna Habitats

Habitats within the survey area are not restricted at the local, sub-regional or regional scale and no restricted or uncommon geological units or land systems occur within the survey area. The Riverine habitat in the survey area is considered significant for fauna. The deep pools and shallow spring fed pools provide an important permanent water source for drinking and a refuge for amphibians and waterfowl that occur in a wide area up and downstream of the survey area. This habitat contains microhabitats not common in other habitat types such as large tree hollows, hollow logs and moist leaf litter which provide a productive ecosystem attracting and supporting a range of predators and prey. This habitat supports conservation listed fauna species such as the Rainbow Bee-eater and Pilbara Olive Python and acts as foraging sites for Northern Quolls, Ghost Bats and Pilbara Leaf-nosed Bats. The survey area contains some of the most important pools in the area (such as Yeera Bluff) that are significant ecological features to the local fauna both up and downstream. The springs and pools of the Robe River that occur in the survey area are considered wetlands of sub-regional significance (Kendrick 2001).

The Drainage Line habitats within the survey area are mainly the broad valley of the Robe River or minor ephemeral drainage lines that are not likely to provide significant refugia for species. Drainage Line habitats, although not necessarily large in terms of area, are common habitats within the Pilbara region and immediate surrounds, e.g. the Robe River.

5.5 Terrestrial Fauna Species

The fauna species recorded and faunal assemblage expected to occur in the survey area is typical of that from the Hamersley Range subregion as well as a subset of typical fauna assemblages across the Pilbara bioregion. The habitats of the survey area are also considered dispersal habitat for all resident fauna species including conservation significant species. The Riverine and Drainage Line habitats linear shape and complex vegetation form natural corridors that link habitats and provide routes for fauna dispersal.

Based on the number of previous records of the MNES species; Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat, the survey area and its surrounds potentially supports locally significant populations. These species may be locally common; however, their presence is restricted

to areas of preferred habitat. Although the fauna habitats of the survey area do not support the caves and den sites these species shelter in, they do provide quality foraging habitat in close proximity to an abundance of suitable shelter. This feature is an important component to supporting the populations and presence of the MNES species in the survey area and the surrounding area.

The Rainbow Bee-eater is one of the most widespread bird species in Australia (Barrett et al. 2003) and is commonly recorded in biological surveys. The Riverine and the Drainage Line habitats provide foraging habitat and in areas containing sandy substrate, such as river banks potential breeding habitat. Within the Pilbara this species is classified as a resident, winter visitor and a passage migrant (Johnstone, Burbidge, and Darnell 2013). As such, this species is not reliant upon the habitats found within the survey area.

The Eastern Great Egret occurs across the Pilbara and is considered uncommon to very common throughout that range (Johnstone, Burbidge, and Darnell 2013). This species has been previously recorded within the survey area in the Riverine habitat (Astron Environmental Services 2014) and in the vicinity of the survey area (Astron Environmental Services 2014, 2016f; ecologia Environment 2013).

5.6 Aquatic Ecosystem

5.6.1 Water Quality

Water quality was highly variable amongst sites, with salinity levels ranging from fresh (592 µS/cm) to brackish (1,700 µS/cm), pH from circum-neutral (6.9) to slightly alkaline (7.9) and dissolved oxygen from hypoxic (14.5%) to supersaturated (134.9%). There were no obvious longitudinal gradients upstream or downstream of the Jimmawurrada-Robe confluence.

Exceedance of ANZECC/ARMCANZ default 95% TVs was recorded for nitrogen nutrients (N-total, N-NO_x and N-NH_3) at most sites upstream and downstream of the Jimmawurrada-Robe confluence. Elevated background levels of N-NO_3 and N-NH_3 within the survey area are unsurprising, given that the Robe River catchment is already effected by current and historic pastoral practices, with groundwaters also appearing to be enriched. Cattle, or evidence of high cattle use (e.g. manure, hoof prints and trampled ground), were observed at a number of pools during the current survey. Elevated N-total and N-NO_x downstream of the Jimmawurrada-Robe confluence may also reflect discharge of nitrogen-enriched groundwater from existing mine operations, though the relative contribution of anthropogenic and natural sources to nitrogen enrichment in surface waters of the survey area is unknown. With the exception of dissolved zinc at RRU5 and RRD3, no heavy metal analyte exceeded ANZECC/ARMCANZ default 95% TVs in the survey area.

5.6.2 Aquatic Fauna

Current results indicate little ecological difference between “reference” sites upstream of the proposed Mesa H development, and downstream sites that may be potentially exposed to dewatering discharge operations. As such, these results provide a good starting point to enable the detection of any potential future ecological changes.

5.6.2.1 Microinvertebrates

A total of 81 microinvertebrate taxa were recorded from the survey area, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69 were recorded at upstream reference sites. The microinvertebrate fauna was generally typical of that commonly recorded from tropical/sub-tropical freshwater systems, comprising protists, rotifers,

copepods, cladocerans (water fleas) and ostracods (seed shrimp), with Lecanidae dominating within the Rotifera. There were no significant differences in total mean microinvertebrate taxa richness between reference and potentially exposed sites, nor was there any significant difference in richness of any of the major microinvertebrate groups (protists, rotifers, micro-crustaceans) between these reaches.

One microinvertebrate species listed for conservation significance, the calanoid copepod *Eodiaptomus lumholtzi* (IUCN Vulnerable), was recorded at potentially exposed site RRD6. The conservation listing of this species is considered in need of revision because it is now known to occur at numerous locations across the Pilbara region, including sites along the Fortescue River, Coondiner Creek, Kalgan Creek, Weeli Wolli Creek, Mindy Mindy Creek, Koodaideri Springs, Caves Creek, Duck Creek and the Cane River, as well as Papua New Guinea.

5.6.3 Hyporheic Fauna

Hyporheic sampling collected 59 taxa in total, the majority of which were species not specially adapted to groundwater environments (stygoxene). Of these 59 taxa, 8% were considered stygobitic (obligate groundwater inhabitants), 31% occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), and 2% possible hyporheic taxa. There were no obvious longitudinal gradients or patterns in hyporheic taxa richness between reference and potentially exposed sites, though hyporheic taxa richness was relatively high at RRD1, RRU6, RRD2 and RRU4, suggesting strong connectivity between ground- and surface waters at these sites.

One stygobitic taxa recorded (*Nedsia* sp.) is considered a SRE species. *Nedsia* sp. was collected from sites potentially exposed to dewatering discharge (RRD1 – 4), as well as upstream reference sites (RRU3, RRU4 and RRU6). These amphipods could not be confidently identified to species level due to a current lack of taxonomic resolution within the Melitidae amphipods and would require DNA sequencing.

5.6.4 Macroinvertebrates

A total of 148 macroinvertebrate taxa were recorded from surface waters, with composition typical of freshwater systems throughout the world. There were no clear upstream/downstream gradients in macroinvertebrate richness within the survey area, with no significant difference in mean total taxa richness, and mean richness of most major macroinvertebrate groups, between reference and potentially exposed sites. Similarly, multivariate analysis detected no distinguishable separation of reference or potentially exposed sites based on macroinvertebrate species assemblage structure.

One macroinvertebrate species listed for conservation significance, the Pilbara Pin Damselfly *Eurysticta coolawanyah* (IUCN Near Threatened), was recorded at potentially exposed downstream sites RRD3 and RRD4. It is likely that both RRD3 and RRD4 are important refuge pools for Pilbara Pin Damselfly in the area, as both are persistent waterbodies which support relatively high densities of emergent macrophyte, which are used for perching, mating and oviposition (egg-laying).

5.6.5 Fish

A total of 3,515 individual fish, representing 11 species, were recorded in the survey area. True freshwater species included Western Rainbowfish, Spangled Perch, Pilbara Tandan (Eel-tailed Catfish), Fortescue Grunter, Barred Grunter, Terapontidae (Grunter) hybrids and Bony Bream. Estuarine/marine vagrant fish species included Milkfish, Tarpon/Ox-eye Herring, Mullet and Banded Scat/Striped Butterfish, the majority of which were recorded at the downstream reach. There was no significant difference in mean total abundance of fish between upstream and downstream sites,

nor was there any significant difference in mean abundance of each individual species between the reaches. Healthy (breeding) populations of Western Rainbowfish, the most abundant fish species of the survey area, were recorded from both the upstream and downstream reaches; however, Spangled Perch and Pilbara Tandan recruitment appeared to be low throughout the survey area.

The conservation listed Fortescue Grunter (*Leiopotherapon aheneus*; IUCN Lower Risk/Near Threatened; P4) was recorded at all sites both upstream and downstream of the proposed Mesa H development. This species is endemic to the Pilbara, only known from the Fortescue, Robe and Ashburton River systems. Within this range it is considered to be common and was the second most abundant fish collected during the survey.

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Appendix A: Mesa H Baseline Aquatic Ecosystem Survey – Wet Season Sampling 2016

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Mesa H Project

Baseline Aquatic Ecosystem Survey
Wet Season Sampling 2016

WRM
Wetland Research & Management

Final Report
April 2017

Mesa H Project

Baseline Aquatic Ecosystem Survey
Wet Season Sampling 2016

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Final
April 2017

Frontispiece (left to right): freshwater mussels (*Velesunio* spp.) at RRU6, upstream of the Jimmawurrada-Robe confluence; RRD5 at Gnieraoora/Dthulurat; measuring milkfish (*Chanos chanos*) at RRD4 in the Medawandy Waters area.

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Recommended Reference Format

WRM (2017) Mesa H Project Baseline Aquatic Ecosystem Surveys - Wet Season Sampling 2016. Unpublished report to Astron Environmental Services Pty Ltd by Wetland Research & Management. Final Report, April 2017.

Acknowledgements

WRM thank Mathew Love for overall management of the project on behalf of Astron Environmental Services Pty Ltd (Astron). Dr Stuart Pearse and John Trainer (Astron) are thanked for comments on the draft report. Laboratory analyses of surface water quality samples collected by WRM were performed by ChemCentre, Bentley WA. Groundwater data were provided courtesy of the Proponent. Adrian Pinder (Parks and Wildlife) is thanked for providing raw data from the Pilbara Biological Survey (PBS), and Streamtec Pty Ltd/UWA are thanked for sharing their unpublished reports on the aquatic fauna of the Robe River. The authors acknowledge, and are very grateful to the Kuruma-Marthudunera Traditional Owners and in particular Brendan Bobby, for sharing their stories, welcoming us to the land and allowing the sampling of the river pools.

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Document history

Version	Date submitted to reviewer	Reviewed by	Date comments received
Draft v0	15/09/16	Dr Andrew Storey (WRM, internal review)	15/09/16
Draft v1	16/09/16	Dr Stuart Pearse & John Trainer (Astron)	21/09/16
Draft v2	30/09/16	Peter Royce, Melinda Brand & Emma Carrol (Rio Tinto)	20/03/17
Final	19/04/17		

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EXECUTIVE SUMMARY

This report summarises the results of a baseline sampling program for aquatic ecosystems of the Robe River system, both upstream and downstream of the proposed Mesa H iron ore development ("the Project"), managed by Rio Tinto on behalf of the Proponent (Robe River Mining Co. Pty Ltd) in the West Pilbara region of Western Australia. The aim of the sampling program was to document the current ecological condition of the Robe River prior to the implementation of the Mesa H development, which will require dewatering and surplus water discharge, which will result in a surface discharge footprint along the Robe River. The baseline survey included a number of named permanent pools in the Project area known to have ecological and cultural value, such as Gnieraoora (or Dthulurat) at Yeera Bluff. This report also includes a review of previous aquatic fauna surveys of the Robe River, and other nearby systems (*e.g.* Bungaroo Creek, Jimmawurrada Creek and Mungarathoona Creek), including conservation significant species known to occur in the vicinity of the Project area, which provides regional context for the sampling program.

The sampling design included six sites downgradient of the confluence of Jimmawurrada Creek and the Robe River (immediately upstream of the existing Mesa J operation) (RRD1 - 6), which are likely to fall within the zone of dewatering discharge (*i.e*. 'potentially exposed' sites), and six sites (RRU1 - 6) located upstream of the confluence (*i.e.* 'reference' sites). Sites were surveyed during the late wet season (April/May) 2016. The permanency and consistency of flow in the Robe River is already influenced by groundwater abstraction and dewatering discharge from the existing Mesa J mine operation, and so the current sampling program documents "current" ecological condition, more so than "natural" condition. Water quality, microinvertebrates (zooplankton), hyporheic fauna, macroinvertebrates and fish were successfully sampled at each of the 12 sites.

The main findings of the baseline survey were:

- Water quality was highly variable amongst sites, with salinity levels ranging from fresh (592 µS/cm) to brackish (1,700 µS/cm), pH from circum-neutral (6.9) to slightly alkaline (7.9) and dissolved oxygen from hypoxic (14.5%) to supersaturated (134.9%). There were no obvious longitudinal gradients in water quality parameters upstream or downstream. Site RRU6 (~1 km upstream of the Jimmawurrada-Robe confluence) and the downstream sites tended to have higher salinity (as electrical conductivity and total dissolved solids), alkalinity, hardness and concentrations of associated ions, than sites upstream. Some of this variability was attributed to differences in volume of the remnant pools sampled and evapoconcentration effects under recessional flows, however, higher concentrations of some ions downstream of the Jimmawurrada-Robe confluence (most notably magnesium and sulfate) was considered a possible artefact of current mining operations.
- Exceedances of ANZECC/ARMCANZ (2000) default trigger values for the protection of 95% of species in slightly-moderately disturbed tropical northern Australian systems were recorded for nitrogen nutrients (N-total, N-NO_x and N-NH_3) at most sites upstream and downstream of the Jimmawurrada-Robe confluence. Elevated background levels of N-NO_3 and N-NH_3 within the Project area are unsurprising, given that the Robe River catchment is already effected by current and historic pastoral practices, with groundwaters also appearing to be enriched. Elevated N-total and N-NO_x downstream of the Jimmawurrada-Robe confluence may also reflect discharge of nitrogen-enriched groundwater from existing mine operations, though the relative contribution of anthropogenic and natural sources to nitrogen enrichment in surface and groundwater of the Project area is unknown. The majority of heavy metal analytes, with the exception of dissolved zinc at RRU5 and RRD3, did not exceed ANZECC/ARMCANZ (2000) default 95% trigger values in the Project area.
- A total of 81 microinvertebrate taxa were recorded from the Project area, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69

were recorded at upstream reference sites. The microinvertebrate fauna was generally typical of that commonly recorded from tropical/sub-tropical freshwater systems, comprising Protista, Rotifera, Copepoda, Cladocera (water fleas) and Ostracoda (seed shrimp), with species from the family Lecanidae dominating within the Rotifera. There were no significant differences in total mean microinvertebrate taxa richness between reference and potentially exposed sites, nor was there any significant difference in richness of any of the major microinvertebrate groups (protists, rotifers, micro-crustaceans) between these sites. One microinvertebrate species listed for conservation significance, the copepod *Eodiaptomus lumholtzi* (IUCN Vulnerable), was recorded at potentially exposed site RRD6. The conservation listing of this species is considered in need of revision because it is known to occur at numerous locations across the Pilbara region, including sites along the Fortescue River, Coondiner Creek, Kalgan Creek, Weeli Wolli Creek, Mindy Mindy Creek, Koodaideri Springs, Caves Creek, Duck Creek and the Cane River, as well as Papua New Guinea.

- A total of 59 taxa were recorded from hyporheic samples, the majority of which were species not specially adapted to groundwater environments (stygoxene). Of these 59 taxa, 8% were considered stygobitic (obligate groundwater inhabitants), 31% occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), and 2% possible hyporheic taxa. There were no obvious longitudinal gradients or patterns in hyporheic taxa richness between reference and potentially exposed sites, though hyporheic taxa richness was relatively high at RRD1, RRU6, RRD2 and RRU4, suggesting strong connectivity between ground- and surface waters at these sites. Stygobitic taxa collected included the amphipod *Nedsia* sp., the thermosbaenacean *Halosbaena tulki,* and the ostracods *Candonopsis* cf. *tenuis* and *Vestalenula marmonieri.* Of these, *Nedsia* sp. is considered a potential short range endemic (SRE) species. *Nedsia* sp. was collected from sites potentially exposed to dewatering discharge (RRD1 – 4), as well as upstream reference sites (RRU3, RRU4 and RRU6).
- A total of 148 macroinvertebrate taxa were recorded from surface waters (117 from upstream reference sites, and 116 from downstream potentially exposed sites), with composition typical of freshwater systems throughout the world, being dominated by Insecta, in particular Diptera (true flies) and Coleoptera (aquatic beetles). There were no clear upstream/downstream gradients in macroinvertebrate richness within the Project area, with no significant difference in mean total taxa richness, or mean richness of most major macroinvertebrate groups, between reference and potentially exposed sites. Similarly, multivariate analysis detected no distinguishable separation of reference or potentially exposed sites based on macroinvertebrate species assemblage structure. One macroinvertebrate species listed for conservation significance, the Pilbara pin damselfly *Eurysticta coolawanyah* (IUCN Near Threatened), was recorded at potentially exposed downstream sites RRD3 and RRD4.
- A total of 3,515 individual fish, representing 11 species, were recorded in the Project area. True freshwater species included western rainbowfish, spangled perch, Pilbara tandan (eel-tailed catfish), Fortescue grunter, barred grunter, Terapontidae (grunter) hybrids and bony bream. Estuarine/marine vagrant fish species included milkfish, tarpon/ox-eye herring, mullet and banded scat/striped butterfish, the majority of which were recorded at the downstream reach. The conservation listed Fortescue grunter (*Leipotherapon aheneus*; IUCN Lower Risk/Near Threatened; Parks and Wildlife Priority 4) was the second most abundant fish species of the Project area, recorded at all upstream and downstream sites. Similar to other fauna indices, there was no significant difference in mean total abundance of fish between upstream and downstream sites, nor was there any significant difference in mean abundance of each individual species within the Project area. Healthy (breeding) populations of western rainbowfish, the most abundant fish species of the Project area, were recorded from upstream and downstream reaches; however, spangled perch and Pilbara tandan recruitment appeared to be low throughout the Project area.

1 INTRODUCTION

1.1 Background

Robe River Mining Co. Pty Ltd (the Proponent) is evaluating the potential development of the Mesa H iron ore deposit, located 16 km south-west of Pannawonica, in the West Pilbara region of Western Australia (Figure 1). The development envelope for Mesa H traverses the Robe River and lies adjacent to the existing Mesa J mine operation.

As part of the Mesa H development, dewatering of underlying groundwater will be required to allow mining of sections of ore (~20%) which occur below the water table (BWT). Options for disposal of excess dewatering water from the Mesa H development include discharge to an unnamed ephemeral tributary of the Robe River, between Mesa H and Mesa J, and/or discharge into Jimmawurrada Creek, east of Mesa J (Figure 1, or potentially an additional location north of Mesa H). The former two discharge points are currently used by the Mesa J operation.

The permanency and consistency of flow in the Robe River is already influenced by groundwater abstraction and dewatering discharge from existing mine operations (Aquaterra 2004). Groundwater drawdown and discharge from Mesa H may also affect aquatic ecosystems in the local vicinity. This includes a number of named permanent pools known to have ecological and cultural value, such as Gnieraoora (or Dthulurat) at Yeera Bluff (Figure 1).

Astron Environmental Service Pty Ltd (Astron) commissioned *Wetland Research & Management* (WRM) to design and conduct a baseline sampling program encompassing aquatic ecosystems of the Robe River both upstream and downstream of the Mesa H development (the "Project area"). The aim of the sampling program is to document current ecological condition of the system, and procure benchmark aquatic fauna and water quality data against which any future changes may be assessed post-commencement of the Mesa H development, including cumulative effects from dewatering drawdown ('drying') and discharge (quality and quantity). The permanency and consistency of flow in the Robe River is already influenced by groundwater abstraction and dewatering discharge from the Mesa J mine, and so the current sampling program will document "current" ecological condition moreso than "natural" condition. Where possible, monitoring sites established by Streamtec Pty Ltd (Streamtec) and The University of Western Australia (UWA) on the Robe River (Figure 1) have been included in the program. Since 1991, annual sampling for fish and benthic macroinvertebrates has been conducted by Streamtec/UWA as part of long-term monitoring for the Mesa J Project (Streamtec 1996, 1999, 2003, 2007, 2009, 2010, 2012 and 2014, Dobbs and Davies 2009).

1.1.1 Legislative framework

At a State level, native aquatic fauna are protected under the *Wildlife Conservation Act 1950* (WC Act) and their environment is protected under the *Environmental Protection Act 1986* (EP Act). This includes freshwater turtles, frogs, fish and invertebrates (including hyporheic and stygal invertebrates). Hyporheic invertebrates inhabit subsurface interstitial spaces in coarse creek bed sediments. Stygal invertebrates are aquatic, obligate groundwater-dwelling species known to be present in a variety of rock types and are often also present in the hyporheos.

The EP Act provides for environmental impact assessment (EIA) of proposals (and schemes) likely to have a significant effect on the environment. As part of the EIA process, the Act requires the Environmental Protection Authority of Western Australia (EPA) to report on key environmental factors to the Minister for Environment. Environmental factors and associated objectives are the EPA's basis for assessing whether a proposal (or scheme's) impact on the environment is acceptable. Two key environmental factors relate to water resources:

i) Hydrological Processes - with the objective "To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected".

ii) Inland Waters Environmental Quality - with the objective "To maintain the quality of groundwater and surface water so that environmental values are protected".

Proponents are required to provide baseline information on these two factors (and others) in order to inform the EIA process.

The WC Act provides for species and ecological communities to be specially protected and listed as either 'threatened' because they are under identifiable threat of extinction, or 'priority' because they are rare, or otherwise in need of special protection. This encompasses species with small distributions (occupying an area of less than 10, 000 km^2) defined as short range endemics, or SREs (Harvey 2002, EPA 2009). The EPA's Guidance Statement 20 (EPA 2009) requires that impacts on SRE invertebrates be considered during the EIA process.

It can be difficult to determine whether or not a species belonging to a SRE Group is actually a species with a range <10,000 km^2. The Western Australian Museum (WAM) uses a three-tier classification scheme for SRE species which we have applied to hyporheic fauna in this report:

- **Confirmed SREs** are species with a known distribution range <10,000 km^2. The taxonomy is well known and the group is well represented in collections and/or via comprehensive sampling.

- **Potential SREs** are species that belong to a group where there are gaps in our knowledge of the taxon, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is imperfectly understood because sampling has been patchy.

- **Widespread (not SRE) species** have a known distribution range >10,000 km^2. The taxonomy is well known and the species is well represented in collections and/or via comprehensive sampling.

WAM further uses five sub-categories if a species is determined to be a "Potential SRE". These sub-categories are:

1. Data deficient: There are insufficient data available to determine SRE status, either because there is a lack of geographic and taxonomic information, or because the individuals sampled cannot be identified to species level (*e.g.* wrong sex, juvenile, damaged);

2. Habitat Indicators: The status of a species can be elucidated through its association with a particular habitat and vice versa;

3. Morphological Indicators: The status of a species can be determined through its morphological characteristics;

4. Molecular Evidence: DNA sequence data reveal patterns congruent or incongruent with SRE status for a species; and

5. Research & Expertise: Available research data and/or WAM expertise provide the basis for a decision about the species' status.

The Department of Parks and Wildlife (Parks and Wildlife) also maintains a list of priority fauna species that are of conservation importance but, for various reasons, do not meet the criteria for listing as threatened. Parks and Wildlife uses the International Union for Conservation of Nature (IUCN) Red List

criteria for assigning species and communities to threat categories. Not all Western Australian species listed by the IUCN are also listed by Parks and Wildlife.

Objectives for the management of potential impacts on water-dependent ecosystems are also outlined in the Western Australian Department of Water (DoW) Western Australian Water in Mining Guideline (DoW 2013) and include:

- Minimise the adverse effects of the abstraction and release of water on environmental, social and cultural values;
- Ensure the cumulative effects of mining operations are considered and managed;
- Use a monitoring and evaluation process, to adaptively manage the effects of abstractions and releases on the water resources;
- Maximise cooperation in water management activities between nearby water users, to reduce impacts on the environment;
- Plan for, and manage, the effects of climate variability and change.

At a Federal level, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for native fauna and their habitats to be specially protected and listed as nationally or internationally important. Relatively few aquatic species in Western Australia are listed as threatened or endangered under the WC Act or EPBC Act. Lack of knowledge of their distributions often precludes aquatic invertebrates for listing as threatened or endangered. The EPA has stated that listing under legislation should therefore not be the only conservation consideration in EIA (EPA 2004).

The current baseline sampling constituted a Level 1 survey for EIA, as described under the EPA's Environmental Assessment Guideline (EAG) No. 12 (EPA 2013), and in accordance with EAG No. 8 (EPA 2015), with the focus on hydrological processes and ecosystem maintenance. At the time of the survey (April/May 2016), the aforementioned EAGs were the most up-to-date EAGs availaible.

1.1.2 Other relevant policy - ANZECC/ARMCANZ (2000) Guidelines

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) "… provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values (users) for natural and semi-natural water resources in Australia and New Zealand". These guidelines form part of the National Water Quality Management Strategy (NWQMS), a joint national approach to improving water quality in Australian and New Zealand waterways. The NWQMS was originally endorsed by two Ministerial Councils - the former Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) and the former Australian and New Zealand Environment and Conservation Council (ANZECC).

State regulators have been known to apply the trigger values detailed in the ANZECC/ARMCANZ (2000) guidelines as compliance values for mining companies in the Pilbara, where developments may impact creeklines through dewatering and discharge operations. Yet, in some systems water quality data recorded during baseline surveys, conducted prior to any disturbance, do not actually meet the default ANZECC/ARMCANZ (2000) trigger values. Therefore, it is important to obtain adequate baseline water quality data and develop system-specific guidelines, as recommended in the ANZECC/ARMCANZ (2000) guidelines, to avoid issues with non-compliance as a result of inappropriate trigger values being used by regulators.

The ANZECC/ARMCANZ (2000) guidelines are currently under review and updates are provided by the Joint Steering Committee for the Revision on the Federal Department of the Environment and Energy website (www.environment.gov.au/water/quality/national; downloaded on 30 May 2016).

1.2 Scope of Works for Current Study

The scope of works for the current study was to establish riverine baseline monitoring sites, and to develop a robust dataset to allow statistical testing for potential change over time. Specifically, the scope of work included:

- Identification of baseline and future riverine monitoring sites, and where possible, include long-term monitoring sites established previously by Streamtec/UWA;
- Semi-qualitative sampling for aquatic fauna (microinvertebrates, hyporheic invertebrates, benthic macroinvertebrates, fish) and water quality to allow statistical comparison of any changes overtime;
- Qualitative visual assessment of general habitat conditions at all sites;
- Record opportunistic visual sightings of any turtle and frog species present;
- Identification of all specimens to the lowest taxonomic level practicable;
- An assessment of the conservation status of aquatic fauna recorded;
- Report water quality data against ANZECC/ARMCANZ (2000) guidelines for freshwater ecosystems;
- Preparation of a detailed technical report of all findings.

1.3 Rationale for Sampling Components of Aquatic Fauna

Microinvertebrates

Aquatic microinvertebrate fauna consists of microscopic fauna including micro-crustacea (ostracods, copepods and cladocera), protists and rotifers (nominally <53 μm in size). Aquatic microinvertebrates are used as bioindicators throughout the world for many reasons. The microinvertebrate community holds a strategic position in food webs (Bunn and Boon 1993, Zrum and Hann 1997, Jenkins and Boulton 2003). They provide a food source for higher trophic levels, such as macroinvertebrates (Bunn and Boon 1993, Jenkins and Boulton 2003), fish (King 2004, Vilizzi and Meredith 2009), and waterbirds (Crome 1985). Most fish species depend on microinvertebrates for their first feed after hatching (Geddes and Puckridge 1989). Therefore, any change in the microinvertebrate community will ultimately result in changes to the entire aquatic ecosystem. Microinvertebrates also have intimate contact with the surrounding environment, being planktonic, and continually exposed to the ambient water quality. Hence, they are vulnerable to environmental pollutants and can be a useful biomonitoring tool (Kaur and Ansal 1996).

Hyporheic fauna

The hyporheic zone, comprising subsurface interstitial spaces in coarse creek bed sediments, is recognised as a critical component of many streams and rivers (Edwards 1998). The hyporheic zone creates habitat and connectivity between surface and sub-surface (groundwater) zones, provides a rearing habitat and important refuge for aquatic invertebrates, and importantly in the context of the Pilbara region, buffering from floods (Palmer *et al.* 1992, Dole-Olivier and Marmonier 1992), disturbance in food supply (Edwards 1998) and drought (Cooling & Boulton 1993, Coe 2001, Hose *et al*. 2005). The aquatic fauna of hyporheic zones is collectively referred to as hyporheos. Typically, hyporheos have poor dispersal capabilities, are confined to discontinuous habitats, are highly seasonal (usually more active in the wet season following significant flows) and have low levels of fecundity, and are therefore commonly classified as SRE as defined by Harvey (2002)[1]. A number of taxa frequently encountered in hyporheic zones, including stygal amphipods, isopods and syncarids (crustaceans) are classified as SRE, and are therefore of high conservation value. The subterranean fauna of the Pilbara is characterised by high levels of diversity and short range endemism (Eberhard *et al*. 2005, Halse *et al*. 2014), with increasing aridity and cessation of surface flows over the last 60 – 70 million years causing once epigean

[1] Short range endemic as defined by Harvey (2002): a species occupying an area of less than 10, 000 km^2.

(surface dwelling) fauna to disperse and become isolated in groundwater environments (Finston *et al*. 2011).

Macroinvertebrates

Aquatic macroinvertebrates (nominally 53 - 250 µm in size) typically constitute the largest and most conspicuous component of aquatic invertebrate fauna in both lentic (still) and lotic (flowing) waters. Macroinvertebrates are used as a key indicator group in the bioassessment of the health of Australia's streams and rivers under the National River Health Program (Schofield and Davies 1996), and have inherent value for biological monitoring of water quality (ANZECC/ARMCANZ 2000). Macroinvertebrates are considered to be temporary residents if their life-cycle contains a winged-adult form (*e.g.* dragonflies, damselflies, mayflies, aquatic beetles, caddisflies, *etc.*), therefore being proficient in aerial dispersal between waterbodies (Gray and Fisher 1981). Permanent residents include those which can persist as larvae during periods of drought by aestivating or encysting in sediments (*e.g.* Baetidae, Simuliidae, Ceratopogonidae, Chironomidae), or produce desiccation-resistant propagules or eggs which hatch upon inundation (*e.g*. ciliates, rotifers, flatworms, nematodes, segmented worms and crustaceans) (Radzikowski 2013).

Fish

Historically, fish diversity has been used worldwide as an indicator of ecosystem health (*e.g.* Hugueny e*t al*. 1996, Oberdoff *et al.* 2002, Pont *et al.* 2006). Because fish continually inhabit the receiving water, they integrate the chemical, physical and biological 'histories' of the watercourse. Most fish species have a long life span and therefore reflect both long-term and current water quality. Sampling fish assemblages can be used to assess a range of environmental disturbances, such as changes in habitat, water quality and land use (Hugueny *et al.* 1996). Fish also tend to be the most conspicuous biota in freshwater systems, have significant social amenity and are relatively easy to sample and identify.

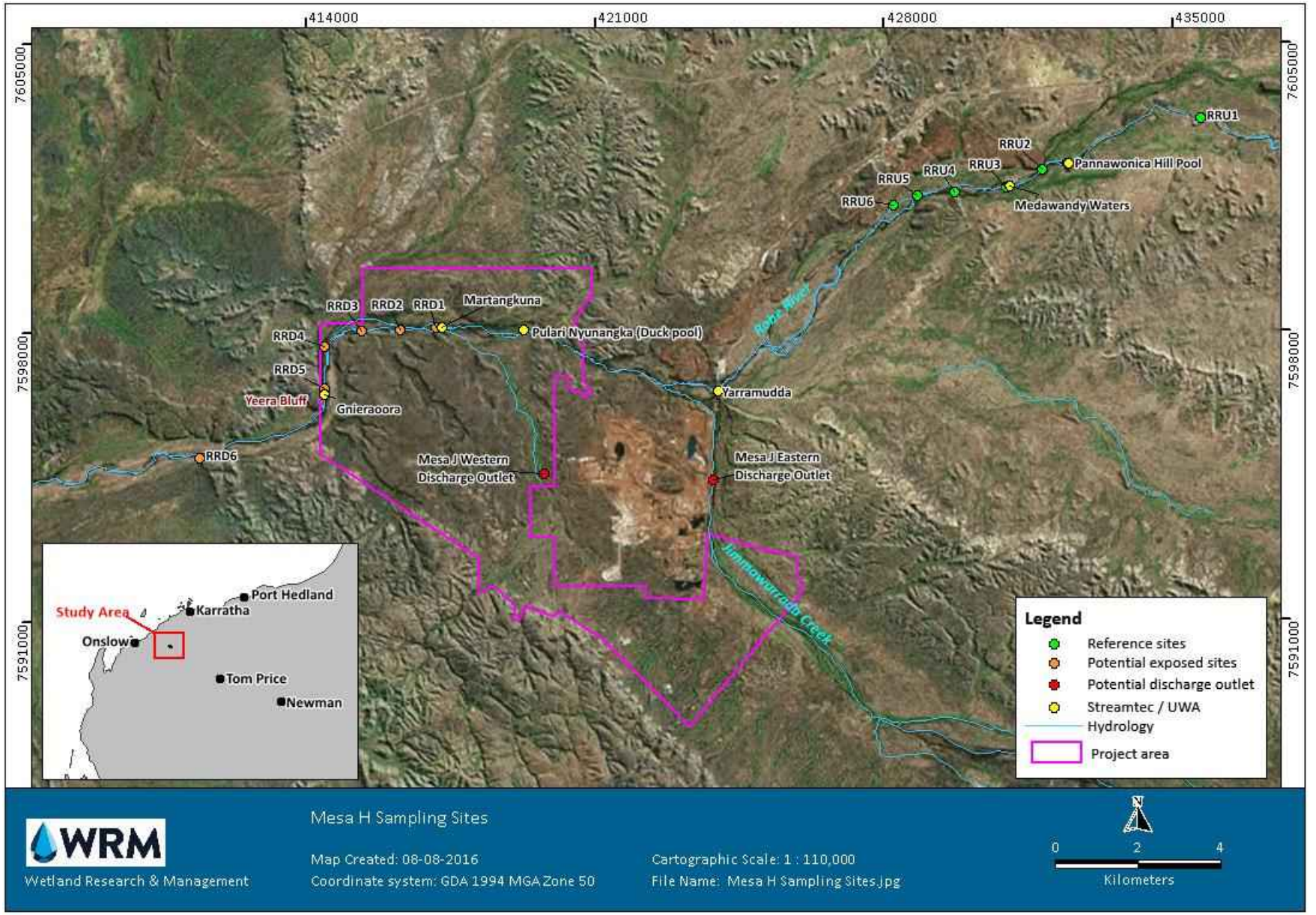


Figure 1. Location of Mesa H Project area and baseline aquatic ecosystem sampling sites (● reference, ● potential exposed) and historic Streamtec/UWA sites (●).

2 STUDY AREA

2.1 Climate

The Project area is located on the western edge of the Hamersley Ranges, approximately 100 km south-west of Karratha and south-west of Pannawonica. Climate of the region is semi-arid, with relatively dry winters and hot summers. The nearest long-term Bureau of Meteorology (BOM) gauging station is Pannawonica (no. 005069; 1971 - 2016), where total annual rainfall ranges from 113 to 700 mm, and monthly rainfall from 0 to 444 mm. Most rainfall occurs during the summer months (November to March) and is predominantly associated with cyclonic events; when flooding frequently occurs along creeks and rivers. Due to the nature of cyclonic events and thunderstorms, total annual rainfall in the region is highly unpredictable and individual storms can contribute several hundred millimetres of rain at one time.

Prior to sampling in April/May 2016, slightly above-average monthly rainfall was recorded in the latter part of 2015 (October & November) (Figure 2). However, total monthly rainfall was well below the 45-year average in the mid to late wet season of 2016, particularly during February, March and April (Figure 2). As such, there was no surface flow connecting pools along the Robe River at the time of sampling between 1st and 8th May. However, toward the end of the sampling period, a major storm event on the 5th - 6th May caused widespread flooding across the Robe River catchment, resulting in above average total rainfall for May (Figure 2). Pannawonica also recorded above average rainfall in June and July (Figure 2).

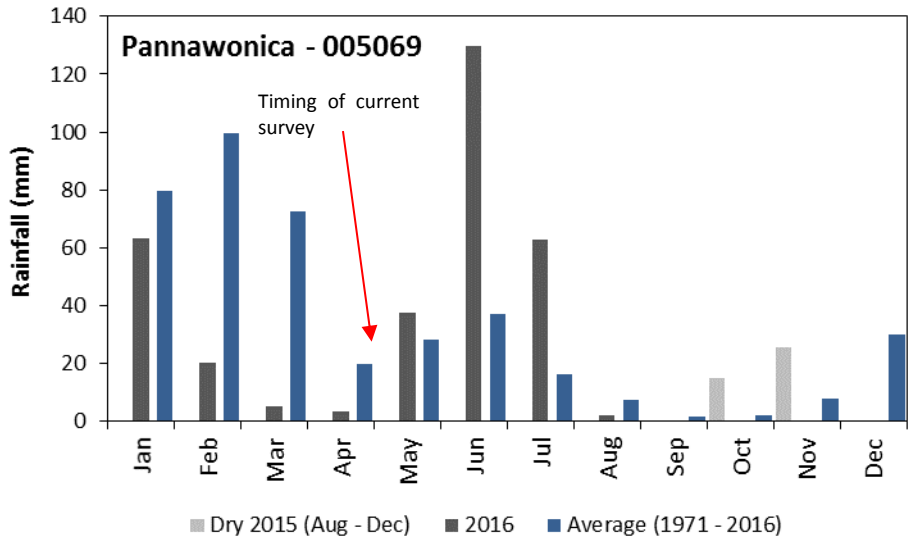


Figure 2. Average monthly rainfall (1971 – 2016) and total monthly rainfall (2016) for Bureau of Meteorology (BOM) Pannawonica Gauging Station (005069).

2.2 Hydrogeology

The Project area lies within the Robe River catchment, a significant river system in the region, with a catchment area of 7,571 km^2 and numerous braided tributaries (DoW 2012). The Robe River channel covers a linear distance of 190 km, 63% of which lies upstream of the Project area (EPA 1991). The immediate valley is 300 - 500 m wide. Jimmawurrada Creek is the only major tributary in the vicinity of the Project area, flowing northward along the eastern flank of Mesa J.

Jimmawurrada Creek joins the Robe River upstream of Mesa J (Figure 1). The Jimmawurrada Creek sub-catchment has an area of approximately 400 km^2 and constitutes the lower section of Bungaroo Creek

catchment, with a combined area of around 1,261 km^2 (DoW 2012). Both the Jimmawurrada and Bungaroo Creek catchments are included in the Bungaroo Creek Water Reserve that protects the water resources in these catchments and underlying aquifer that supply the West Pilbara Water Supply Scheme (WPWSS) (RDA 2013). The WPWSS delivers public drinking water to the towns of Karratha, Dampier, Roebourne, Cape Lambert and Point Samson (DoW 2012).

Surface flow in the Robe and tributary rivers is naturally ephemeral, typically only occurring in response to significant rainfall events and continuing for one to two months. There is one DoW streamflow gauging station on Robe River; Yarraloola (no. 707 002; 1972 - 2016), at the North West Coastal Highway crossing, 36 km west of the Project area. The maximum total monthly river discharge for the period of record at Yarraloola is 773.9 GL (February 2009) and the maximum instantaneous discharge is 12,203 m^3/sec (February 2009). Low or no flow typically occurs from July to December, when the river is reduced to a series of isolated pools. The number and permanence of these pools is dependent on antecedent rainfall and groundwater levels (Antao & Braimbridge 2010). Since streamflow records began at Yarraloola in 1972, 14 zero-flow years have been recorded, including seven in the last two decades (2002, 2003, 2007, 2010, 2012, 2013 & 2014).

The major aquifer underlying the Robe River is the gravelly alluvium which has a saturated thickness of up to 15 m adjacent the main channel and extends laterally up to 5 km across the Robe River Valley (Antao & Braimbridge 2010). Groundwater flow through the gravels maintains permanent pools in the Robe River. The gravelly aquifer is underlain by fractured, permeable Trealla Limestone and highly transmissive Robe Pisolite. Robe Pisolite is an iron-enriched pisolitic alluvial sedimentary rock that fills the broad valley between ridges of the Brockman Iron Formation, originally as ancestral drainage channels (palaeochannels) of the Robe River (commonly known as a Channel Iron Deposits (CID), and forms the target ore deposit at Mesa H (and Mesa J).

Groundwater flow in the Pisolite is towards the Robe River and where the Pisolite is deepest, probably contributes to baseflow within the Robe River (Aquaterra 2005). The gravel and Pisolite aquifers are recharged primarily *via* river discharge. Modelling by DoW indicates the aquifers have the potential to absorb a significant percentage of river flow; however, due to the unpredictable flow regime, recharge is very low in two out of every five years (Antao & Braimbridge 2010). Near the Jimmawurrada-Robe confluence, the Pisolite is very shallow and unsaturated. Stream-aquifer interaction upstream in the Bungaroo and Jimmawurrada valleys contributes to recharge along with direct rainfall infiltration.

2.3 Water Quality

2.3.1 Surface water

Water quality monitoring has been conducted quarterly at five pools in the Robe River and at the existing dewatering discharge point on Jimmawurrada Creek. The Robe River pools are located upstream (Medawandy Waters), adjacent to (Yarramudda) and downstream (Japanese, Martangkuna, Gnieraoora) of the existing mine operation (refer Figure 1 & Section 3). Pools have been monitored for pH, conductivity (EC), total dissolved solids (TDS), nitrogen and phosphorus, turbidity, total suspended solids (TSS) and biological and chemical oxygen demand. Dewatering discharge has been monitored for pH, TDS, TSS and concentration of dissolved metals (Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn). Unfortunately, the limit of reporting for most metals was not sufficiently low to allow comparison against ANZECC/ARMCANZ (2000) default trigger values (TVs) for the protection of freshwater ecosystems. In general, dewatering discharge to Jimmawurrada Creek appeared to be of low salinity (< 800 mg/L TDS), low TSS (< 5 NTU) and with a pH range of 6.2 - 8.5. The water is a predominantly sodium bicarbonate and calcium bicarbonate type, indicative of recharge water (Aquaterra 2004).

Available long-term quarterly monitoring data for the Robe River pools (1992 - 2004) indicates surface waters to be fresh (453 - 1,400 µS/cm EC; 300 - 904 mg/L TDS), with pH values typically in the range 7.0 - 9.0, and relatively low turbidity (< 10 NTU) under baseflow conditions. Maximum salinity levels recorded during quarterly monitoring were in 2003 following two years of low rainfall. Salinity generally tends to be lower in upstream pools than in pools adjacent to, and downstream of Mesa J. Background levels of total nitrogen (N-total) and nitrate-nitrogen ($N\text{-}NO_3$) often exceed default ANZECC/ARMCANZ (2000) TVs for protection against eutrophication (0.15 mg/L N-total; 0.03 mg/L $N\text{-}NO_X$), with levels of up 3.45 mg/L N-total and 3.1 mg/L $N\text{-}NO_3$ recorded at Medawandy waters, upstream of Mesa J. In general $N\text{-}NO_3$ appears to constitute most of the N-total present in surface waters in the pools. There are no data on dissolved metal concentrations in the pools.

Long-term annual monitoring of Robe River pools by Streamtec/UWA indicated similar physicochemical water quality characteristics to those identified from quarterly monitoring by the Proponent; fresh (EC < 1,200 µS/cm), slightly acidic to alkaline (pH 6.6 - 8.3) waters with relatively low turbidity during the dry season (< 8 NTU), becoming markedly more turbid following wet season flood events (often exceeding 70 NTU) (Dobbs & Davies 2009, Streamtec 2014). There was significant spatial and temporal variation in dissolved oxygen (DO) levels (< 2 mg/L to > 12 mg/L), depending on time of day sampled and permanency of pools. N-total and total phosphorus (P-total) often exceeded ANZECC/ARMCANZ (2000) default TVs (Dobbs & Davies 2009, Streamtec 2014).

2.3.1 Groundwater

At the time of reporting, groundwater quality sampling in the Project area had been conducted on three occasions, in December 2015 and twice during 2016. A comprehensive suite of parameters was sampled in 10 bores; MB15MEH001 to 4, 6 to 9, and 13 to 14. This sampling will be followed by more comprehensive groundwater assessment during 2016. The December 2015 sampling suggests groundwater quality in the majority of the bores to be similar to surface waters, *i.e.* fresh (489 - 1,110 µS/cm, 452 - 822 mg/L TDS), circum-neutral to slightly alkaline (pH 7.3 - 7.7) and with relatively high DO levels (7.2 - 9.1 mg/L). Two bores had brackish water; MB15MEH013 (3,040 µS/cm, 2,770 mg/L) and MB15MEH014 (1,920 µS/cm, 1,450 mg/L). Groundwaters in most bores (except MB15MEH001) were enriched in $N\text{-}NO_3$ relative to ANZECC/ARMCANZ (2000) default TVs for surface waters for protection against eutrophication. Maximum concentration was 23.9 mg/L $N\text{-}NO_3$ in MB15MEH014. Default TVs have yet to be developed for groundwaters. In their absence, ANZECC/ARMACANZ (2000) recommend that default TVs for surface waters be applied with caution, acknowledging that they may not be representative of natural background concentrations in groundwater.

In three bores, dissolved concentrations of chromium (Cr), manganese (Mn) and/or zinc (Zn) were also in exceedance of ANZECC/ARMCANZ (2000) default 95% species protection level TVs[2] for surface waters. This included MB15MEH001 (Mn, Zn), MB15MEH004 (Zn), MB15MEH013 (Cr, Zn) and MB15MEH004 (Cr).

2.4 Cultural and Ecological Values

The Project area is located within the Hamersley sub-region of the Pilbara Biogeographic Region as categorised under the national Interim Biogeographic Regionalisation for Australia (IBRA). Existing tenure in the area is a mixture of unallocated and leased Crown land. The Mesa H development would be implemented under Mining Lease ML248SA, which covers the Project area and other deposits

[2] Note, default TV for Ni should be modified for water hardness (as $CaCO_3$) at the time of sampling using algorithms provided in Table 3.4.3 of ANZECC/ARMCANZ (2000).

throughout the Robe River valley. In addition to ML248SA, the Project area lies substantially within Yarraloola Station pastoral lease (PL 3114-1127). The lease is held by Robe River Iron Associates joint venture through the Yarraloola Pastoral Company, and managed by Rio Tinto. The Station was established in 1916 as a sheep station, but currently runs cattle.

Numerous Aboriginal sites of significance have been identified within the Robe River valley. The Native Title Claim of the Kuruma Marthudunera Native Title Claimant Group covers 15,717 km^2 south of Karratha, incorporating the Project area and Yarraloola Station (YMAC 2011). The entire Robe River, also known as Jajiwarra, is of significant cultural value to the Kuruma and Marthudunera people, in particular permanent pools such as Yarramudda and Weedai immediately upstream of the Project area, Dthulurat (Gnieraoora) at Yeera Bluff, Joordi (or Jongardi) 14 km downstream of Yeera Bluff, and Chalyarn Pool on Mungarathoona Creek, a tributary of the Robe River.

As the Pilbara has an arid and variable climate with irregular episodic rainfall events, sources of water are of high ecological value. The permanent pools of the Robe River are an important component of the river ecosystem, supporting a diverse range of aquatic fauna and specialised flora such as yellow bladderwort (*Utricularia australis*) and water chestnut (*Eleocharis dulcis*). The pools act as refuges for fauna during periods of drought (EPA 1991). The riparian zone in the vicinity of the Project area also supports woodlands of silver cadjeput (*Melaleuca argentea*) and eucalypt (*Eucalyptus camaldulensis*, *E. victrix*). Lower tree and shrub layers in these woodlands are atypical of the Fortescue Botanical District, and as such, warrant conservation (EPA 1991). Cyclonic events and associated rainfall can severely affect the riparian vegetation, re-arrange braided channels and alter the size and position of permanent pools through scouring and aggradation (Dobbs & Davies 2009). In March 2004 for example, a rain depression in the wake of tropical cyclone Monty resulted in record rainfalls (376.6 mm) that caused widespread flooding throughout the Robe River valley and its surrounding catchments (Aquaterra 2004). High flows and flash flooding associated with cyclone Monty uprooted much of the Cadjeput woodland along the river channel in the vicinity of the Jimmawurrada-Robe confluence.

A number of potential short range endemic (SRE) aquatic invertebrates are known from the vicinity of the Project area and potentially occur within drawdown and dewatering impact zones. These species include stygal amphipods, isopods and syncarids, which are also known to occur in the hyporheic zones of the Robe River and/or tributary rivers. Further discussion of these species is provided in Section 3.

3 REVIEW OF PREVIOUS AQUATIC FAUNA AND STYGOFAUNA SURVEYS

The most comprehensive surveys of aquatic fauna within the Project area are those of Streamtec/UWA, who have conducted annual sampling of Robe River pools since 1992 (Dobbs & Davies 2009, Streamtec 1996 - 2014). Other recent studies include the Parks and Wildlife Pilbara Biological Survey (PBS); a region-wide survey of aquatic invertebrates conducted between 2003 and 2006, as part of a broader biodiversity survey (see Pinder *et al.* 2010). The PBS featured a number of ephemeral, long-term and permanent waterbodies within the vicinity of the Project area, including Mungarathoona Creek to the west, Myannore Creek and Yarraloola Station Claypan to the north-west, Nyeetbury Spring on upper Bungaroo Creek to the south-east, Kumina Creek in the upper Robe, and two pools on the Cane River to the south-west (Pinder *et al*. 2010). Morgan and Gill (2004) studied the distribution of fishes in inland waters of Pilbara, sampling 171 sites across 21 river systems between 2000 and 2002. Nearby sites included two pools on the Robe River close to the Project area; two on the lower Robe west of Mesa A/Warramboo, two on the lower Fortescue River to the north-west, and one on the Cane River. WRM previously sampled aquatic invertebrates and fish at Nyeetbury Spring (2009 - 2015) and Yalleen Pool (2010 - 2011) on Bungaroo Creek under the Proponent's Regional Aquatic Fauna Program (see WRM 2016). In 2008 and 2009, baseline surveys for the Australian Premium Iron (API) West Pilbara Iron Ore Project (WPIOP) were conducted, including sites on Mungarathoona Creek, Red Hill Creek and the Cane River (WRM 2009).

Additionally, stygofauna[3] have been sampled by Biota Environmental Sciences in the Mesa A/Warramboo Yarraloola Borefield to the west (Biota 2006a), and within the Ken's Bore and Cardo Bore areas along Red Hill Creek to the south-west (Biota 2010). Bennelongia Environmental Consultants surveyed stygofauna within the Bungaroo Creek catchment in the Buckland Hills area (Bennelongia 2013). Stygofauna were also surveyed by Parks and Wildlife as part of the PBS, including 36 bores within the Robe River catchment, sampled between 2002 and 2005 (see Eberhard *et al*. 2009, Halse *et al.* 2014).

A review of previous aquatic fauna surveys conducted within 100 km of the Project area, including sites sampled, methods used, and notable fauna found, is presented in the following sub-sections. A summary of the studies is provided in Table 1 and the sampling locations are shown in Figure 3. Studies referenced in this review were either conducted by WRM for the Proponent, or were publicly available, or records sourced from the Parks and Wildlife database NatureMap (http://naturemap.dpaw.wa.gov.au). In addition, direct requests were therefore made to Parks and Wildlife in order to obtain additional information on distribution of threatened, priority and vulnerable aquatic fauna.

For each species, conservation significance was assessed by reference to the IUCN Red List of Threatened Species, Parks and Wildlife Threatened and Priority Fauna Lists, as well as The Australian Faunal Directory, The Australian National Insect Collection Database and WRM's in-house database for distribution and occurrence information. Collectively, the previous studies have identified a number of species of conservation significance and/or scientific interest, which have the potential to reside, either seasonally or permanently, within the Project area and its expected drawdown zone and/or dewatering discharge footprint (acknowledging hydrological modelling for drawdown and dewatering discharge was not completed at the time of the survey or reporting).

A summary of aquatic species (including hyporheic species) of conservation and/or scientific value known to occur, or likely to occur within the Project area, is provided in Table 2, at the end of Section 3.

[3] Obligate inhabitants of groundwater environments, *e.g.* aquifers, caves and hyporheic (interstitial) spaces. Morphological adaptations to such environments include reduced body size, lack of pigmentation, reduced or absent eyes, and elongated appendages (*e.g.* antennae).

Table 1. Summary of previous recent aquatic fauna studies (invertebrates and fish) conducted within a 100 km radius of the Mesa H Project area, together with methodologies. Studies are listed in chronological order. Stygofauna assessments appropriate to the Project area are also included. Codes for 'Fauna sampled': Macro = macroinvertebrate; Micro = microinvertebrate; Hypo = hyporheos; Stygo = stygofauna).

Program	Sampled by	Locations sampled	Fauna sampled	Methods used	Taxonomic level	Sampling dates	Reference
Aquatic Fauna (Surface Water and Hyporheos)							
Proponent Mesa J Project Aquatic Ecosystem Study (long-term)	Streamtec / UWA	Robe River pools: • Gnieraoora, Martangkuna, Pulari-Nyunangka, Japanese pool, Yarramudda, Medawandy Waters, Pannawonica Hill pool, Chundy Pool, Ngalooin, Mussel Pool.	Macro Fish	• Macro – kick sampling (250 µm net) all habitats, • Fish – seine net and visual observation (mask and snorkel).	Species	Annually between Nov - Mar, 1991 - 2013.	Streamtec (1996, 1998, 2002, 2007-2009, 2011, 2014); Dobbs and Davies (2009)
Fish Fauna of Pilbara inland waters	Murdoch Uni	• Robe River near Mesa H and J, • Lower Robe River, west of Mesa A/Warramboo, • Lower Fortescue River (40 km NE), • Cane River (75 km SW).	Fish	• Fish – seine nets, gill nets, cast nets, rod and line, and visual observation (mask and snorkel).	Species	Once between Dec 2000 - Nov 2002.	Morgan and Gill (2004)
Hyporheos of five Pilbara springs	Parks and Wildlife	• Nyeetbury Spring on Bungaroo Creek, Robe River catchment (33 km SE).	Hypo	• Stirring up sediments and sweeping with a 250 µm mesh dip net, • Digging up sediments to a depth of 30 cm and collecting fauna caught with 50 µm and 250 µm mesh nets (Karaman-Chappuis method).	Species	Sep 2001.	Halse *et al*. (2002)
Pilbara Biological Study (PBS)	Parks and Wildlife	• Chalyarn Pool, Mungarathoona Creek, Robe River catchment (20 km W), • Red Hill Creek Pool, Robe River catchment (30 km SW), • Nyeetbury Spring on Bungaroo Creek (33 km SE), • Duck Creek Pool on Duck Creek, Ashburton River catchment (46 km SE), • Myannore Creek (49 km NNW), • Yarraloola Station Claypan (65 km NNW), • 2 sites on Cane River; House Pool and Creek Pool (70-75 km SW), • Kumina Creek (74 km SW).	Macro Micro	• Macro - kick sampling (250 µm net) all habitats, • Micro – sweep netting (50 µm mesh).	Species	Aug/Sep 2003, Aug/Sep 2004, May 2005, May 2006.	Pinder *et al.* (2010)

Program	Sampled by	Locations sampled	Fauna sampled	Methods used	Taxonomic level	Sampling dates	Reference
Aquatic Fauna (Surface Water and Hyporheos)							
API WPIOP Baseline Aquatic Fauna Survey	WRM	• 2 sites on Mungarathoona Creek (20 km W), • 6 sites on Red Hill Creek, (40 km SW).	Macro Micro Hypo Fish	• Macro – kick sampling (250 µm net) all habitats, • Micro – sweep netting (53 µm net) water column, • Hypo – Karaman-Chappuis method (53 µm net), • Fish – seine nets and gill nets.	Species	Dec 2008, Apr 2009.	WRM (2009)
Proponent Regional Aquatic Program (long-term)	WRM	• Yalleen Pool on Bungaroo Creek (23 km SE), • Nyeetbury Spring on Bungaroo Creek (33 km SE).	Macro Micro Hypo Fish	• Macro – kick sampling (250 µm net) all habitats, • Micro – sweep netting (53 µm net) water column, • Hypo – Karaman-Chappuis method (53 µm net), • Fish – seine nets and gill nets.	Species	Ongoing, wet and dry seasons since 2009.	WRM (2013, 2016)
Stygofauna							
Pilbara Biological Study (PBS)	Parks and Wildlife	• 36 bores across the Robe River catchment	Stygo	• Replicate hauls with weighted plankton nets (50 µm and 150 µm mesh).	Species	3 wet and 3 dry season occasions 2002 - 2005.	Eberhard *et al.* (2005, 2009); Halse *et al.* (2014)
Robe River Mining Co. Mesa A/Warramboo Baseline Stygofauna Assessment	Biota	• 21 bores within the Warramboo area, Robe River catchment (45 km W) • 20 bores within the Yarraloola area, Robe River catchment (40 km W)	Stygo	• Hauls with weighted plankton nets (150 µm mesh).	Species	Oct 2005.	Biota (2006a)
API WPIOP Baseline Stygofauna Assessment	Biota	• 58 bores within the WPIOP tenement areas, Red Hill Creek catchment (40 km SW)	Stygo	• Hauls with weighted plankton nets (70 µm mesh).	Species	Jun 2008, Sep 2009.	Biota (2010)
Iron Ore Holdings Bungaroo South Subterranean Fauna Assessment	Bennelongia	• 61 bores within Bungaroo South tenement, immediately south of the Project area.	Stygo	• Replicate hauls with weighted plankton nets (50 µm and 150 µm mesh).	Species	Jul 2012, Oct 2012.	Bennelongia (2013)

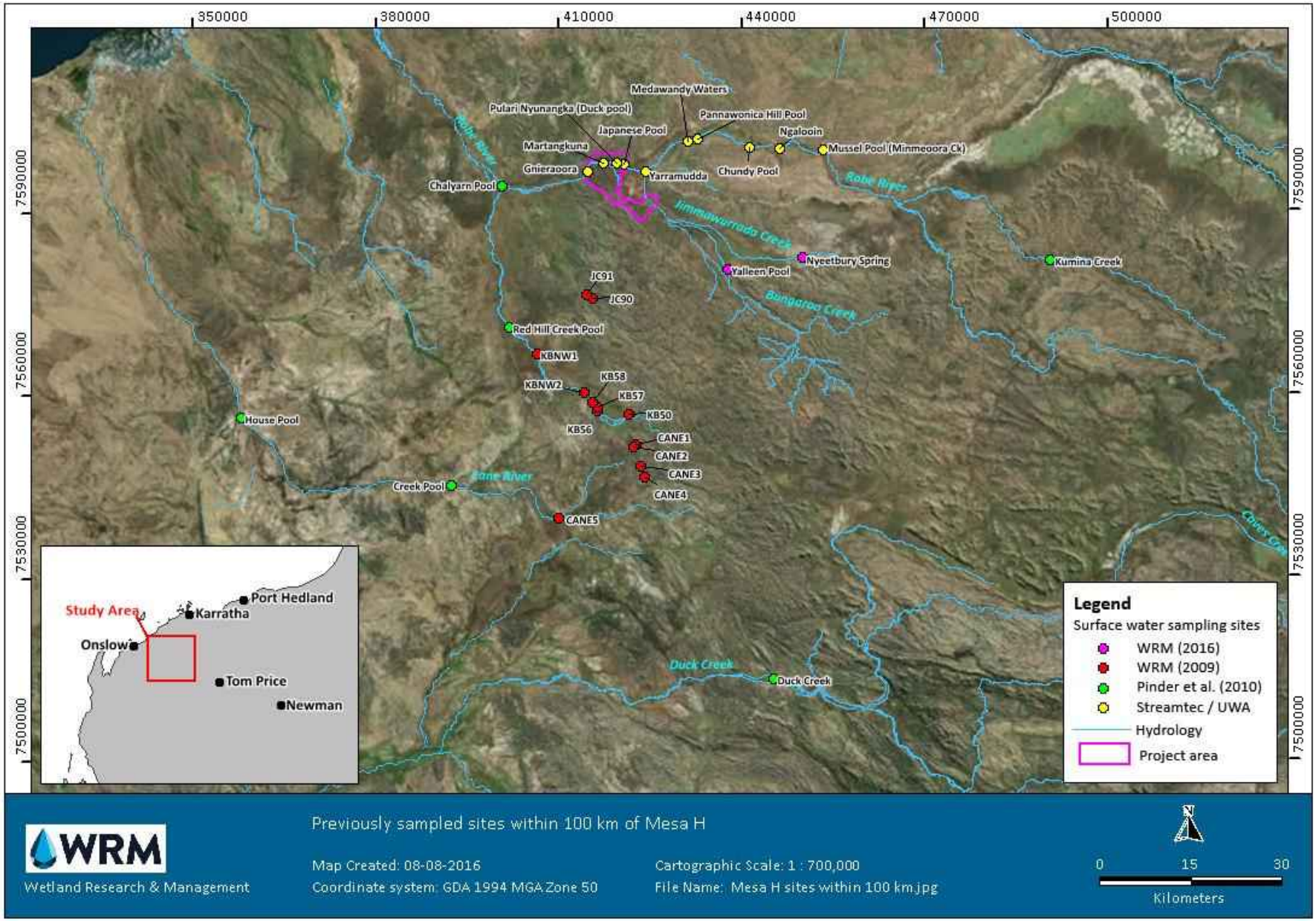


Figure 3. Locations previously sampled for aquatic invertebrates (Streamtec/UWA 1991 - 2014, WRM 2009 - 2016, Pinder *et al.* 2010) and fish (Streamtec 1991 – 2014) within 100 km of the Mesa H project area. Note, individual groundwater bores sampled for stygofauna (Biota 2006a, 2010, Eberhard 2009, Bennelongia 2013, Halse *et al.* 2014) are not detailed. Morgan and Gill (2004) did not provide GPS co-ordinates for their study of Robe River fish fauna.

3.1 Microinvertebrates (zooplankton)

The microinvertebrate fauna within the vicinity of the Project area is poorly known. Eight sites within 100 km of the Project area were sampled for microinvertebrates as part of the Parks and Wildlife PBS (Table 1). Pools sampled within the Robe River catchment included Chalyarn Pool (Mungarathoona Creek) and pools along Red Hill Creek, Myannore Creek, Kumina Creek, Nyeetbury Spring, Yalleen Pool and an ephemeral claypan on Yarraloola Station (Figure 3). Locations sampled outside the Robe River catchment included two pools on the Cane River to the south-west, and one on Duck Creek in the Ashburton River catchment (Figure 3). A combined total of 216 microinvertebrate taxa were recorded from these sites both within and outside of the Robe River catchment, sampled in August and September 2003/2004 (dry season) and May 2005/2006 (wet season). Wet season sampling appeared to favour microinvertebrate richness, with some of the most specious samples taken in May 2005 at House Pool on the Cane River (45 taxa), Red Hill Creek (42 taxa) and Chalyarn Pool (35 taxa).

WRM (2009) surveyed microinvertebrates in Mungarathoona Creek (two sites adjacent to the Jewel Cochrane development, to the south-east) and Red Hill Creek (six sites adjacent to Ken's Bore development) to the south east, as part of baseline aquatic surveys for API's WPIOP (Figure 3). A total 135 microinvertebrate taxa were recorded across two sampling events, conducted in December 2008 and April 2009 (WRM 2009).

WRM also conducts an ongoing aquatic fauna surveys under the Rio Tinto Pilbara Regional Program, which has previously included the microinvertebrate fauna of Yalleen Pool and Nyeetbury Spring on Bungaroo Creek (Figure 3). Biannual surveys collected a total 45 microinvertebrate taxa from Yalleen Pool, sampled between 2010 and 2011 (WRM 2013), and 160 taxa from Nyeetbury Spring, sampled between 2009 and 2016 (WRM 2016).

In each study, the microinvertebrate fauna was generally found to be typical of systems in the arid tropics (*e.g.* Koste and Shiel 1983, Tait *et al.* 1984, Smirnov and De Meester 1996, Segers *et al*. 2004). For example, in the nine featured PBS sites within the Robe River catchment (Table 1), species from the family Brachionidae (Rotifera) were poorly represented (14 taxa). This family tends to dominate temperate rotifer plankton, but is largely replaced by Lecanidae in tropic zones, as appears to be the case in the Pilbara (27 taxa; Pinder *et al.* 2010).

Microinvertebrate fauna of note (*i.e*. of conservation or scientific value) recorded from these studies included the stygal ostracod *Vestalenula matildae*, the rotifers *Colurella oblonga* and *Lecane noobijupi* and the cyclopoid copepod *Paracyclops* sp. 6. All these species have been recorded from within the Robe River catchment.

Vestalenula matildae was recorded at Mungarathoona Creek (Chalyarn Pool) during the PBS (Pinder *et al*. 2010). *V. matildae* is a recently described stygal species of ostracod known from groundwater (bores and wells) in the Ashburton River catchment (Government Well, Divide Well), DeGrey River catchment (Kylena Well, Home Well), and Sherlock River (Muorena Well). It has been recorded from hyporheic zones in the Ashburton (Yindabiddy Pool) and Fortescue River catchments (Weeli Wolli Spring), as well as surface waters in the Ashburton (Horrigans Pool), Fortescue (Gregory Gorge) and DeGrey (Coppin Gap, Chinaman Spring, Running Waters) (Martens and Rosetti 2002, Halse *et al*. 2002, Pinder *et al.* 2010, Schön *et al*. 2010). It appears to be endemic to the Pilbara, with no record to date of occurrence outside the region.

Colurella oblonga was collected at Nyeetbury Spring by WRM in 2012. This constituted the first record of *Colurella oblonga* from the Australian continent. This species is previously known from the southwest islands of Japan and from Europe (Dr Russel Shiel, University of Adelaide, pers. comm.).

Lecane noobijupi was collected from Nyeetbury Spring by WRM in 2011 and 2012, and from Red Hill Creek in 2009. This species is endemic to Western Australia, and appears to have a highly disjunct distribution. It was described from specimens collected from a wetland in the Muir-Unicup catchment in the south-west of the state (Lake Noobijup), and it had been thought to be restricted to that catchment (Segers and Shiel 2003). WRM has since recorded *Lecane noobijupi* from a number of locations throughout the Pilbara region, including Weeli Wolli Creek, Marillana Creek, Coondiner Creek, Mindy Mindy Creek and Kalgan Creek and (WRM 2016). Pinder *et al*. (2010) also recorded it from the DeGrey River. It would now appear that the Pilbara may be the normal locality of this species, and the Muir location in the south-west was an isolated occurrence.

Closer to the Project area, *Paracyclops* sp. 6 was collected from Chalyarn Pool, as well as Nyeetbury Spring and Kumina Creek (Pinder *et al*. 2010). This species is endemic to the Pilbara and is known from only 20 locations across the region, including the Ashburton River (Bobswim Pool, Fork Spring, Whiskey Pool, Cheela Spring, Paperbark Spring, Innawally Pool), Fortescue River (Palm Pool, Gregory Gorge, Palm Spring near Millstream, Joffre Creek), DeGrey River (Pelican Pool, Glen Herring Pool, Chinaman Spring, Minigarra Creek pools, Skull Springs and Bonnie Pool), Harding River (Springs Creek, Harding River Pool) and Sherlock River (Erawallana Spring and Pool Spring) (Pinder et al. 2010, WRM unpub. data).

Of the above-mentioned species, *Lecane noobijupi, Vestalenula matildae* and *Paracyclops* sp. 6 potentially occur within the Project area and its immediate vicinity but have a widespread distribution across the Pilbara.

3.2 Hyporheos

The hyporheos was not sampled by Streamtec/UWA during their long-term study of Robe River pools upstream, nor during the PBS (Pinder *et al.* 2010, Halse *et al.* 2014). However, biannual surveys of the hyporheos of upper Bungaroo Creek by WRM recorded a total of 22 hyporheic taxa from Yalleen Pool (WRM 2013) and 103 from Nyeetbury Spring (WRM 2016). Halse *et al.* (2002) recorded 62 hyporheic taxa from Nyeetbury Spring during one-off sampling in 2001. WRM (2009) also sampled the hyporheos of upper-Mungarathoona Creek and Red Hill Creek in 2008/2009, recording a combined total of 45 taxa.

Fauna of note collected during these studies included stygal amphipods and isopods that are likely SREs. Amphipods from the family Paramelitidae were collected from Yalleen Pool (WRM 2013), one site on Mungarathoona Creek, and three sites on Red Hill Creek (WRM 2009). These specimens were not able to be identified further than family level due to immaturity of life stage; however, they were considered likely to be SREs, given that most stygal Paramelitidae species are restricted to a small number of river systems within close geographical proximity to one-another (Finston *et al.* 2011).

At least three large isopod species are known from the subsurface zone of the Robe River catchment; *Pygolabis* sp. (Tainisopidae), *Tainisopus* sp. (Tainisopidae) and *Pilbarophreatoicus platyarthricus* (Amphisopodidae). Keable and Wilson (2006) documented *Pygolabis* sp. as occurring in the Robe River catchment but did not disclose the specific locality. Bennelongia (2013) also recorded P*ygolabis* sp. from two groundwater bores in the Bungaroo South area. All species of *Pygolabis* appear to be restricted to groundwaters and/or hyporheic zones of one or several creek drainages of the Pilbara region (Fortescue, Ashburton or Robe River catchments) (Keable and Wilson 2003) and at least some appear to be restricted to single sub-basins (Finston *et al.* 2009). Another undescribed, but closely related species, *Tainisopus* sp., is known to occur in the hyporheos of Nyeetbury Spring (Halse *et al.* 2002), as is *Pilbarophreatoicus platyarthricus* (WRM 2016). *P. platyarthricus* was first identified by Knott and Halse (1999) from Robe River specimens (including Chalyarn Pool), which were exclusively collected during the wet season "under cobbles in slow-flowing riffles … maintained by groundwater discharge." This species was also collected in surface water samples at Chalyarn Pool during the PBS (Pinder *at al.* 2010).

Although not specifically targeting hyporheic fauna, there have been a number of surveys of stygal communities in the vicinity of the Project area. These communities have taxa frequently encountered in hyporheic zones including SRE amphipods and isopods. These species may potentially occur in hyporheic zones within dewatering and drawdown zones in the Project area and the immediate vicinity.

The PBS sampled a total of 507 wells and drill holes across the Pilbara between 2002 and 2005, including 36 within the Robe River catchment area (Eberhard *et al.* 2005, 2009, Halse *et al.* 2014). A total of 110 stygal invertebrate taxa were recorded from bores in the Robe River catchment, including taxa belonging to the groups Oligochaeta (segmented worms), Polychaeta (bristle worms), Nematoda (round worms), Turbellaria (flat worms), Gastropoda (snails), Acarina (mites), Rotifera (wheel animals), Copepoda (copepods), Ostracoda (seed shrimps), Isopoda (aquatic slaters), Amphipoda (amphipods/side swimmers), Syncarida (syncarids) and Themosbaenacea (thermosbaenaceans). These taxa are also likey to occur within hyporheic zones of the Robe River. Out of the 110 taxa captured in the Robe River area, 83 were recorded from three or less bores (*i.e*. present at < 10% of bores), while just eight taxa were recorded from more than eight bores (*i.e.* present at > 20% of bores). It is possible that many of the uncommonly recorded stygofauna in this study are SREs.

Biota (2006a) sampled stygofauna from 21 bores within the Mesa A/Warramboo Project area and 20 bores in the Yarraloola area during 2005. In this study, a number of species which are occasionally encountered in hyporheic zones, such as stygal amphipods, copepods, and the themosbaenacean *Halosbaena tulki* were recorded, though it was noted that "there appears to be little in the way of a stygal community present at Warramboo". DNA sequencing delineated four new stygal amphipod species (Melitidae spp.), including two from the bores within the Mesa A/Warramboo Project area (Melitidae sp. A and sp. F), which currently are known only from the Mesa A/Warramboo Project area (Biota 2006a).

Biota (2010) sampled 58 bores in the Cardo East and Ken's Bore areas of the Red Hill Creek catchment. A number of potential SREs were recorded, including Paramelitidae (*Pilbarus* nr *millsi*, Paramelitidae sp. 2 and sp. 6), Melitidae (*Nedsia* spp., nr *Norcapensis* sp.), isopods (*Haptolana yarraloola*, *Kagalana tonde*, *Pygolabis* sp., *Pilbarophreatoicus platyarthricus*) and syncarids (*Bathynella* spp., Billibathynella sp. *Hexabathynella* sp. *Notobathynella sp.*).

Bennelongia (2013) sampled stygofauna in 61 bores within the Bungaroo South area in July and October 2012. Potential SREs recorded included Paramelitidae (Genus 2 sp. B12), Melitidae (*Nedsia* spp.), Neoniphargidae (nr *Wesniphargus*), the isopod *Pygolabis* sp. and syncarids (*Bathynella* spp., *Billibathynella* sp.).

3.3 Macroinvertebrates

Since 1991, Streamtec/UWA have conducted annual surveys for macroinvertebrates at seven long-term pools on the Robe River (Streamtec 1996 - 2014, Dobbs and Davies 2009). Pools include Medawandy Waters, Yarramudda, Japanese Pool, Martangkuna, Pannawonica Hill Pool, Pulari-Nyunangka, Gnieraoora (Figures 1 and 3). Four additional pools were included in the program during the 1990s; Chundy Pool, A1, Ngalooin and Mussel Pool (Figure 3). To date, over 112 macroinvertebrate taxa from 64 families have been recorded by Streamtec/UWA from 16 sampling occasions between February 1991 and December 2013. The most commonly encountered groups were the segmented Oligochaeta, Atyidae (freshwater prawns), Ephemeroptera (mayflies), Chironomidae (non-biting midges) and Dytiscidae (diving beetles). Streamtec/UWA noted that caddisflies (Trichoptera) were susceptible to changes in flow regime and water quality, with a decline in the number of species recorded following 1993, 2005, and 2012 cyclone events (Streamtec 2014).

The macroinvertebrate fauna of Chalyarn Pool (Mungarathoona Creek) was sampled during the PBS (Pinder *et al.* 2010). A total of 70 macroinvertebrate taxa were recorded at Chalyarn Pool in the wet season (May 2005), and 97 taxa were recorded in the dry season (August 2003). Other locations surveyed for macroinvertebrates in the vicinity of the Project area during the PBS included Red Hill Creek pools, Myannore Creek Pool and the Yarraloola Station claypan (Figure 3). A total of 196 macroinvertebrate taxa were recorded across these sites, sampled in August 2003/2004/2005 (dry season) and May 2003/2005/2006 (wet season). The most specious samples among these were collected at Red Hill Creek, with 90 taxa collected in both the wet and dry seasons (Pinder *et al.* 2010).

Macroinvertebrates from Mungarathoona Creek and Red Hill Creek were also sampled as part of baseline aquatic surveys for API's WPIOP area (WRM 2009). A total of 128 macroinvertebrate taxa were recorded across two sampling events; dry season (December) 2008 and wet season (April) 2009 (WRM 2009). The taxonomic list comprised Nematoda (roundworms), Hydrozoa (freshwater hydra), Oligochaeta (segmented worms), Gastropoda (snails and bivalves), Acarina (aquatic mites), Ephemeroptera (mayflies), Odonata (dragonflies and damselflies), Hemiptera (true bugs), Coleoptera (aquatic beetles), Diptera (aquatic fly larvae, including Chironomidae/midges), Trichoptera (caddisflies) and Lepidoptera (aquatic caterpillars).

The macroinvertebrate fauna of Yalleen Pool and Nyeetbury Spring on Bungaroo Creek have been sampled as part of the ongoing Pilbara Regional Aquatic Program for the Proponent (see WRM 2016). A total of 83 macroinvertebrate taxa were collected from Yalleen Pool from a total three sampling occasions; wet (March) and dry season (October) 2010 and wet season (March) 2011 (WRM 2013). A total of 190 macroinvertebrate taxa were recorded from Nyeetbury Spring from a total 13 occasions during biannual sampling (wet and dry seasons) between and October 2009 and May 2016 (WRM 2016).

The composition of macroinvertebrate taxa recorded during all of the above studies was typical of freshwater systems throughout the world (Hynes 1970), being dominated by Insecta (insects), within which Diptera (flies) and Coleoptera (beetles) were particularly well represented.

Of the macroinvertebrate fauna recorded from the Robe River catchment, two species are listed for conservation significance (IUCN Red List), and six are of scientific interest, being Pilbara endemics and/or relatively new to science. All potentially occur within the Project area. Three other Pilbara endemics have the potential to occur within the Project area (having been recorded within 100 km), and based on their known dispersal capabilities (*i.e.* with winged-adult forms with strong capacity for flight). These species are as follows:

- Conservation listed species recorded from the Robe River catchment:

  Eurysticta coolawanyah (Pilbara pin damselfly) (IUCN Near Threatened);
  Hemicordulia koomina (Pilbara emerald dragonfly) (IUCN Near Threatened);

- Pilbara endemic species recorded from the Robe River catchment:

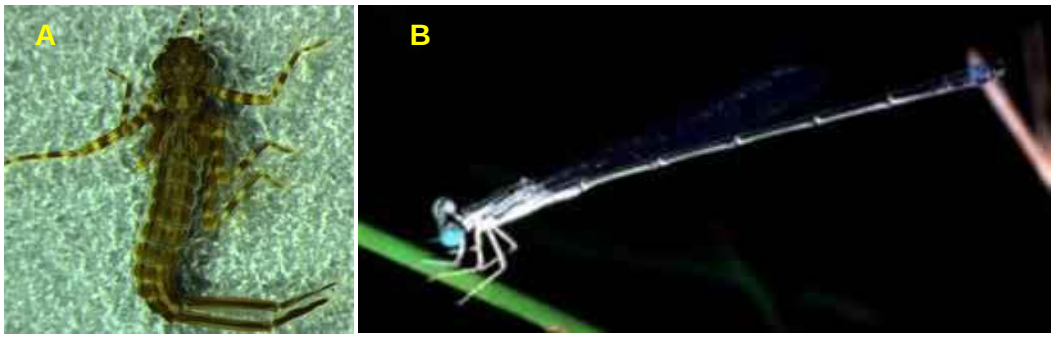
  Agriocnemis kunjina (Pilbara wisp damselfly);
  Ictinogomphus dobsoni (Pilbara tiger dragonfly);
  Nannophlebia injibandi (Pilbara archtail dragonfly);
  Tiporus tambreyi (diving beetle);
  Laccobius billi (water scavenger beetle);
  Haliplus halsei (crawling water beetle);

- Pilbara endemic species recorded from other locations within 100 km of the Project area:
  - *Sternopriscus pilbaraensis* (diving beetle);
  - *Tiporus lachlani* (diving beetle);
  - *Haliplus pilbaraensis* (crawling water beetle).

The Pilbara pin damselfly, *Eurysticta coolawanyah* (Plate 1A-B), is restricted to the Pilbara region, where it prefers riverine pools with an abundance of perching mediums (*e.g.* emergent reeds or overhanging riparian vegetation). *E. coolawanyah* has been collected from Robe River pools by Streamtec/UWA, and from Bungaroo Creek by WRM (2013, 2016). It has also been previously recorded at Chalyarn Pool (Pinder *et al.* 2010). *E. coolawanyah* is listed as Near Threatened[4] on the IUCN Red List of Threatened Species (IUCN 2016), based on its (initially recorded) restricted distribution to an area of less than 500 km^2, and it being thought to occur at less than five locations (Millstream Station, Nanuturra Pools, Palm Pool and the Millstream area); however, it has since been recorded from over 40 locations throughout the Pilbara (Pinder *et al*. 2010). Hawking (2009a) lists no known threats currently, or in the near future, to this species. WRM has encountered *E. coolawanyah* in habitats with a range in frequency of inundation and degree of persistence, including permanent/semi-permanent pools, permanent springs, ephemeral pools and sites permanently inundated and flowing due to dewatering discharge operations, for example at Weeli Wolli Spring.

The Pilbara emerald dragonfly, *Hemicordulia koomina* (Plate 1C-D), has been recorded by Streamtec/UWA from the Robe River, and from Red Hill Creek by Pinder *et al.* (2010). It is known to prefer large, permanent/semi-permanent pools. *H. koomina* is currently listed as Near Threatened on the IUCN Red List (IUCN 2016) but this listing is in need of revision given its more recent collections from numerous localities across several river catchments, including the Fortescue River (Hamersley Gorge, Fortescue Falls, Kalgan Creek), DeGrey River (Bamboo Springs, Minigarra Creek), Ashburton River system (Moreton Pool, Creek Pool near Mt Amy, Henry River pools, Pool at Gorge Junction), Sherlock River (Pool Spring) and Shaw River (Panorama Spring). Despite its widespread occurrence, *H. koomina* is infrequently collected, likely due to its preference for large, permanent pools, which are somewhat uncommon in the Pilbara region and inherently difficult to sample. The major threat to this species is considered to be loss of habitat (*i.e.* drying of permanent pools/waterways) through groundwater abstraction (Hawking 2009b).

Both of these species, particularly the large dragonfly *H. koomina*, are likely to have excellent dispersal capabilities in their winged-adult form (see Plate 1). Dispersal (the movement of individuals from one site to another) is an integral factor in determining the composition of biological communities (Palmer et *al*. 1996, Leibold *et al*. 2004). Aerial dispersal by winged-adult invertebrate fauna (*e.g.* Odonata, Coleoptera, Hemiptera, Ephemeroptera, Diptera and Trichoptera, *etc*.) has been recognised as the most important pathway for colonisation in arid and semi-arid wetlands (Gray and Fisher 1981). Heavy rainfall during the wet season also serves as a cue for many aquatic invertebrate taxa to migrate from perennial wetlands to colonise more ephemeral bodies of water (Lytle and Poff 2004). Given their proficient dispersal capabilities, and the record of these species at multiple locations within close proximity to the Project area, it is considered likely that macroinvertebrate sampling could reveal the presence of one or both of *E. coolawanyah* or *H. koomina* within the Project area.



[4] A species is listed under the IUCN Red List as Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future (IUCN 2016).

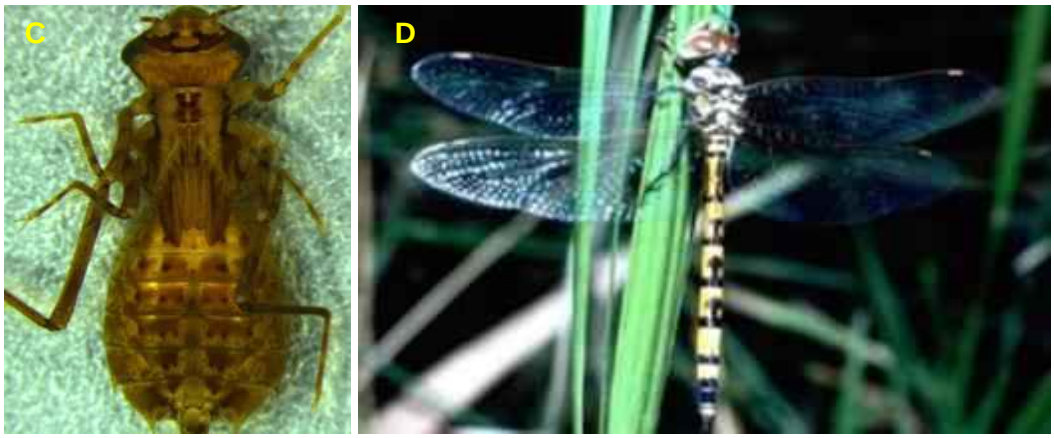


Plate 1. Pilbara pin damselfly, *Eurysticta coolawanyah* (A) nymph and (B) adult, and Pilbara emerald dragonfly *Hemicordulia koomina* (C) nymph and (D) adult (photos A and D courtesy of Jan Taylor ©).

The endemic Pilbara tiger dragonfly, *Ictinogomphus dobsoni*, is recorded infrequently and in low abundances from permanent still or sluggish waters of the Pilbara region (Watson 1991). It is known from a number of sites along the Fortescue, Robe, Ashburton, Yule, DeGrey and Sherlock rivers (DEC 2009, Pinder *et al*. 2010, CSIRO 2015). Near the Project area, *I. dobsoni* has been recorded from pools along the Robe River (Streamtec/UWA), Mungarathoona Creek (Chalyarn Pool) and Red Hill Creek (Pinder *et al*. 2010).

The Pilbara archtail dragonfly, *Nannophlebia injibandi*, is also restricted to the Pilbara region. This species was recorded infrequently during the PBS at Millstream Delta and Gregory Gorge in the Fortescue River catchment (Pinder *et al.* 2010). Within the vicinity of the Project area, *N. injibandi* has been recorded from Robe River pools near Mesa H (Streamtec/UWA) and from Red Hill Creek (WRM 2009).

The Pilbara wisp damselfly *Agriocnemis kunjina,* is a Pilbara endemic rarely encountered. It is previously known from Millstream, Harding River, and Tanberry Creek (ANIC Database); however, it was not recorded during the PBS (Pinder *et al.* 2010). *A. kunjina* is known from both still and flowing waters (Theischinger and Hawking 2006), and has been recorded from Robe River pools in the vicinity of the Project area (Streamtec/UWA) and from Yalleen Pool (WRM 2013).

The aquatic hydrophilid beetle *Laccobius billi* is a Pilbara endemic species that also is rarely collected. *L. billi* was only recorded from one site during the PBS; Cangan Pool on the Yule River (Pinder *et al.* 2010). WRM (2009) recorded *Laccobius billi* at Mungarathoona Creek and from a number of Red Hill Creek sites.

The haliplid beetles *Haliplus halsei* and *H. pilbaraensis* are both endemic to the Pilbara region, and are relatively new to science, having only been recently described (Watts and McRae 2010). Each species appears to occur widely throughout the Pilbara, and have been recorded at localities such as Glen Ross Creek, Coondiner Pool, the Fortescue Marsh, Moreton Pool, Paradise Pool, Munreemya Billabong, Wackilina Creek Pool, West Peawah Creek Pool, Harding River Pool, and an un-named creek in Millstream (Watts and McRae 2010). Closer to the Project area, *Haliplus halsei* has been recorded from Chalyarn Pool and Myannore Creek during the PBS (Pinder *et al*. 2010), while *Haliplus pilbaraensis* has been recorded from Red Hill Creek by WRM (2009).

The dytiscid beetle *Sternopriscus pilbaraensis* is endemic to the Pilbara, is relatively common and known from a range of systems, including Red Hill Creek, the Fortescue River (Gregory Gorge and Kalgan Pool), Ashburton River (Bobswim Pool, Yandabiddy Pool, Whiskey Pool, Ashburton at Gorge Junction, Innawally Pool and Rocky Island Pool), DeGrey River (Pool at Yarrie Homestead, Pelican pool on

Nullagine, Tanguin Rockhole, Paradise Pool, Munereemya Billabong, Carleecarleethong Pool, Minigarra Creek Pools, Bonnie Pool, Cookes Creek Pools, Running Waters and Pool on Tongolock), Rudall River (Watrara Creek Pool), Shaw River (Panorama Spring), Sherlock River (Kangan Pool) and the Harding River (Harding River Pool) (Pinder *et al.* 2010).

The diving beetles *Tiporus tambreyi* and *T. lachlani* are also relatively common and widespread across the region (Pinder *et al.* 2010, WRM unpub. data), though *T. lachlani* is less frequently encountered than its congener (Pinder *et al.* 2010, WRM unpub. data). In the vicinity of the Project area, *T. tambreyi* has been recorded from Robe River pools (Streamtec/UWA), Chalyarn Pool (Pinder *et al.* 2010) and Red Hill Creek (WRM 2009, Pinder *et al.* 2010), while *T. lachlani* has only been previously recorded from Red Hill Creek (Pinder *et al.* 2010).

3.4 Fish

The fish fauna of the Pilbara region is unique, with 13 freshwater species recorded from inland waters to date, including catadromous[5] species (Allen *et al.* 2002, Morgan and Gill 2004). Of the freshwater species, three (or possibly four) are considered endemic to the region. These include the golden gudgeon (*Hypseleotris aurea*), the Murchison River hardyhead (*Craterocephalus cuneiceps*), one undescribed eel-tailed catfish, the Pilbara tandan *Neosilurus* sp.[6], and the conservation listed Fortescue grunter (*Leiopotherapon aheneus*) (Morgan and Gill 2004). *L. aheneus* (Plate 2) is currently listed on the IUCN Red List of Threatened Species as Lower Risk/Near Threatened (IUCN 2016), and as a Priority 4 (P4)[7] species on the Parks and Wildlife Priority Fauna List (Parks and Wildlife 2016). The Fortescue grunter has a restricted distribution within the Pilbara, and is only known from the Fortescue, Robe and Ashburton River systems (Allen *et al*. 2002, Morgan and Gill 2004). This species is considered to be reasonably common within its range.

Plate 2. Fortescue grunter *Leiopotherapon aheneus.* Photo by Chris Hofmeester (WRM) ©.

Other known species from Pilbara inland waters include the spangled perch (*Leiopotherapon unicolor*), barred grunter (*Amniataba percoides*), western rainbowfish (*Melanotaenia australis*), bony bream (*Nematalosa erebi*), flathead goby (*Glossogobius giuris*), empire gudgeon (*Hypseleotris compressa*), Hyrtl's tandan (eel-tailed catfish; *Neosilurus hyrtlii*), blue catfish or lesser salmon catfish (*Arius graeffei*), and the Indian short-finned eel (*Anguilla bicolor*) (Allen *et al.* 2002, Morgan and Gill 2004, Beesley 2006). The most common and widespread species are spangled perch, western rainbowfish and bony bream (Plate 3). The western rainbowfish, for example, has a range extending from the Ashburton River in the Pilbara to the Adelaide River near Darwin, inhabiting rivers, creeks, swamps, lakes and reservoirs

[5] Catadromous fishes live in freshwater as juveniles or sub-adults, but migrate to marine habitats to spawn.

[6] Previously referred to as *Neosilurus hyrtlii*. Recent genetic evidence indicates the Pilbara species is distinct from elsewhere in Australia (Peter Unmack, National Evolutionary Synthesis Centre, North Carolina, pers. comm.).

[7] P4 species are those with limited distributions "in need of monitoring" (Parks and Wildlife 2016).

(Allen *et al.* 2002). Spangled perch and bony bream are considered to be two of Australia's most widespread freshwater fish species, found in drainages throughout the Pilbara, Kimberley, Northern Territory, Queensland, northern New South Wales, as well as in Lake Eyre and the Murray-Darling system (Allen *et al.* 2002).

In addition, the Pilbara Drainage Division contains two endemic cave fishes restricted to the North West Cape region; the blind gudgeon (*Milyeringa veritas*) and the blind cave eel (*Ophisternon candidum*) (Allen *et al.* 2002, Morgan and Gill 2004). Both *M. veritas* and *O. candidum* are listed as Vulnerable under the EPBC Act.

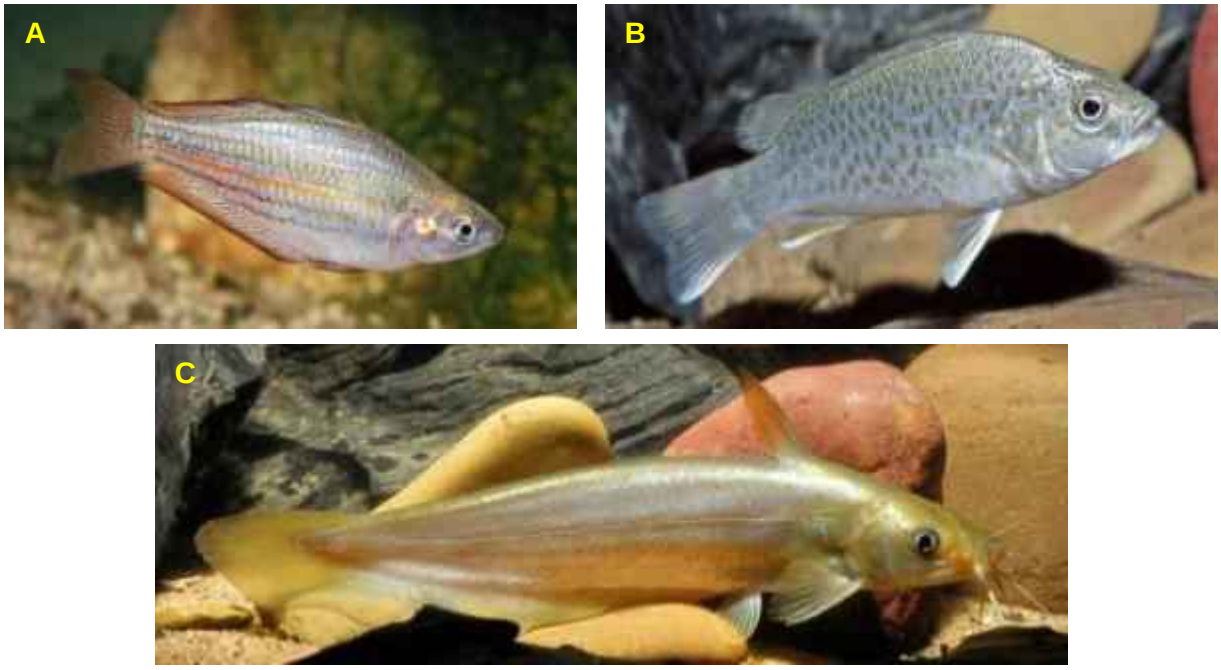


Plate 3. The three most commonly encountered freshwater fish species in the Pilbara; (A) western rainbowfish *Melanotaenia australis*, (B) spangled perch *Leiopotherapon unicolor* and (C) Pilbara tandan *Neosilurus* sp. (photos courtesy of Mark Allen ©).

Freshwater systems of the Pilbara also host a number of species that are considered to be of marine or estuarine origin, most of which have a non-obligatory freshwater juvenile phase. These commonly include barramundi (*Lates calcarifer*), mangrove jack (*Lutjanus argentimaculatus*), sea mullet (*Mugil cephalus*) and tarpon or ox-eye herring (*Megalops cyprinoides*) (Morgan and Gill 2004). The presence of marine/estuarine species in freshwater systems of the Pilbara is likely to be influenced by the frequency, timing and duration of flood events; the species listed above would only enter rivers if flooding coincided with their recruitment phase, while distance moved upstream is governed by the duration of the flood event (Morgan and Gill 2004). As floods recede, it is common for these species to become isolated in permanent upstream pools, forming small remnant populations that are cut-off from marine habitats (Morgan and Gill 2004).

Streamtec/UWA sampled the fish fauna of Robe River pools using seine nets, dip nets, and visual observation. Six freshwater fish species were recorded, including western rainbowfish, spangled perch, Pilbara tandan, barred grunter, bony bream and the conservation listed Fortescue grunter. Additionally, five marine vagrant/estuarine species were recorded, including tarpon, banded scat or striped butterfish (*Selenotoca multifasciata*), threadfin silver-biddy (*Gerres filamentosus*), sea mullet and mangrove jack.

Morgan and Gill (2004) surveyed four Robe River sites for fish using a combination of sampling methods (refer Table 1). Six freshwater species were again recorded (western rainbowfish, spangled perch, Pilbara tandan, barred grunter, bony bream and Fortescue grunter); however, no marine/estuarine

species were reported. Morgan and Gill (2004) also included historic records from the Western Australian Museum (WAM) that list empire gudgeon as occurring in the Robe River in the vicinity of the Project area.

The Department of Water (DoW) conducted a review of the ecological values of the lower Robe River, west of the North West Coastal Highway crossing point and Mesa A/Warramboo deposits, which included a summary of the freshwater and estuarine fish fauna of that reach (Antao and Braimbridge 2010). The review did not document any species from the lower Robe River that were not recorded by Streamtec/UWA or Morgan and Gill (2004).

WRM (2016) has recorded seven species from Nyeetbury Spring on upper Bungaroo Creek; Pilbara tandan, western rainbowfish, flathead goby, spangled perch, Fortescue grunter, barred grunter, and a fish that appears to be a hybrid between two of the three co-occurring terapontids (grunters; spangled perch, barred grunter and Fortescue grunter). At Yalleen Pool on Bungaroo Creek, WRM (2013) recorded only western rainbowfish, spangled perch and Pilbara tandan. WRM (2009) also surveyed the fish fauna of upper-Mungarathoona Creek, recording five species; western rainbowfish, spangled perch, Pilbara tandan, barred grunter and Fortescue grunter.

3.5 Other Fauna

3.5.1 Turtles

Although not typically targeted in aquatic surveys, one species of native turtle is known from the Pilbara region; the flat-shelled *Chelodina steindachneri.* This species has a widespread distribution throughout the Pilbara, having been recorded from most major river systems in the region, from the DeGrey River in the north to the Murchison River in the south (Kuchling 1988, WRM unpub. data). These turtles are adapted to survive drought by burrowing into the dry river beds (Kuchling 1988). Only one clutch of seven to eight relatively small eggs is laid each year; a pattern that appears to be adapted to a relatively long period of aestivation of up to three years (Kuchling 1988).

EPA (1991) note *Chelodina steindachneri* as present at Gnieraoora and Martangkuna, but do not state the source of the records, which was possibly the 1991 survey by Streamtec/UWA. Neither Antao and Braimbridge (2010) nor Pinder *et al.* (2010) document turtles. Similarly, turtles were not recorded or observed at upper-Mungarathoona Creek or Red Hill Creek by WRM (2009); however, given its widespread distribution across the Pilbara region, it is possible that *Chelodina steindachneri* may reside in pools in the vicinity of the Project area.

3.5.2 Frogs

The Pilbara is host to 13 species of frogs, three of which are endemic to the region; *Pseudophryne douglasi* (Gorge toadlet), *Uperoleia glandulosa* (Glandular toadlet) and *U. saxatilis* (Pilbara toadlet) (Tyler and Doughty 2009, Doughty *et al*. 2011). None of these species are currently listed for conservation significance, though *U. saxatilis* has only recently been described (Catullo *et al.* 2011). *U. saxatilis* is broadly distributed throughout the Pilbara, occurring in or near rocky creeks, and appears to be adapted to rocky landscapes (Catullo *et al.* 2011, Doughty *et al*. 2011). *U. glandulosa* has a more restricted distribution in the northern coastal Pilbara but penetrates inland along the Yule River drainage (Catullo *et al.* 2011, Doughty *et al*. 2011). *Pseudophryne douglasi* is a rare species that has an ancient relictual arid distribution separate from other toadlets (Doughty *et al*. 2011, WA Museum).

The Pilbara, Gascoyne and Murchison populations of the desert tree frog, *Litoria rubella*, are separated from Kimberley and Northern Territory populations by the Great Sandy Desert. *L. rubella* is known to

occur in a wide range of habitats across northern Australia, including northern Western Australia, Northern Territory, north-east of South Australia, Queensland, and northern New South Wales (Tyler and Knight 2011). The desert tree frog is commonly found sheltering under stones or bark around creeks and waterholes, and can breed at any time of year if water is present (Tyler and Knight 2011).

Frogs are difficult to survey in the Pilbara region, as captures are typically dependent on rainfall that is spatially and temporally variable (Doughty *et al*. 2011). Many frog species of the Pilbara aestivate over dry periods to avoid desiccation, emerging following rains to opportunistically breed and spawn (Tyler and Doughty 2009). No data were available on targeted frog surveys in the vicinity of the Project area, and although there have been a number of terrestrial vertebrate surveys (*e.g.* Biota 2005, 2006b, 2009, Strategen 2006), few have recorded frogs. Biota (2006a) recorded two species of Hylidae (tree frogs): *L. rubella* and *Cyclorana maini* - and one Myobatrachidae (southern frog) species *Uperoleia russelli* during baseline surveys for the Mesa A/Warramboo project area. In addition to *L. rubella* and *U. russelli*, Biota (2009) recorded the ornate burrowing frog *Platyplectrum ornatus* (formerly *Limnodynastes ornatus)* from the Red Hill Creek catchment.

3.6 Summary of Known Species of Conservation and/or Scientific Interest

Table 2 below provides a summary of known aquatic invertebrates (including hyporheos) and fish of conservation and/or scientific interest.

Table 2. Aquatic species (invertebrates and fish) of conservation and/or scientific value known to occur, or likely to occur, within the Project area.

Species	Common name	Scientific value	Conservation listing	Occurrence within 100 km of Project area	Likelihood of occurrence within the Project area	Occurrence elsewhere
Microinvertebrates						
Lecane noobjupi	Rotifer	WA endemic	N/A	Nyeetbury Spring, Red Hill Creek	High in surface waters	Weeli Wolli Ck, Marillana Ck, Coondiner Ck, Mindy Mindy Ck, Kalgan Ck and Un-named Ck, DeGrey R. Also in SW Western Australia
Paracyclops sp. 6	Copepod (micro-crustacean)	Pilbara endemic	N/A	Chalyarn Pool	High in surface waters	20+ locations Pilbara-wide
Vestalenula matildae	Ostracod (micro-crustacean)	Pilbara endemic	N/A	Chalyarn Pool	High in surface waters	Various systems of the Ashburton R., DeGrey R., Fortescue R. and Sherlock R.
Hyporheos						
Paramelitidae spp.	Stygal amphipods	Potential SRE	N/A	Yalleen Pool, Red Hill Ck, Mungarathoona Ck.	High in ground-waters and hyporheos	Unknown given family level identification.
Melitidae spp.	Stygal amphipods	Potential SRE	N/A	Bores across the Robe River catchment area	High in ground-waters; Low-moderate in hyporheos	Unknown given family level identification
Haptolana yarraloola	Stygal isopod	Potential SRE	N/A	Bores in the lower Robe River catchment area – Mesa A/Warramboo/Yarraloola	Low	Recently described species; known only from Mesa A/ Warramboo/Yarraloola bores
Kagalana tonde	Stygal isopod	Potential SRE	N/A	Bores in the lower Robe River catchment area – MesaA/Warramboo/Yarraloola	Low	Recently described genus and species; elsewhere known from Cane River and Hardey River catchments
Pilbarophreatoicus platyarthricus	Stygal isopod	Potential SRE	N/A	Chalyarn Pool, Nyeetbury Spring, Bores in the Robe River catchment area	High in ground-water and hyporheos	Weeli Wolli Ck, Coondiner Ck, Bobswim Pool (Ashburton R.)
Pygolabis sp.	Stygal isopod	Potential SRE	N/A	One undescribed species known from the Robe River catchment	High in ground-water and hyporheos	Uncertain. Members of this genus restricted to either Fortescue, Ashburton or Robe catchment groundwater and hyporheos
Tainisopus sp.	Stygal isopod	Potential SRE	N/A	Nyeetbury Spring	Low-moderate; only known from Nyeetbury Spring hyporheos	Unknown given genus level identification

Species	Common name	Scientific value	Conservation listing	Occurrence within 100 km of Project area	Likelihood of occurrence within the Project area	Occurrence elsewhere
Parabathynellidae spp.	Stygal syncarids	Potential SRE	N/A	Unknown given genus level identification	High in ground-waters; Low-moderate in hyporheos	Unknown given genus level identification
Macroinvertebrates						
Hemicordulia koomina	Pilbara emerald dragonfly	Pilbara endemic	IUCN, Near Threatened	Robe River pools, Red Hill Ck.	High in surface waters	Fortescue R., Coondiner Ck; now known to be widespread throughout the Pilbara, though infrequently collected
Eurysticta coolawanyah	Pilbara pin damselfly	Pilbara endemic	IUCN, Near Threatened	Chalyarn Pool, Robe River pools, Yalleen Pool	High in surface waters	Ashburton R. (Bobswim Pool); Kalgan Ck; Coondiner Ck; Fortescue R.
Ictinogomphus dobsoni	Pilbara tiger dragonfly	Pilbara endemic	N/A	Chalyarn Pool, Robe River pools, Red Hill Ck.	High in surface waters	Fortescue, Ashburton, Yule, DeGrey and Sherlock rivers
Nannophlebia injibandi	Pilbara archtail dragonfly	Pilbara endemic	N/A	Robe River pools, Red Hill Ck.	Low-Moderate in surface waters	Fortescue R. catchment, but uncommonly collected
Agriocnemis kunjina	Pilbara wisp damselfly	Pilbara endemic	N/A	Robe River Pools, Yalleen Pool	Low-Moderate in surface waters	Millstream, Harding River, Tanberry Ck; rarely collected
Haliplus halsei	Aquatic beetle	Pilbara endemic	N/A	Chalyarn Pool, Myannore Ck.	Low-Moderate in surface waters	Uncommonly collected from ephemeral systems and claypans, *e.g.* the Fortescue Marsh and Coondiner Pool
Haliplus pilbaraensis	Aquatic beetle	Pilbara endemic	N/A	Red Hill Ck.	Low-Moderate in surface waters	Uncommonly collected from ephemeral systems and claypans, *e.g.* the Fortescue Marsh and Coondiner Pool
Sternopriscus pilbaraensis	Diving beetle	Pilbara endemic	N/A	Red Hill Ck.	Moderate in surface waters	A range of systems across the Pilbara, fairly commonly collected
Tiporus tambreyi	Diving beetle	Pilbara endemic	N/A	Chalyarn Pool, Robe River pools, Red Hill Ck.	Moderate-High in surface waters	A range of systems across the Pilbara, very commonly collected
Tiporus lachlani	Diving beetle	Pilbara endemic	N/A	Red Hill Ck.	Low-Moderate in surface waters	A range of systems across the Pilbara, infrequently collected
Laccobius billi	Aquatic beetle	Pilbara endemic	N/A	Mungarathoona Ck, Red Hill Ck.	Low-Moderate in surface waters	Yule R. and Fortescue R.

Species	Common name	Scientific value	Conservation listing	Occurrence within 100 km of Project area	Likelihood of occurrence within the Project area	Occurrence elsewhere
Fish						
Leiopotherapon aheneus	Fortescue grunter	Pilbara endemic	IUCN Near Threatened; Parks and Wildlife P4	Robe River pools, Red Hill Ck., Mungarathoona Ck.	High in surface waters	Fortescue R (below Fortescue Marsh); Ashburton R.

4 METHODS FOR BASELINE SURVEYS

4.1 General

For the current baseline field sampling, WRM employed sampling design, methods and general approaches consistent with the following:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000);
- Environment Protection Authority (EPA) Guidance No. 20, Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA 2009);
- EPA Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Guidance No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004).

Aquatic fauna sampling methods were also similar to the following:

- Streamtec/UWA surveys of benthic macroinvertebrates of the Robe River (see Dobbs and Davies 2009, Streamtec 2014);
- Parks and Wildlife surveys of benthic macroinvertebrates for the regional Pilbara Biological Survey (PBS) (see Pinder *et al.* 2010).

4.2 Licences

This study was conducted under Department of Fisheries (DoF) Exemption #2706 (Authority to Take Fish for Scientific Purposes), and Parks and Wildlife Licence SF010732 (Licence to Take Fauna for Scientific Purposes).

As a condition of these licences, taxa lists and reports are required to be submitted to the respective government departments, and have been done so.

4.3 Sampling Design and Sites

The sampling design is an mBACI (multiple Controls - Before/After - Control/Impact) type design (Keough and Mapstone 1995). Location and number of sites were selected to provide data for robust statistical analysis and to meet requirements of such a design. An mBACI design is considered ideal for impact assessment, as impacts may be placed in context with natural temporo-spatial catchment changes. An mBACI type design provides both benchmark information as well as a strong basis to detect future changes. Reference sites upstream of the Project area were selected to serve as the "control" for potentially impacted sites. Surveys conducted in April/May 2016 are part of the benchmark or "before" phase against which to assess any potential future changes.

Sampling was conducted during the late wet season, between 28th April and 7th May 2016.

A total of 12 pools were sampled along the main channel of the Robe River (Table 3 and Figure 1). Sites included six potentially exposed sites within the predicted surface extent of dewatering discharge, and six reference sites upstream of the Jimmawurrada Creek-Robe River confluence.

Table 3. Aquatic ecosystem sampling sites on the Robe River. Equivalent sites monitored by Streamtec/UWA are also indicated.

Type	WRM Site	Description	GPS co-ordinates (zone 50 K)		Date sampled	Maximum wetted width, length and depth of pool (m)			Streamtec/ UWA site
			Easting	Northing		Width	Length	Depth	
Reference	RRU1	Approx. 3.7 km upstream of Pannawonica Hill.	435628	7603253	05-05-16	20	100	1.2	
	RRU2	Approx. 600 m downstream of Streamtec/UWA site at Pannawonica Hill Pool; upper end of Medawandy Waters area, adjacent Mesa N.	431811	7602046	28-04-16	9	55	3.0	Pannawonica Hill
	RRU3	Approx. 1.6 km downstream of Pannawonica Hill, near Mesa N; within the Medawandy Waters area.	430912	7601562	28-04-16	5	3	1.0	Medawandy
	RRU4	Approx. 1.5 km downstream of RRU3; within the Medawandy Waters area, in the vicinity of Mesa M.	429677	7601439	28-04-16	20	120	1.0	
	RRU5	Approx. 1 km downstream of RRU4; within the Medawandy waters area, adjacent Mesa L.	428769	7601342	29-04-16	10	40	1.2	
	RRU6	Approx. 1 km upstream of Jimmawurrada Creek confluence; lower end of the Medawandy waters area, at base of Mesa L.	424573	7597240	07-05-16	12	40	0.6	
Potentially Exposed	RRD1	Martangkuna; approx. 600 m downstream of existing Mesa J dewatering discharge point (*i.e*. western discharge point).	417110	7598094	30-04-16	3	7	0.8	Martangkuna
	RRD2	Approx. 0.9 km downstream of RRD2.	416245	7598031	30-04-16	6	12	0.7	
	RRD3	Approx. 1 km downstream of RRD3.	415309	7598013	30-04-16	5	25	1.0	
	RRD4	Approx. 1.1 km downstream of RRD3; 1 km upstream of Yeera Bluff.	414419	7597633	29-04-16	20	150	2.0	
	RRD5	Gnieraroora / Dthulurat* at Yeera Bluff; 8.6 km downstream of existing Mesa J western discharge point.	414426	7596622	29-04-16	25	45	4.0	Gnieraoora
	RRD6	Approx. 12.5 km downstream of existing Mesa J western discharge point; within projected discharge footprint (at 20 ML/day).	411415	7594924	30-04-16	30	20	1.2	

* Dthulurat = Western Guruma name.

The original intent was that the assessment would utilise, wherever possible, long-term data from sites sampled by Streamtec/UWA; however, only two of these sites are located within the predicted footprint of surface discharge extent; Martangkuna (RRD1) and Gnieraoora/Dthulurat (RRD5). Therefore, four new sites (RRD2, RRD3, RRD4 and RRD6) were added to allow a more robust characterisation of ecological condition within this reach (Table 3 and Figure 1). These sites may also be exposed to any runoff from the Project area.

Of the sites sampled by Streamtec/UWA upstream of the Jimmawurrada-Robe confluence, two were selected as reference sites for the Project area; Medawandy and Pannawonica Hill Pool; however, only Medawandy (RRU3) held surface water at the time of sampling in April-May 2016. Therefore, five new reference sites were established within the Medawandy Waters area; RRU1, RRU2, RRU4, RRU5 and RRU6 (Table 3 and Figure 1). Site photographs are provided in Appendix 1.

The 2016 sampling was timed to correspond with recessional flow conditions at the end of the wet (April-May) season. It was considered that the end of the wet season would be a more ecologically important time of year to sample, as biological diversity would be expected to be at its highest. By comparison, lower biological diversity may be expected at the start of the wet season, as many invertebrate fauna would not yet have emerged/colonised the seasonal creeks.

4.4 Water Quality

At each site, pH, dissolved oxygen and temperature were measured *in situ* using hand-held Wissenschaftlich-Technische-Werkstätten (WTW) field meters. Meters were calibrated immediately prior to field surveys. Water depth was measured using a graduated pole. Undisturbed water samples were collected for laboratory analyses of major ions, alkalinity, dissolved metals, nutrients and total suspended solids (TSS). Water samples for nitrogen and phosphorus nutrient and dissolved metal analyses were filtered in the field through 0.45 µm nitrocellulose filters. To avoid contamination, all sample bottles and filtering equipment used for dissolved metals were acid-washed (0.1% nitric acid) prior to use. Bottles and filters used for nutrients weren't acid washed to avoid nitrogen contamination from nitric acid. Water samples for analysis of dissolved metals and nutrients were collected using nitrile gloves. All samples were double-wrapped in polyethylene zip-lock bags and kept cool on ice-packs in an esky while in the field and during transport. At the end of each field day, samples were either refrigerated (ions and metals) or frozen (nutrients). Samples were stored refrigerated or frozen for a maximum of 10 days prior to transport on ice to analytical laboratories at ChemCentre, Bentley, together with chain-of-custody forms. All water quality variables measured are summarised in Table 4.

4.4.1 Comparison against ANZECC/ARMCANZ Guidelines

Water quality data were compared against default ANZECC/ARMCANZ (2000) guidelines (trigger values) for the protection of freshwater ecosystems (provided in Appendix 2). Default trigger values (TVs) for 95% aquatic species protection were considered more appropriate than default TVs for 99% protection, given that the Robe River catchment in the vicinity of current mining operations is already slightly to moderately disturbed by historic mining and pastoral practices (Strategen 2006). In accordance with ANZECC/ARMCANZ (2000) however, the default 99% TVs were applied to bioaccumulating metals such as selenium. For metals and nutrients, dissolved concentrations (0.45 µm filtered samples) were compared to the default TVs. Filtered concentrations were considered a better reflection of the fraction that may be bioavailable. By contrast, comparison of the default TVs to the total metal or total nutrient concentration may overestimate the risk to the environment (ANZECC/ARMCANZ 2000).

Table 4. Measured and derived water quality and habitat parameters. Metals (Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, S, Se, U, V, Zn) and nutrients ($N\text{-}NH_3$, $N\text{-}NO_2$, $N\text{-}NO_3$, $N\text{-}NO_X$, N-total, P-total) were measured as dissolved concentration. All units for water quality parameters are mg/L unless stated otherwise.

Water Quality Parameters	Code	Habitat Parameters	Code
Temperature (°C)	Temp	Maximum pool depth (m)	depth
pH (H^+)	pH	Maximum wetted length of pool (m)	length
Dissolved oxygen (%)	DO%	Mean wetted width of pool (m)	width
Dissolved oxygen (mg/L)	DO	Mineral substrates (total % cover within habitat)	min
Conductivity (µS/cm)	EC	Bedrock (% cover)	bedr
Redox (mV)	Redox	Boulders >256 mm (% cover)	boul
Alkalinity (as $CaCO_3$)	Alk	Cobbles 64-256 mm (% cover)	cobb
Ammonia	$N\text{-}NH_3$	Pebbles 16-64 mm (% cover)	pebb
Arsenic	As	Gravel 4-16 mm (% cover)	grav
Barium	Ba	Sand 1-4 mm (% cover)	sand
Boron	B	Silt <1 mm (% cover)	silt
Cadmium	Cd	Mean particle size (from substrate proportions)	phi
Calcium)	Ca	Emergent macrophyte (% cover)	emerg
Carbonate	CO_3	Submerged macrophyte (% cover)	submerg
Chloride (mg/L)	Cl	Floating macrophyte (% cover)	float
Chromium (µg/L)	Cr	Algae (% cover)	algae
Copper (µg/L)	Cu	Detritus (% cover)	detr
Hardness (as $CaCO_3$)	Hard	Riparian vegetation canopy (% canopy cover)	ripvegco
Hydrogen carbonate	HCO_3	Large woody debris (>10 cm diameter) (% cover)	LWD
Iron	Fe	Root mats (% cover)	rootm
Lead	Pb	Trailing riparian vegetation (% cover)	ripveg
Magnesium	Mg	Habitat diversity (total no. of habitat types)	habdiv
Manganese	Mn	Substrate compaction (1 = loose, to 5 = armoured)	compct
Nickel	Ni	Substrate diversity (total no. substrate types)	subdiv
Nitrate-nitrogen	$N\text{-}NO_3$		
Nitrite-nitrogen	$N\text{-}NO_2$		
Nitrogen oxides	$N\text{-}NO_X$		
Nitrogen-total	N-total		
Phosphorus-total	P-total		
Potassium	K		
Selenium	Se		
Sodium	Na		
Sulfate	$S\text{-}SO_4$		
Sulfur	S		
Total dissolved solids	TDS		
Total suspended solids	TSS		
Uranium	U		
Vanadium	V		
Zinc	Zn		

4.5 Habitat Characteristics

Details of habitat characteristics at each site were recorded (Table 4) to assist in explaining any patterns in faunal assemblages, particularly due to existing differences in benthic substrate composition. Habitat parameters were assessed for the approximately 10 m section of river over which each macroinvertebrate sample was collected. Water depth was measured with a graduated pole. Substrate type was visually assessed and recorded as estimated percent cover by bedrock, boulders, cobbles, pebbles, gravel, sand, silt and clay, from which mean particle size was determined using the phi scale. As an indication of habitat heterogeneity, the number of organic and inorganic substrate types

represented at each site was totalled. Habitat characteristics recorded included estimated percent cover by inorganic sediment, submerged macrophyte, floating macrophyte, emergent macrophyte, algae, large woody debris, detritus, roots and trailing vegetation.

WRM has specific worksheets for this task to ensure qualitative habitat recordings between sites are as comparable as possible. To limit variation due to different observers, all estimations were made by the same sampler.

4.6 Microinvertebrates (zooplankton)

Microinvertebrate samples were collected from each site by gentle sweeping over an approximate 15 m distance with a 53 µm mesh plankton net (Plate 4). Care was taken not to disturb the benthos (bottom sediments) during sampling. Samples were preserved in 70% ethanol and sent to Dr Russell Shiel at the University of Adelaide, South Australia, for processing. Dr Shiel is a world authority on microfauna, with extensive experience in fauna survey and impact assessment across Australasia, including the Pilbara.

Plate 4. Microinvertebrate sampling at RRD4.

Microinvertebrate samples were processed by identifying the first 200-300 individuals encountered in an agitated sample decanted into a 125 mm^2 gridded plastic tray, with the tray then scanned for additional missed taxa also taken to species and recorded as 'present'. Specimens were identified to the lowest taxon possible, *i.e*. species or morphotypes. Abundance data were reported as log_{10} scale abundance classes (*i.e.* 1 = individual, 2 = 2-10 individuals, 3 = 11-100 individuals, 4 = 101-1000 individuals, 5 = >1000). Where specific names could not be assigned, vouchers were established. These vouchers are held by Dr Shiel at Adelaide University, Adelaide, Australia.

4.7 Hyporheos

At each site, hyporheic sampling was conducted using the Karaman-Chappuis method (Delamare Deboutteville 1960). This involved digging a hole approximately 20 cm deep and 40 cm diameter in alluvial gravels in dry streambed adjacent to the water's edge, allowing the hole to infiltrate with water, and sweeping the water column with a modified 110 µm mesh plankton net (Plate 5). The water column was swept immediately after the hole had filled, and again after approx. 30 minutes, once other sampling had been conducted.

Plate 5. Hyporheic sampling at RRU3.

Samples were preserved in 70% ethanol and returned to the laboratory for processing. Any aquatic fauna present was removed from samples by sorting under a low power dissecting microscope. In-house expertise was used to identify the majority of hyporheic taxa using available published keys and through reference to the established voucher collections held by WRM. External specialist taxonomic expertise was sub-contracted to assist with Chironomidae (Dr Don Edward, UWA) and micro-crustacea (Dr Russel Shiel, University of Adelaide).

All taxa recorded from hyporheic samples were classified using the categories of Boulton (2001):

- stygobite, *i.e.* obligate groundwater species, with special adaptations to survive such conditions,
- permanent hyporheos stygophile, *i.e.* epigean[8] species that may occur in both surface and groundwaters, but is a permanent inhabitant of the hyporheic zone,
- occasional hyporheos stygophile, *i.e.* species that use the hyporheic zone seasonally or during early life history stages, or
- stygoxene, *i.e.* species that appear rarely and apparently at random in groundwater habitats; there by accident or seeking refuge during spates or drought; not specialised for dwelling permanently underground.

4.8 Macroinvertebrates

Macroinvertebrate sampling was conducted with a 250 µm mesh FBA pond net (Plate 6). All meso-habitats were sampled, including trailing riparian vegetation, woody debris, open water column and benthic sediments with the aim of maximising the number of species recorded. Each sample was washed through a 250 µm sieve to remove fine sediment, while leaf litter and other debris were carefully washed in the sieve and removed by hand. Samples were then preserved in 70% ethanol. In the laboratory, macroinvertebrates were removed from samples by sorting under a low power dissecting microscope.

Plate 6. Macroinvertebrate sampling at RRU5.

Collected specimens were identified to the lowest practicable level (typically genus or species) and enumerated to $\log_{10}$ scale abundance classes (*i.e.* 1 = individual, 2 = 2-10 individuals, 3 = 11-100 individuals, 4 = 101-1000 individuals, 5 = >1000). In-house expertise was used to identify invertebrate taxa using available published keys and through reference to the established voucher collections held by WRM. External specialist taxonomic expertise was sub-contracted to assist with Chironomidae (Dr Don Edward, UWA).

4.9 Fish

A number of fish sampling methods were used at each site in order to collect as many species and individuals as possible. Methods included electrofishing, seine nets and gill nets. Electrofishing was conducted with a Smith-Root Model LR24 battery powered backpack electrofisher (Plate 7A). Electrofishing is an extremely useful and efficient sampling tool in rivers with clear, low salinity, slow flow water. All meso-habitats within a maximum 40 m reach were shocked with the intention of recovering as many species/individuals as possible. Shocking was not continuous, but targeted areas of optimum habitat, whereby the operator would shock, move to a new habitat before shocking again, and so prevent fish being driven along in front of the electrical field.

Duplicate 30 m multi-panel gill nets were set at each site where there was sufficient depth of water (Plate 7B). Each net consisted of 6 x 5 m panels, with panels increasing in size from 1" to 6" stretched mesh size. The nets were set perpendicular to the bank, with the smallest mesh set against the bank, and the large mesh positioned into the channel with a float and weight to keep the nets in place. At

[8] Epigean – living or occurring on or near the surface of the ground.

each sampling location, two nets were set for approximately 2.5 hours. Nets were checked frequently to avoid fish deaths. Catch from the duplicate nets were combined to form one replicate sample from each sampling location.

Smaller species and juveniles were sampled by beach seine (10 m net, with a 2 m drop and 6 mm mesh) deployed in shallow areas where there was little vegetation or large woody debris. Typically, two seine hauls were made at each location to maximise the number of individuals caught.

All fish were identified in the field, measured for standard length (SL)[9], and then released alive. Fish nomenclature followed that of Allen *et al.* (2002). Fish measurements provided information on the size structure, breeding and recruitment of fish populations.

Plate 7. Example of electrofishing (left), and setting gill nets at RRU1 (right).

4.10 Data Analysis

Samples were grouped *a priori* into categories according to exposure; potentially exposed sites downgradient of the Jimmawurrada-Robe confluence (RRD) or reference sites upgradient of the Jimmawurrada-Robe confluence (RRU). Water quality and species richness (number of taxa) data were plotted in order to illustrate spatial differences. For comparison of species richness against previous studies, invertebrate taxonomy was standardised across datasets to account for differences in taxonomic resolution and/or advancements in taxonomic knowledge between studies (*i.e.* some taxa were condensed to family or order level to enable comparison). As such, taxa richness may appear lower than was originally reported in each study. Where sufficient numbers of each fish species were measured, length-frequency histograms of current data were plotted.

Univariate analyses (one-way ANOVA) was used to test for statistically significant (p <0.05) differences in water quality variables and micro- and macroinvertebrate species richness between groups (RRD, RRU). The assumptions of normality and homogeneity of sample variances were checked using Shapiro-Wilk and Levene's tests, respectively. Data were $\log_{10}(x+1)$ transformed where appropriate. All univariate analyses were performed using IBM SPSS Statistics (v21) software package.

Multivariate patterns in micro- and macroinvertebrate species assemblages were analysed using procedures from the PRIMER (v7) software package (Clarke and Gorley 2006). Non-metric Multi-Dimensional Scaling (nMDS) ordination plots (Clarke and Warwick 2001) were constructed to visualise differences between sites. nMDS ordinations were based on Bray-Curtis similarity measures for species abundance ($\log_{10}$ class) data. Ordinations were depicted as two-dimensional plots. The Analysis of

[9] Standard length (SL) - measured from the tip of the snout to the posterior end of the last vertebra or to the posterior end of the mid-lateral portion of the hypural plate (*i.e.* this measurement excludes the length of the caudal fin).

Similarity (ANOSIM) routine within PRIMER was used to test for significant ($p < 0.05$) differences in species assemblages between groups (RRD, RRU), based on both abundance (log_{10} class) and presence/absence data. The SIMPER routine within PRIMER was used to determine those species contributing most to the similarity/dissimilarity between significant site groupings identified by ANOSIM.

Too few taxa were recorded from hyporheic samples to warrant ANOVA or PRIMER analyses of these data.

4.11 Survey Limitations

Inherent physical sampling deficiencies are acknowledged as a barrier to sampling aquatic fauna, and in particular fish. For example, fish catch rates may have been hindered by the abundance of aquatic vegetation (macrophytes and algae) which physically obstructed seine and gill nets at some sites. This was somewhat compensated for by the use of a back-pack electrofisher, which generates a pulsed direct electrical current to draw fish out from under such habitat.

This study provides a snapshot of water quality conditions and faunal communities at a single point in time, and is unlikely to fully capture the range of temporal/seasonal variability within the Project area. Prior to sampling, total monthly rainfall at Pannawonica Gauging Station was well below the 45-year average, particularly during February, March and April. As such, there was no surface flow connecting pools along the Robe River, with pools heavily receded and even some fish mortality evident, possibly due to low overnight dissolved oxygen concentrations. The relative lack of rainfall leading up to the survey may also have caused recordings of some other water quality parameters, such as salinity and nutrients, to be higher than would be expected under “average” wet season baseflow conditions, due to evapo-concrentration effects and lack of flushing within the system. Dry conditions may also have affected aquatic faunal communities, particularly hyporheic fauna, which require saturation of the alluvium and strong connectivity between ground and surface waters, and fish, with many speces known to require higher baseflows and connectivity between pools to enable upstream migration and spawning.

5 RESULTS AND DISCUSSION

5.1 Water Quality

5.1.1 General

Raw data for spot measurements of water quality, made in conjunction with aquatic fauna sampling, are provided in Appendix 3. Water quality was highly variable amongst sites (Figures 4 and 5). Salinity levels ranged from fresh[10] (592 µS/cm, RRD5) to brackish (1,700 µS/cm, RRU6), pH from circum-neutral (6.9, RRU3) to slightly alkaline (7.9, RRU1), hardness from 230 mg/L (RRD2) to 520 mg/L (RRU6), total suspended solids from <1 mg/L (RRD4, RRU3, RRU4) to 34 mg/L (RRD5), and dissolved oxygen from hypoxic[11] (14.5%, RRU5) to supersaturated (134.9%, RRD6).

There were no obvious longitudinal gradients upstream or downstream of the Jimmawurrada-Robe confluence. Site RRU6 (located ~1 km upstream of the confluence), together with the downstream sites, tended to have higher salinity (as EC and TDS), alkalinity, hardness and concentrations of associated ions, than sites upstream (Figure 3). Maximum values for most of these parameters (*i.e.* EC, TDS, hardness, Na^+, Cl^+, Ca^{2+}, $S\text{-}SO_4$, Mg^{2+}) and for nitrogen (as N-total, $N\text{-}NO_X$, $N\text{-}NH_3$) were recorded at RRU6. Average concentration of K^+, $S\text{-}SO_4$ and total dissolved sulfur (S) was significantly higher downstream of the Jimmawurrada-Robe confluence (one-way ANOVA, Table 5).

Table 5. Summary results from one-way ANOVAs testing for significant (p <0.05) differences in mean concentrations of water quality parameters, upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Only significant results are shown. Mean (±SE) vales for untransformed data are also provided.

Water quality parameter	ANOVA (df = 1, 11)			Mean (±SE)	
	MS	F	p	RRD (n = 6)	RRU (n = 6)
Fe	0.005	9.52	0.012	0.05 (0.01)	0.12 (0.005)
K	23.24	21.96	0.001	8.4 (0.52)	5.6 (0.29)
S	352.08	35.62	<0.001	25.3 (0.95)	14.5 (1.54)
$S\text{-}SO_4$	2104.10	15.52	0.003	70.2 (4.67)	43.7 (4.83)

The significantly higher concentrations of some ions, most notably $S\text{-}SO_4$, and to a lesser extent Mg (Figure 4), downstream of the Jimmawurrada-Robe confluence, may reflect the influence of dewatering discharge from current mining operations. Some inter-site variability could also be attributed to differences in volume of the remnant pools sampled, and evapoconcentration effects under recessional flows. For example RRU6, where maximum values for a number of parameters were recorded, was the shallowest of the pools sampled (maximum water depth of 0.6 m), and supported extensive organic deposits and abundant macrophyte growth (*Typha* and *Potamogeton*) (Appendix 4). The relative abundance of macrophytes, algae and accumulated organics would also be expected to have varying effect on DO levels, pH and rates of nutrient recycling within each of the pools. The higher level of TSS recorded at Gnieraoora (RRD5) compared to all other sites (Figure 5) was likely due to recent cattle activity, which caused the physical disturbance and suspension of benthic sediments.

At most sites, Na^+ was the dominant cation, with Ca^{2+} sub-dominant, and HCO_{3-} the dominant anion, with Cl^- sub-dominant. The exception was RRU6, where Cl^- was dominant and HCO_{3-} sub-dominant. This suggests groundwater ingress had less influence on the water chemistry of the remnant pool at RRU6

[10] Fresh defined as < 1,500 µS/cm; brackish = 1,500 – 4,500 µS/cm; saline = 4,500 - 50,000 µS/cm; hypersaline > 50,000 µS/cm (DoE 2003). Classifications were presented as TDS (mg/L) in DoE (2003) so a conversion factor of 0.68 was used to convert to conductivity µS/cm as recommended by ANZECC/ARMCANZ (2000).

[11] Dissolved oxygen (DO) levels of zero percent saturation = anoxic; < 20% = defined as hypoxic; 100% = saturated; >100% = super-saturated; more oxygen is dissolved than would be in a state of equilibrium.

than at other pools, which may help to also explain the relatively higher salinity at RRU6 (*i.e*. less groundwater inflow to offset effects of evapoconcentration).

5.1.2 Exceedance of ANZECC/ARMCANZ default TVs

Exceedance of ANZECC/ARMCANZ default 95% TVs was recorded for EC, DO, dissolved zinc, N-total, N-NO_x and N-NH_3 at a number of sites upstream and downstream of the Jimmawurrada-Robe confluence (refer Appendix 3). No exceedance of ANZECC/ARMCANZ (2000) default TVs was recorded for any other parameter. Exceedances are discussed in the following sub-sections.

Electrical Conductivity (EC)

EC values were in exceedance of the ANZECC/ARMCANZ (2000) TV (250 µS/cm) at all sites sampled, although surface waters could still be classified as "fresh" (<1,500 µS/cm) at most sites (Figure 4). The relatively higher EC at RRU6 (1,700 µS/cm) constitutes "brackish" conditions, and was above EC levels reported during long-term monitoring of Robe River pools by Streamtec/UWA and the Proponent (*i.e.* 453 - 1,400 µS/cm). Elevated EC was again considered due to high levels of evapoconcentration in these isolated pools, a process common to surface waters in arid/semi-arid zones (Jolly *et al.* 2008). Although some dilution may occur following wet season rains, salinity can often remain high in arid-zone surface waters due to the variability of flows and flushing of stored salts (Jolly *et al.* 2008). ANZECC/ARMCANZ (2000) acknowledge that the default TV for EC may not be representative of local background levels in all areas of Australia. In such instances, ANZECC/ARMCANZ (2000) recommend developing site-specific trigger values (SSTVs) relevant to local conditions.

Dissolved Oxygen (DO)

Daytime DO saturation was below the ANZECC/ARMCANZ (2000) lower TV (80%) at the majority of sites, and above the upper TV (120%) at RRD6 (134.9%) (Figure 5 andAppendix 3). In aquatic ecosystems, low DO levels are typically considered of greater concern than high levels; however, super-saturated levels (>100%) during the day are often indicative of anoxic or hypoxic conditions at night. Low DO is commonly associated with standing pools (with little physical aeration) that support heavy organic loads (*e.g.* aquatic vegetation, algae, bacteria, *etc.*) (Caraco and Cole 2002). DO saturation is typically lowest in the early morning, following overnight consumption of oxygen through the respiratory processes of aquatic biota (Caraco and Cole 2002, Connolly *et al.* 2004, Flint *et al.* 2014). Sites which exhibited particularly low DO in the current study (*e.g.* RRU3 16.1%, RRU5 14.5%) were sampled early in the morning (*i.e.* between 0700 hrs and 0830 hrs), and also tended to support relatively high abundances of macrophytes and/or algae (Appendix 4). While the oxygen needs of aquatic biota differ between species and life history stages, values less than 50% saturation are associated with chronic responses in fish and macroinvertebrates (Connolly *et al.* 2004, Flint *et al.* 2014).

Super-saturation can occur when net photosynthesis exceeds total oxygen consumption in waterbodies, and is common in areas of high algal and macrophyte growth, particularly if spot measurements are taken later in the day (Caraco and Cole 2002). The organic habitat at RRD6, (134.9% DO) comprised emergent and submerged macrophyte (covering 50% of the site area; Appendix 4), and the spot measurement of DO was taken at 1230 hrs, when photosynthetic processes were likely near their peak. Waterbodies with super-saturated daytime DO are likely to experience overnight hypoxia or anoxia, as respiration by plants, algae, bacteria and other aquatic fauna deplete DO (Caraco and Cole 2002, Connolly *et al.* 2004, Flint *et al.* 2014).

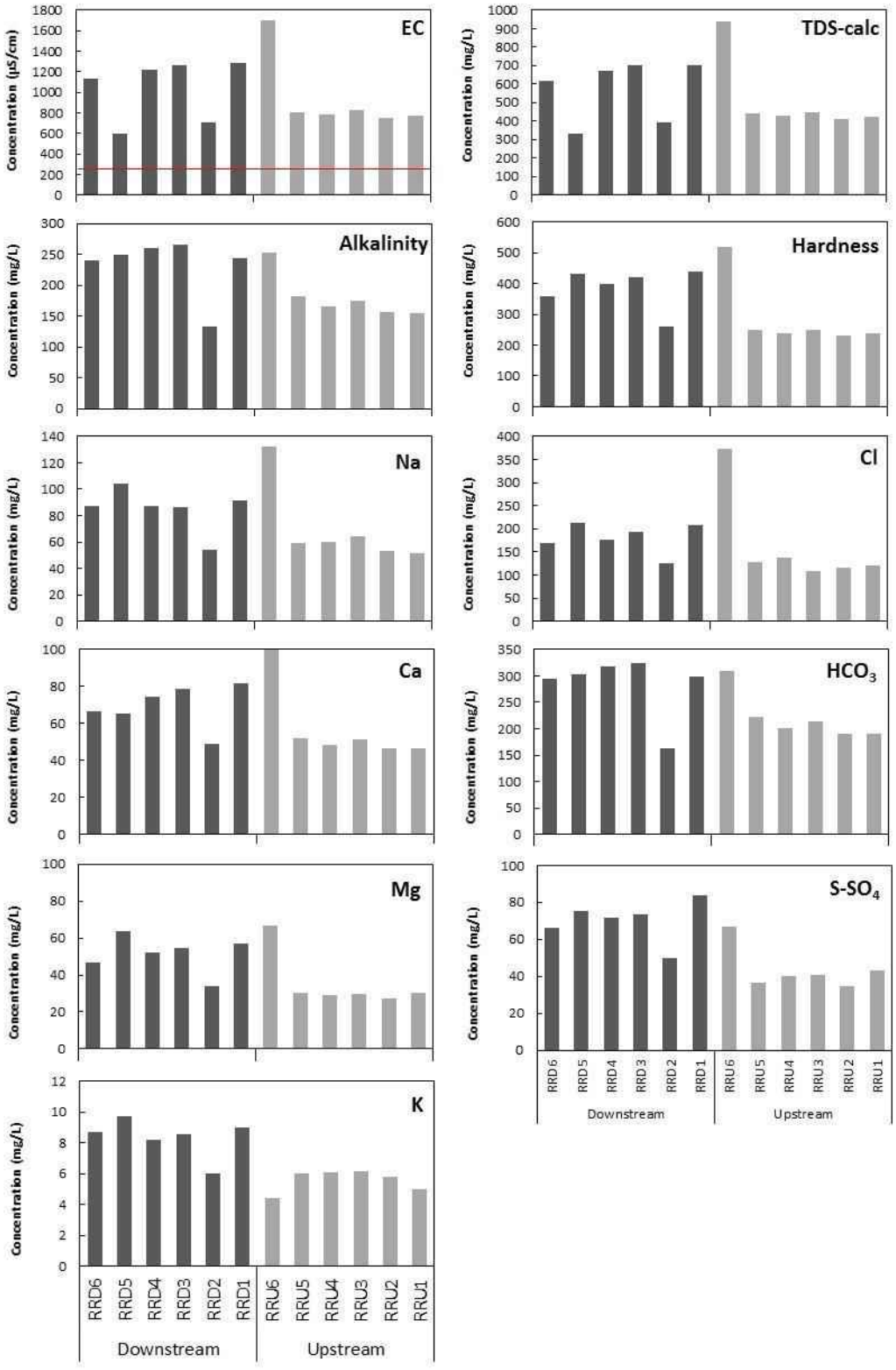


Figure 4. Comparison of EC, alkalinity, hardness and concentration of major ions amongst surface water sampling sites upstream (RRU1 to 6) and downstream (RRD1 to 6) of the Jimmawurrada-Robe confluence. Refer Table 1 for explanation of site codes and Figure 1 for location of sites. ANZECC/ARMCANZ (2000) default 95% species protection level TV (unbroken red line) is indicated for relevant parameters.

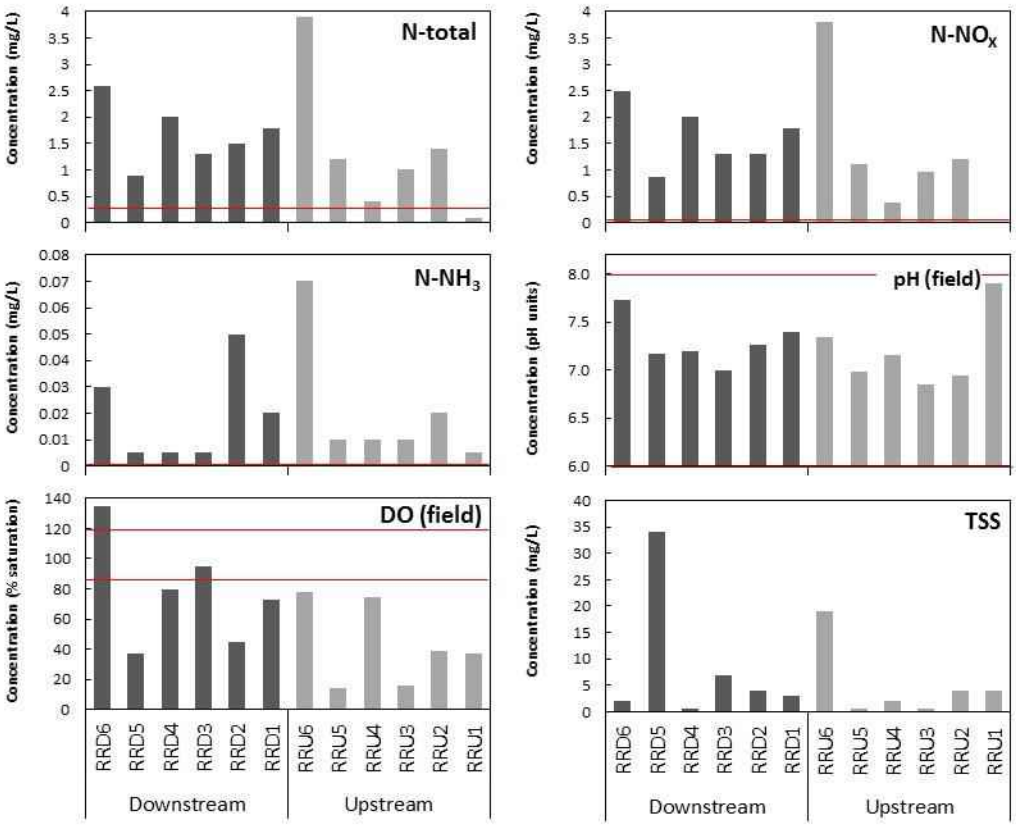


Figure 5. Comparison of N-total, N-NO_X, N-NH_3, pH, DO and TSS amongst surface water sampling sites upstream (RRU1 to 6) and downstream (RRD1 to 6) of the Jimmawurrada-Robe confluence. Refer Table 1 for explanation of site codes and Figure 1 for location of sites. ANZECC/ARMCANZ (2000) default 95% species protection level TV (unbroken red line) is indicated for relevant parameters; upper and lower TVs are shown for pH and DO.

Dissolved zinc

Dissolved zinc (dZn) concentration was in exceedance of ANZECC/ARMCANZ (2000) TVs (0.008 mg/L) at RRU5 (0.012 mg/L) and RRD3 (0.011 mg/L) (Appendix 3). ANZECC/ARMCANZ (2000) provide algorithms to calculate hardness modified TVs (HMTVs), as hardness has an ameliorating effect on the toxicity of a number of metals including cadmium, lead, nickel and zinc[12]. However, once the algorithm was applied, concentrations of dZn at RRU5 and RRD3 still excceded HMTVs. Although elevated, it is unknown what proportion of dZn was labile (bioavailable) or unavailable through processes such as complexing with dissolved organic carbon. Where dissolved levels are elevated, ANZECC/ARMCANZ (2000) recommends testing for labile concentrations/bioavailability to assess if levels are likely to be toxic to aquatic fauna. Given that exceedances of the ANZECC/ARMCANZ (2000) TV were recorded at sites both upstream (reference) and downstream of the Jimmawurrada-Robe confluence, it is unlikely that current Mesa J discharge operations are influencing dZn levels in the Project area.

Nitrogen (N-total, N-NO_X, N-NH_3)

At most sites (except RRU1), N-total, N-NO_X and N-NH_3 exceeded ANZECC/ARMCANZ (2000) default 95% TVs for protection against eutrophication (0.3 mg/L N-total, 0.01 mg/L N-NO_X, 0.01 mg/L N-NH_4[13])

[12] HMTV algorithm for zinc = Default TV*(Hardness/30)^0.85.
[13] Ammonia was analysed as nitrogen-ammonia (N-NH_3), so a conversion factor of 1 was used to convert to nitrogen as ammonium (N-NH_4) for comparison against ANZECC/ARMCANZ (2000) default TV for protection against eutrophication.

(Figure 5 and Appendix 3). N-NO_X levels were greatly in exceedance, *i.e.,* 10 times the default TV at most sites. N-NO_3 constituted nearly all of the measured N-NO_X and N-total (Appendix 3).

In order to compare against the default 95% TV for nitrate as a toxicant (0.7 mg/L NO_3), N-NO_3 concentrations were converted to NO_3 concentration by multiplying by a factor of 4.4. NO_3 exceeded the default 95% TV for nitrate as a toxicant at most sites (except RRU1); however, the default toxicant TV is currently under review as being too conservative. The new ANZECC/ARMCANZ 95% TV for NO_3 as a toxicant is likely to be around 2 - 2.5 mg/L N-NO_3 (~11 mg/L NO_3) (R. van Dam, *eriss*, pers. comm.), and will incorporate most recent data from acute and chronic toxicity testing in New Zealand. Recently published guidelines for Canada also recommend a higher guideline of 2.9 mg/L N-NO_3 (~13 mg/L NO_3) for freshwaters (CCME 2014). In comparison to the proposed ANZECC/ARMCANZ TV of 2 - 2.5 mg/L N-NO_3, only the concentration at RRU6 (3.8 mg/L) was still in exceedance, though the concentration at RRD6 (2.5 mg/L) was close to exceedance. Similar elevated levels of N-NO_3 have been recorded at Medawandy Waters (3.1 mg/L N-NO_3, 3.45 mg/L N-total) during previous monitoring in the Project area (Rio Tinto unpub. data).

Elevated background levels of N-NO_3 and N-NH_3 within the Project area are unsurprising, given that the Robe River catchment is already effected by current and historic pastoral practices (Strategen 2006). Cattle, or evidence of high cattle use were observed at a number of pools during the survey. Elevated N-NO_3 and N-NH_3 in waterbodies caused by livestock disturbance can reduce acid-neutralising capacities of waterbodies, adversely affect the growth, survival and reproduction of aquatic fauna, and most notably stimulate eutrophication and algal blooms (Camargo and Alonso 2006). Another potential anthropogenic source is ammonium nitrate used in mine explosives, though groundwaters in arid zone areas across Australia are often naturally enriched in nitrate, as is the case in the current Project area (Magee 2009).

Significantly higher concentrations of some ions, most notably S-SO_4, and to a lesser extent Mg, as well as elevated N-total and N-NO_x downstream of the Jimmawurrada-Robe confluence (Figures 4 and 5), may also reflect the influence of current mining operations discharges on the water quality of the downstream reach. The elevated S-SO_4 and Mg may indicate presence of geochemical reactions, resulting in the release of these elements downstream of the existing discharge points. The elevated nitrogen levels may indicate discharge of groundwater elevated in nitrates, with groundwaters in the vicinity of current mining operations appearing to be enriched (*e.g.* up to 23.9 mg/L N-NO_3 in bore MB15MEH014) (Rio Tinto unpub. data). The relative contribution of anthropogenic and natural sources to nitrogen enrichment in surface and groundwater of the Project area is unknown, but discharge of nitrogen-enriched groundwater has resulted in elevated nitrate levels in surface waters downstream of other BWT mining operations in the Pilbara.

5.2 Microinvertebrates

5.2.1 Species richness and abundance

A total of 81 microinvertebrate taxa were recorded from the Project area in May 2016, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69 were recorded at upstream reference sites (Table 6 and Appendix 5). The list includes groups which could not be identified to species level due to unresolved taxonomy and/or immature specimens. Therefore, the total microinvertebrate species richness is likely to be greater than that reported. Microinvertebrate composition included Protista (protists), Rotifera (rotifers), Copepoda (copepods), Cladocera (water fleas) and Ostracoda (seed shrimp) (Table 6). Generally, Rotifera dominated microinvertebrate taxa at each site, with comparatively few Copepoda, Ostracoda and Cladocera. The microinvertebrate fauna was generally typical of that commonly recorded from tropical/sub-tropical freshwater systems

(*e.g.* Koste and Shiel 1983, Tait *et al.* 1984, Smirnov and De Meester 1996, Segers *et al*. 2004), with Lecanidae dominating within the Rotifera, with Brachionidae and other families less prominent (Appendix 5).

Table 6. Summary of higher-order microinvertebrate taxa composition in the Robe River, upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Refer Appendix 5 for full species list.

Microinvertebrates		Number of Taxa	
Scientific name	Common name	RRD (*n* = 6)	RRU (*n* = 6)
Protista	Protists	7	12
Rotifer	Rotifers	20	33
Micro-crustacea			
Cladocera	Water fleas	5	11
Copepoda	Copepods	9	6
Ostracoda	Seed shrimps	5	7
Total taxa richness		**46**	**69**

Microinvertebrate taxa richness ranged from 33 taxa at RRD6 and RRU5, to just one taxa at RRD5 (Figure 6). There was no significant difference in mean total taxa richness between downstream potentially exposed sites and upstream reference sites (one-way ANOVA, Table 7). Nor were there any significant upstream-downstream differences in taxa richness of major groups of microinvertebrate (rotifers, protists, micro-crustacea) (Table 7).

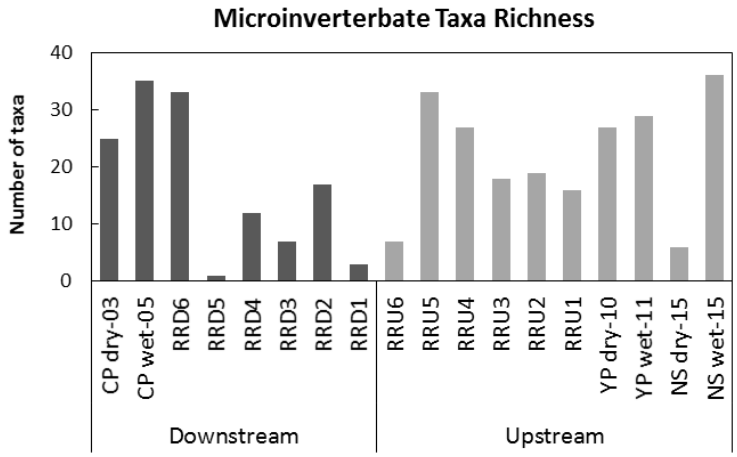


Figure 6. Microinvertebrate taxa richness recorded during the current study, upstream (RRU1 to 6) and downstream (RRD1 to 6) of the Jimmawurrada-Robe confluence, compared with most recent data for nearby Chalyarn Pool (CP; Pinder *et al.* 2010), Yalleen Pool (YP; WRM 2013) and Nyeetbury Spring (NS; WRM 2016). Refer Figure 1 for location of sites.

Table 7. Summary results from one-way ANOVAs testing for significant (p <0.05) differences in taxa richness of major microinvertebrate groups, upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Mean (±SE) vales for untransformed data are also provided.

Microinvertebrate metric	ANOVA (df = 1, 11)			Mean (±SE)	
	MS	F	*p*	RRD (*n* = 6)	RRU (*n* = 6)
Total taxa richness	184.1	1.672	0.225	12.17 (4.81)	20.00 (3.69)
Protista richness	8.333	1.168	0.305	2.33 (0.92)	4.00 (1.24)
Rotifera richness	80.08	2.313	0.159	3.67 (2.46)	8.83 (2.34)
Micro-crustacea richness	3.000	0.183	0.183	6.17 (2.01)	7.17 (1.20)

5.2.2 Comparison against previous surveys

To provide spatial context for microinvertebrate fauna within the Project area, total taxa richness at each site within the Project area was compared against most recent data for nearby pools upstream and downstream of the Project area, *i.e.* Yalleen Pool and Nyeetbury Spring on upper Bungaroo Creek (WRM 2013, 2016), and Chalyarn Pool on Mungarathoona Creek (Pinder *et al.* 2010) (Figure 6). Each of these previous studies used similar microinvertebrate sampling techniques (sweep netting using 50 - 53 µm mesh FBA pond net) and taxonomic resolution to those approaches for the current study.

Some temporal variation was observed between wet and dry season sampling events, with the wet season favouring microinvertebrate taxa richness at Chalyarn Pool, Yalleen Pool and Nyeetbury Spring (Figure 6). At sites upstream of the Jimmawarruda-Robe confluence, taxa richness was spatially variable, with richness at RRU4 and RRU5 similar to that recorded at Yaleen Pool (both seasons) and Nyeetbury Spring in the wet-15 (Figure 6), and slightly higher than that recorded at RRU1, RRU2 and RRU3. Richness was lowest at Nyeetbury Spring in the dry-15, comparable to that recorded at RRU6 in the current study (Figure 6). Within the potentially exposed downstream reach, taxa richness at sites closest to the confluence (RRD1 to RRD5) was generally lower than that recorded at sites further downstream (RRD6 and Chalyarn Pool in both seasons) (Figure 6).

Large spatial (and temporal) variability in species richness and abundance are commonly reported for freshwater systems world-wide. Variation typically depends on factors such as flow regime (with lotic habitat generally favouring taxa richness), pool size, primary production rates and water quality parameters (Miquelis *et al.* 1998, Schiemer *et al*. 2001, Schöll *et al.* 2012). In Pilbara surface waters, microinvertebrate taxa richness is known to fluctuate markedly between sites and seasons (Pinder *et al.* 2010, WRM unpub. data). It is possible that below-average rainfall in the months prior to the current survey may have contributed to the somewhat lower microinvertebrate taxa richness recorded at sites such as RRD1, RRD3, RRD5 and RRU6. Pinder *et al.* (2010) found the wet season (higher rainfall) to generally favour taxa richness during the PBS, as was the case at Chalyarn, Yalleen and Nyteetbury (Figure 6); however, as these studies only provide a snapshot of the microinvertebrate fauna at pools within the Project area, the specific factors driving taxa richness and composition remain unknown.

5.2.3 Spatial variation in species assemblages

Multivariate analysis (ANOSIM) detected no significant difference in microinvertebrate species assemblage composition between upstream reference and downstream potentially exposed sites (Table 8), suggesting there was a high degree of natural variability and overlap amongst assemblages both upstream and downstream of the Jimmawarruda-Robe confluence. Although SIMPER analysis found only a 21% similarity of species assemblages between the upstream and downstream reaches, nMDS plotting displayed no discernible separation of upstream/downstream sites based on Bray-Curtis similarity (Figure 7). SIMPROF analysis did detect some clustering of sites, though with no clear patterns in relation to upstream/downstream location (Figure 7). For example, the upstream sites RRU1, RRU2 and RRU3 clustered with downstream site RRD2, and upstream sites RRU5 and RRU6 clustered with downstream site RRD6, based on similarity of microinvertebrate species assemblages (Figure 7). RRD1 and RRD3 also clustered with a high degree of similarity (Figure 7).

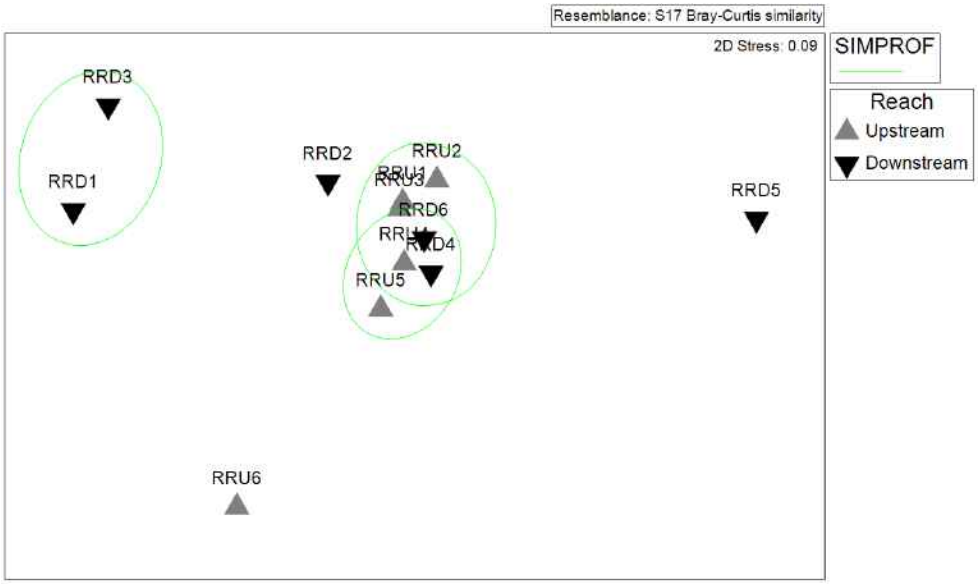


Figure 7. Plot of nMDS ordination on microinvertebrate species assemblages (log_{10} abundance class) upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Ordination based on Bray-Curtis similarity, with SIMPROF analysis as green circles overlain demonstrating significant clustering of sites. Refer Table 1 for explanation of site codes and Figure 1 for location of sites.

Table 8. Summary results from ANOSIM testing for significant (p <0.05) differences in microinvertebrate assemblages (Bray-Curtis similarity) upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence.

Microinvertebrate assemblage similarity (Bray-Curtis)	ANOSIM	
	R-statistic	*p*
Abundance (log_{10} class)	0.115	0.108
Presence/absence	0.137	0.097

The sampling design allows comparison of change in the similarity (Bray-Curtis) of microinvertebrate assemblages over time between reference and potential exposed sites. The premise being that if the degree of similarity between exposed and reference sites differs significantly over time (compared with pre-mine similarity), this would indicate mine-related response rather than stochastic variability due to factors such as climatic change.

5.2.4 Conservation significance of microinvertebrate fauna of the Project area

The majority of microinvertebrate taxa recorded from the Project area were common, ubiquitous species with Australasian or cosmopolitan distributions; however, the calanoid copepod *Eodiaptomus lumholtzi*, currently listed on the IUCN Red List of Threatened Species as Vulnerable (Reid 1996), was recorded at potentially exposed site RRD6. *E. lumholtzi* was assessed as Vulnerable in 1996 (IUCN ver. 2.3), as it was then known only from a few localities; Lake Woods in Northern Territory, Collinson's Lagoon at Ayr and Saltern Lagoon in the Valley of Lagoons, west of Ingham, Queensland. IUCN (2016) states this assessment requires updating because *E. lumholtzi* has since been recorded from many localities across the Australasian region. *E. lumholtzi* has been recorded previously by the authors at locations across the Pilbara region, including sites along Fortescue River, Coondiner Creek, Kalgan Creek, Weeli Wolli Creek, Koodaideri Springs, Caves Creek, Duck Creek and Cane River (WRM unpub. data). *E. lumholtzi* has also been found in Papua New Guinea, and is considered to have a pan-tropical distribution (Vlaardingerbroek 1989, WRM unpub. data).

Of scientific interest was the collection of an undescribed species of Lecanidae rotifer, *Lecane* n. sp., recorded both upstream and downstream of the Jimmawarruda-Robe confluence (RRU5 and RRD6). Morphologically, this species is similar to the described *Lecane quadridentata*, with the two variants synonymized by Segers (1995); however, the smaller Australian variant recorded in the current study is now recognised as a separate species, and forms part of a wider *L. quadridentata* species complex (Dr Russel Shiel, University of Adelaide, pers. comm.).

5.3 Hyporheic Fauna

5.3.1 Species richness and abundance

A total of 59 taxa were recorded from the hyporheic zone of pools in the Project area (Appendix 6). The majority of these taxa were classified as stygoxene (54%), *i.e.* species that appear in groundwater habitats by accident or seeking refuge during drought, and not specially adapted to subterranean inhabitation. Of these, 8% were classified as stygobitic, *i.e.*, obligate groundwater inhabitants with specialised morphological adaptations to survive in such environments (stygofauna). Of the remaining taxa, 31% were considered occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), 2% were possible hyporheic taxa, and 5% were unable to be classified (Appendix 6). Although classifications followed those of Boulton (2001), this type of analysis should be treated with some caution, as results are likely affected by available information on life history, taxonomic resolution, and interpretation of classification categories.

Hyporheic taxa richness (combined richness of stygobites, occasional hyporheic stygophiles and possible hyporheic fauna) ranged from two taxa at upstream reference site RRU2, to 12 taxa at potentially exposed downstream site RRD1 (Figure 8). Relatively high hyporheic taxa richness was also recorded at RRU6 (nine taxa), RRU4 and RRD2 (eight taxa), and RRU3 and RRD5 (seven taxa) (Figure 8). The high taxa richness encountered in the hyporheos of these sites, and because surface water was present at these sites despite below average rainfall in the months prior, suggests at least some connectivity between ground- and surface waters (*i.e.* they may be groundwater-supported pools).

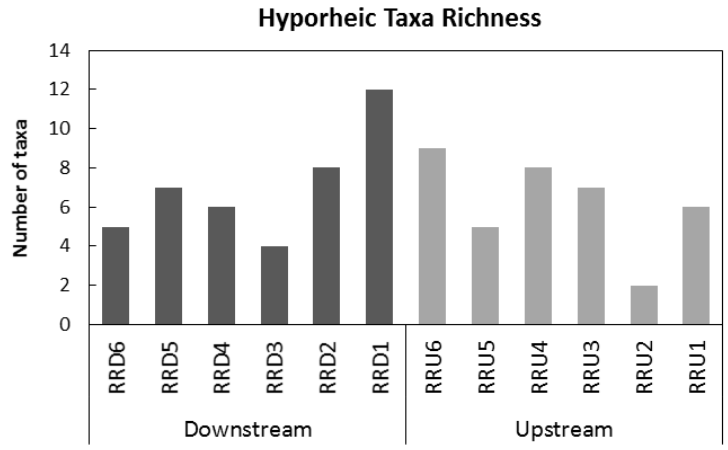


Figure 8. Hyporheic taxa richness (combined richness of stygobites, occasional hyporheic stygophiles and possible hyporheic fauna) of sites upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence.

5.3.2 Conservation significance of hyporheic fauna of the Project area

Of the fauna collected in hyporheic samples of the Project area, only the amphipod, *Nedsia* sp. is considered likely to be a potential SRE species.

Nedsia sp. (family Melitidae) was recorded from the hyporheic zones of RRU3, RRU4 and RRU6 upstream of the Jimmawurrada-Robe confluence, and RRD1, RRD2, RRD3 and RRD4 downstream of the confluence (Appendix 6). *Nedsia* amphipods were also recorded in the surface water macroinvertebrate samples of RRD3 and RRD4 (Appendix 7). These amphipods could not be confidently identified to species level due to a current lack of taxonomic resolution within the Melitidae amphipods and would require DNA sequencing.

Biota (2006a) recorded four genetically-distinct amphipods of the family Melitidae from bores in the Yarraloola area, downstream (west) of the Project area. A fifth distinct Melitidae lineage was recorded from the Bungaroo Creek area to the southeast (Biota 2006a). Interestingly, based on genetic evidence, each of the four Melitidae lineages from the Yarraloola area have been isolated from one-another for between 2.4 and 6.65 million years, highlighting the extreme degree of amphipod short-range endemism that can occur amongst aquifers in the region despite close geographical proximity (Biota 2006a). Biota (2010) and Bennelongia (2013) also recorded a high abundance of Melitidae amphipods from bores to the south of the current Project area. The majority of these specimens belonged to the genus *Nedsia* (*Nedsia* nr. *hulberti* and *Nedsia* spp.). It is currently unknown whether the *Nedsia* recorded in the current study represent one or more of the *Nedsia* species or Melitidae halotypes recorded by Biota (2006a, 2010) and Bennelongia (2013) or a separate species previously unrecorded.

Although not conservation listed or considered SRE species, the following are stygal species, with their presence indicating some connectivity between ground- and surface-waters. As such, they are of some interest.

The Thermosbaenacean *Halosbaena tulki* was recorded both upstream (RRU3) and downstream (RRD2, RRD3 and RRD4) of the Jimmawurrada-Robe confluence. *Halosbaena tulki* is the single species of Thermosbaenacean known from the Southern Hemisphere, where it appears to be restricted to the Pilbara region (Poore and Humphreys 1992). Thermosbaenacea are a rare order of crustacean, with approximately 16 species known worldwide, all of which are restricted to groundwater environments (Poore and Humphreys 1992). In the vicinity of the Project area, this species was previously collected from seven bores in the Yarraloola area by Biota (2006a).

The ostracod *Candonopsis* cf. *tenuis* is known to occur widely across Australia (DeDeckker 1982, Karanovic and Marmonier 2002), including groundwaters of the Pilbara (Halse *et al.* 2002). WRM has recorded *C.* cf. *tenuis* from the hyporheic zone of a number of sites in the Weeli Wolli Creek catchment, Coondiner Creek, Kalgan Creek, Hamersley Gorge and the Ashburton River (WRM unpub. data). During the current study, *C.* cf. *tenuis* was collected from the hyporheic zone of upstream reference site RRU6 (Appendix 6).

Vestalenula marmonieri is a stygal ostracod species known only from Western Australia and New Caledonia (Schön *et al.* 2010). This species is relatively widespread across the Pilbara region (being collected from over 50 locations by Pinder *et al.* (2010) during the PBS), though due to its preference for phreatic[14] environments, is most commonly associated with groundwater-fed systems such as Weeli Wolli Creek (WRM unpub. data). In the current study, *V. marmonieri* was recorded from potentially exposed downstream sites RRD1 and RRD5, and upstream reference site RRU1 (Appendix 6). *V.*

[14] Groundwater environments.

marmonieri was also collected in microinvertebrate samples of RRU1, RRU2, RRU3, RRU6, RRD2, RRD4 and RRD5 (Appendix 5).

5.4 Macroinvertebrates

5.4.1 Species richness and abundance

A total of 148 macroinvertebrate taxa were recorded from the Project area, of which 116 were present at sites downstream of the Jimmawurrada-Robe confluence, and 117 at upstream reference sites (Table 9, Appendix 7). In this context, "taxa" includes groups which could not be identified to species level, due to unresolved taxonomy and/or immaturity of specimens. Therefore, the total macroinvertebrate taxa richness at each site is likely greater than reported herein. The macroinvertebrate fauna comprised Cnidaria (freshwater hydra), Mollusca (freshwater snails and bivalves), Oligochaeta (aquatic segmented worms), Crustacea (amphipods and freshwater shrimp), Acarina (water mites), Collembolla (springtails), Odonata (dragonflies and damselflies), Ephemeroptera (mayflies), Hemiptera (true bugs), Coleoptera (aquatic beetles), Diptera (two-winged or "true" fly larvae), Trichoptera (caddisflies) and Lepidoptera (aquatic moth larvae; Table 9). Macroinvertebrate composition was typical of freshwater systems throughout the world (Hynes 1970), being dominated by Insecta (comprising 89% of all taxa), with Diptera (29%) and Coleoptera (32%) most prominent within this class. There were 46 singleton taxa recorded (*i.e.* those recorded from only one site), and 12 taxa were considered common taxa, *i.e.* they were present at over 80% of sites. These included the snail *Melanoides* spp., segmented worms (Oligochaeata spp.), the freshwater shrimp *Caridina indistincta*, the mayflies Baetidae spp. and *Cloeon* sp. Red Stripe, the pygmy backswimmer *Paraplea* spp., and the midge larvae/pupae Ceratopogonidae spp., Dasyheleinae spp., Chironomidae spp., *Polypedilum* sp. 1, *Larsia albiceps* and *Paramerina* sp. (Appendix 7).

Table 9. Summary of higher-order microinvertebrate taxa composition in the Robe River, upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Refer Appendix 7 for full species list.

Macroinvertebrates		Number of Taxa	
Scientific name	Common name	RRD (n = 6)	RRU (n = 6)
Cnidaria	Freshwater hydra	1	0
Oligochaeta	Aquatic worms	1+	1+
Gastropoda	Freshwater snails	4	5+
Bivalvia	Freshwater bivalves	0	1
Amphipoda	Stygal amphipods	2	0
Decapoda	Freshwater shrimps	1+	1+
Acarina	Water mites	1+	1+
Ephemeroptera	Mayflies	6	5
Odonata	Dragonflies and damselflies	14	14
Hemiptera	True bugs	18	16
Coleoptera	Aquatic beetles	30	35
Diptera	Two-winged flies	30	31
Trichoptera	Caddisflies	7	4
Lepidoptera	Aquatic moth larvae	2	2
	Total taxa richness	**116**	**117**

+ indicates a taxa could only be identified to genus/family/order level (not species level), and as such more than one species is likely to be present within this taxonomic group.

Macroinvertebrate taxa richness at upstream sites ranged from 34 taxa at RRU3 and RRU5, to 72 taxa at RRU1 (Figure 9). Richness at sites downstream of the Jimmawarruda-Robe confluence ranged from 38 taxa at RRD3 and RRD5, to 56 taxa at RRD2 (Figure 9). There was no significant difference in total

taxa richness between downstream potentially exposed sites and upstream reference sites (one-way ANOVA, Table 10). Nor were there any significant upstream-downstream differences in taxa richness of most major macroinvertebrate groups (Table 10). The exception was Ephemeroptera (mayflies), where mean richness was significantly higher at sites downstream of the confluence (4.3) compared to those upstream (2.5) (Table 10). This was largely due to the lower richness/absence of *Tasmanocoenis* sp. P/*arcuata* (Caenidae) and *Cloeon fluviatile* (Baetidae) at upstream sites, particularly RRU4 to 6 closest to the confluence.

Table 10. Summary results from ANOVAs testing for significant (p <0.05) differences in taxa richness of major macroinvertebrate groups (indicated by *), upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Mean (±SE) vales for untransformed data are also provided.

Macroinvertebrate metric	ANOVA			Mean (±SE)	
	MS	F	p	RRD (n = 6)	RRU (n = 6)
Total taxa richness	0.083	0.001	0.982	46.2 (3.5)	46.3 (6.1)
Diptera richness	0.000	0.000	1.000	14.0 (1.8)	14.0 (4.6)
Coleoptera richness	18.75	0.587	0.461	8.5 (2.4)	11.0 (2.2)
Hemiptera richness	0.333	0.035	0.855	6.3 (1.1)	6.0 (1.4)
Odonata richness	1.333	0.377	0.553	5.33 (0.6)	6.0 (0.9)
Trichoptera richness	1.333	1.429	0.260	1.7 (0.4)	1.0 (0.4)
Ephemeroptera richness	10.08	6.798	0.026*	4.3 (0.5)	2.5 (0.5)
Mollusca richness	0.083	0.068	0.799	2.7 (0.4)	2.8 (0.5)
Crustacea richness	0.750	-0.738	0.411	2.7 (0.5)	2.2 (0.3)

5.4.2 Comparison against previous studies

To provide spatial context for macroinvertebrate fauna within the Project area, total taxa richness at each site was compared against most recent data for nearby pools upstream and downstream, *i.e.* Yalleen Pool and Nyeetbury Pool on upper Bungaroo Creek (WRM 2013, 2016), and Chalyarn Pool on Mungarathoona Creek (Pinder *et al.* 2010) (Figure 9). Each of these previous studies used similar macroinvertebrate sampling techniques (kick-sweep netting using 250 µm mesh FBA pond net) and taxonomic resolution to those of the current study.

Taxa richness within the Project area (34 – 72 taxa) was generally comparable to that previously recorded for Yalleen Pool (39 – 45), Nyeetbury Spring (51 – 52) and Chalyarn Pool (49 – 77) (Figure 9). The lack of spatial variability in macroinvertebrate taxa richness between studies probably reflects the similar hydrological nature and size of these pools (*i.e.* all are either permanent/semi-permanent riverine pools, flowing only after heavy rainfall) because they are all within relatively close geographical proximity to one-another (*i.e.* within 20 – 30 km, and all part of the Robe River catchment). Pinder *et al.* (2010) noted riverine pools of the Pilbara (particularly those of the same catchment) generally display a high degree of homogeneity, in terms of macroinvertebrate species richness and composition, in comparison to similarly sized turbid wetlands and claypans.

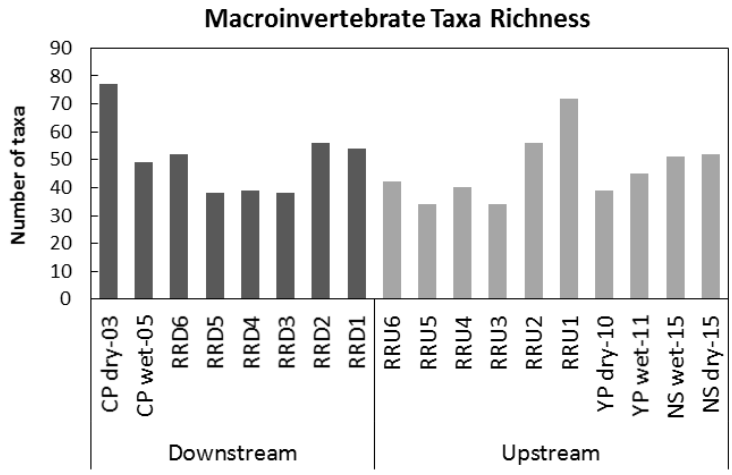


Figure 9. Macroinvertebrate taxa richness recorded during the current study, upstream (RRU1 to 6) and downstream (RRD1 to 6) of the Jimmawurrada-Robe confluence, together with most recent data for nearby Chalyarn Pool (CP; Pinder *et al.* 2010), Yalleen Pool (YP; WRM 2013) and Nyeetbury Spring (NS; WRM 2016). Refer Figure 1 for location of sites.

To provide temporal/seasonal context for macroinvertebrate taxa richness in the current Project area, April/May (wet season) 2016 figures were compared against historic mean dry season taxa richness recorded at Robe River pools by Streamtec/UWA between 2002 and 2011[15]. Again, both studies utilised the same macroinvertebrate sampling technique (sweep netting using a 250 µm mesh FBA pond net), and taxonomy was standardised across datasets to account for inherent variation/advancements in taxonomic knowledge between studies (*i.e.* some taxa were condensed to family or order level to enable comparison). As such, taxa richness may appear lower than was originally reported in each study.

At the reach upstream of the Jimmawarruda-Robe confluence, mean dry season richness at Medawandy Waters (22) and Pannawonica Hill (23) were generally comparable to wet season taxa richness recorded at RRU3 (22), RRU4 (30), RRU5 (20) and RRU6 (26), but slightly lower than taxa richness recorded at RRU1 (54) and RRU2 (38) (Figure 10). Downstream of the confluence, mean dry season richness recorded at Gnieroora, Martangkuna, Pulari, Japanese Pool and Yarramudda (20 – 27 taxa) was also similar to wet season richness recorded at RRD1, RRD3, RRD4 and RRD5 (21 – 33 taxa), and only slightly lower than that recorded at RRD6 (41 taxa) and RRD2 (38 taxa). The apparent lack of seasonal variability in taxa richness likely reflects the capacity for pools of the Project area to hold water year-round (*i.e.* they are either permanent/semi-permanent), acting as refuge pools for migratory macroinvertebrates during the dry season, and generally favouring both temporary and permanent resident macroinvertebrate species over more ephemeral waterbodies (Sponseller *et al.* 2001, Pinder *et al.* 2010). Furthermore, Pinder *et al.* (2010) found there to be little seasonal variation in macroinvertebrate assemblages at permanent/semi-permanent riverine pools of the Pilbara region in comparison to more ephemeral waterbodies, particularly when flooding had not occurred prior to wet season sampling (as was the case in the current study). It must be noted that the current study provides only a snapshot of the macroinvertebrate fauna of the Project area and taxa richness could still vary considerably between time periods.

[15] The most recent round of macroinvertebrate data (2013) was not included in analysis, as Streamtec (2014) did not feature a raw species list. Earlier species lists (1996 & 1998) were not included in the analysis due to the vast improvements in taxonomic knowledge and microscope technology since those studies.

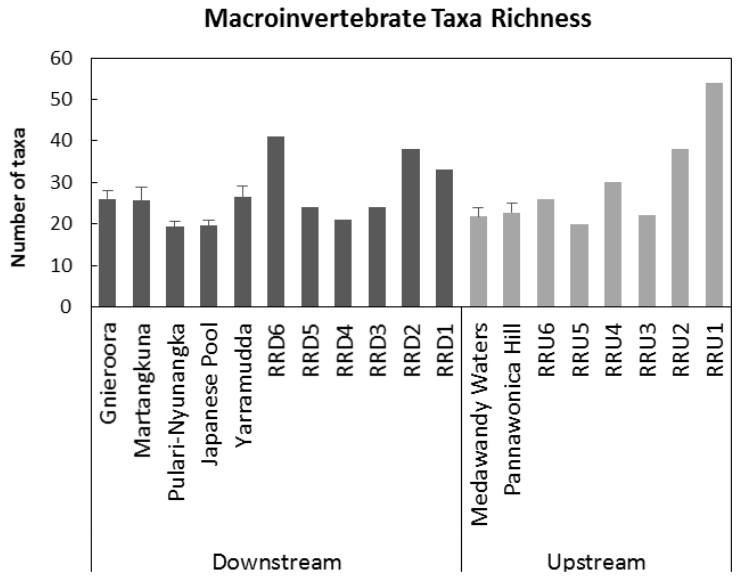


Figure 10. Comparison of standardised macroinvertebrate taxa richness recorded during the current study, with that recorded by Streamtec/UWA during long-term monitoring of Robe River pools. Refer Figure 1 for location of sites.

5.4.3 Spatial variation in species assemblages

Multivariate analysis (ANOSIM) detected no significant difference in macroinvertebrate species assemblage composition between upstream reference and downstream potentially exposed sites (Table 11), suggesting there was a high degree of natural variability and overlap amongst upstream/downstream sites. Although SIMPER analysis found only a 45% similarity of species assemblages between upstream and downstream sites, nMDS plotting displayed no distinguishable separation of upstream/downstream sites based on Bray-Curtis similarity (Figure 11), with SIMPROF analysis (not shown) detecting no clustering of these groups. One site (RRU3) was separate from all other sites, which is attributed to the low overall taxa richness (34) recorded at this site compared to others. As with taxa richness, the lack of variability in upstream/downstream macroinvertebrate assemblages likely reflects the relatively similar hydrological nature (permanent/semi-permanent) of pools in the Project area.

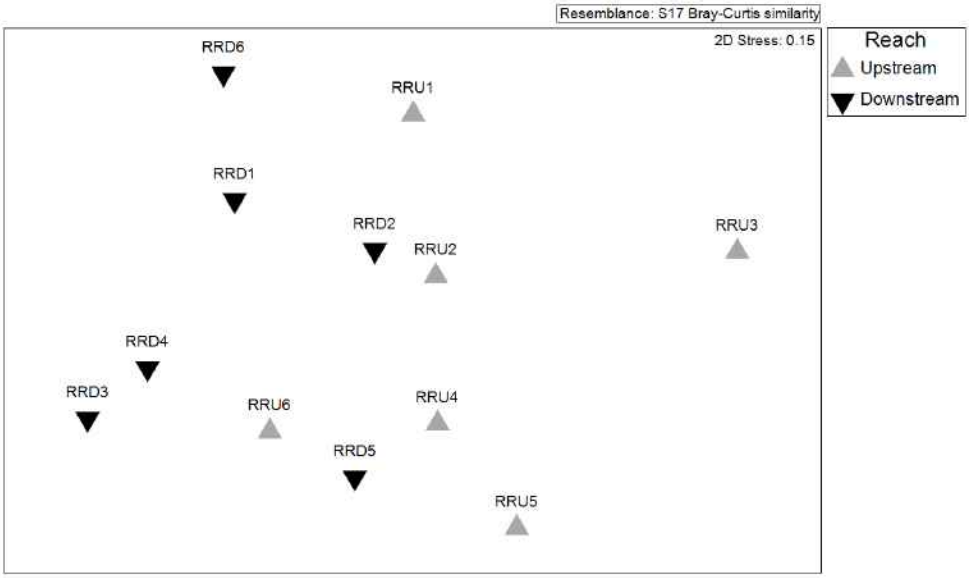


Figure 11. Plot of nMDS ordination on macroinvertebrate species assemblages (log_{10} abundance class) upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence. Ordination based on Bray-Curtis similarity. Refer Table 1 for explanation of site codes and Figure 1 for location of sites.

Table 11. Summary results from ANOSIM testing for significant (p <0.05) differences in macroinvertebrate assemblages (Bray-Curtis similarity) upstream (RRU) and downstream (RRD) of the Jimmawurrada-Robe confluence.

Macroinvertebrate assemblage similarity (Bray-Curtis)	ANOSIM	
	R-statistic	*p*
Abundance (log_{10} class)	0.154	0.106
Presence/absence	0.111	0.186

5.4.4 Conservation significance of macroinvertebrate fauna of the Project area

The Pilbara pin damselfly, *Eurysticta coolawanyah* (family Isostictidae), is endemic to the Pilbara region, and is currently listed as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2016). *Eurysticta coolawnyah* was recorded from two sites in the current study; RRD3 and RRD4, both downstream of the Jimmawarruda-Robe confluence (Appendix 7). *E. coolawanyah* is known from over 40 locations across the Pilbara (Pinder *et al.* 2010), and has been recorded by WRM from a number of riverine pools and springs along the Fortescue River, DeGrey River, Coondiner Creek, Kalgan Creek and Weeli Wolli Creek (WRM unpub. data). Along the Robe River, this species has been recorded consistently by Streamtec/UWA, as well as from Bungaroo Creek (WRM 2013) and Mugarathoona Creek (Pinder *et al.* 2010).

It is likely that both RRD3 and RRD4 are important refuge pools for *E. coolawanyah* in the area, as both are persistent waterbodies which support relatively high densities of emergent macrophyte (see Appendix 4). Damselflies (such as *E. coolawanyah*) are known to actively select sites with greater concentrations of emergent macrophyte, which are used for perching, mating and oviposition (egg-laying) (D'Amico *et al.* 2004, Rouquette and Thomson 2004, Ward and Mill 2005, Remsburg and Turner 2009).

Although the following species are not listed for conservation significance, they are endemic to the Pilbara region and therefore of some scientific interest. The Pilbara tiger dragonfly, *Ictinogomphus dobsoni* (family Lindeniidae), was collected at reference site RRU3, and potentially exposed sites RRD1, RRD4 and RRD6 (Appendix 7). This species appears to be relatively common across the Robe River

catchment, having been recorded from Chalyarn Pool, Red Hill Creek (Pinder *et al*. 2010) and a number of permanent/semi-permanent Robe River pools (Streamtec/UWA). Elsewhere, *I. dobsoni* has been recorded from many of the other major river systems of the Pilbara, including the Fortescue, Ashburton, Yule, DeGrey and Sherlock rivers (DEC 2009, Pinder *et al*. 2010, CSIRO 2015). Large pools within the Project area epitomise ideal refuge habitats for *I. dobsoni*, which is known to prefer still or sluggish permanent riverine waterbodies (Watson 1991).

The Pilbara endemic dytiscid beetle *Tiporus tambreyi* was recorded at reference sites RRU3, RRU4 and RRU6, and potentially exposed site RRD1 (Appendix 7). This species is common and ubiquitous across the region, and in the vicinity of the Project area, has been recorded from Robe River pools (Streamtec/UWA), Chalyarn Pool (Pinder *et al.* 2010) and Red Hill Creek (WRM 2009, Pinder *et al.* 2010).

The haliplid beetle *Haliplus pilbaraensis,* recorded from reference site RRU1 (Appendix 7), is endemic to the Pilbara region and relatively new to science (Watts and McRae 2010). This species appears to occur fairly widely throughout the Pilbara, and has been recorded at localities such as Glen Ross Creek, Coondiner Pool, the Fortescue Marsh, Moreton Pool, Paradise Pool, Munreemya Billabong, Wackilina Creek Pool, West Peawah Creek Pool, Harding River Pool, and an un-named creek in Millstream (Watts and McRae 2010). Closer to the Project area, *H. pilbaraensis* was previously recorded from Red Hill Creek (WRM 2009).

5.5 Fish

5.5.1 Species composition and abundance

A total of 3,515 individual fish were caught, measured and released in the Project area; 1,578 from upstream reference sites (RRU1 - 6), and 1,937 from sites downstream of the Jimmawarruda-Robe confluence (RRD1 - 6). Seven true freshwater taxa were recorded, including the western rainbowfish, spangled perch, Pilbara tandan (eel-tailed catfish), Fortescue grunter, barred grunter, bony bream, and a hybridised form of Terapontidae (grunter) (Table 12). Four species captured were of estuarine/marine origin, including milkfish, tarpon (ox-eye herring) (Plate 8), mullet and banded scat (striped butterfish) (Plate 8) (Table 12). Each of the freshwater species, with the exception of bony bream, was recorded both upstream and downstream of the Jimmawarruda-Robe confluence (bony bream were only recorded upstream of the confluence) (Table 12). The marine vagrant tarpon and mullet were also recorded both upstream and downstream of the confluence; however, milkfish and banded scat were only recorded from the downstream reach (Table 12). Each of these species, except milkfish, was previously recorded from the Robe River by Morgan and Gill (2004) and Streamtec/UWA.

Table 12. Summary of freshwater and estuarine/marine vagrant fish species recorded in the Project area, including scientific and common names. ✓ = fish species was present.

Origin	Species	Common name	Downstream						Upstream					
			RRD6	RRD5	RRD4	RRD3	RRD2	RRD1	RRU6	RRU5	RRU4	RRU3	RRU2	RRU1
Freshwater	*Melanotaenia australis*	Western rainbowfish	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Neosilurus sp.	Pilbara tandan			✓	✓	✓			✓		✓	✓	✓
	Leipotherapon unicolor	Spangled perch	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Leipotherapon aheneus	Fortescue grunter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Amniataba percoides	Barred grunter	✓		✓	✓		✓	✓	✓				
	Terapontidae sp.	Grunter hybrid		✓			✓		✓	✓		✓		✓
	Nematalosa erebi	Bony bream											✓	
Estuarine/ marine	*Chanos chanos*	Milkfish	✓		✓									
	Megalops cyprinoides	Tarpon/ox-eye herring	✓	✓		✓	✓	✓		✓	✓		✓	
	Mugil sp.	Mullet		✓				✓			✓		✓	
	Selenotoca multifasciata	Banded scat/striped butterfish	✓	✓	✓	✓	✓	✓						

There was no significant difference in mean abundance of fish upstream and downstream of the Jimmawarruda-Robe confluence (one-way ANVOA, $p = 0.433$), nor was there any significant difference in mean abundance of any of the individual species between the upstream and downstream reaches (one-way ANOVA, $p < 0.05$). There was a significant difference in mean species richness between upstream and downstream sites, with mean richness significantly higher downstream of the Jimmawarruda-Robe confluence (one-way ANVOA, $p = 0.008$). This was mainly due to the greater presence of estuarine species such as banded scat, milkfish and tarpon at the downstream reach (Table 12).

Western rainbowfish were the most abundant fish of the Project area, with a total of 2,401 individuals captured. Western rainbowfish were present at all sites, with 1,019 recorded from upstream reference sites (42%), and 1,382 recorded from downstream sites (48%) (Figure 12). Fortescue grunter (685 individuals) and spangled perch (203 individuals) were the second and third most abundant species of the Project area, respectively. Fortescue grunter were collected from all sites, with similar numbers captured both upstream (320 individuals; 47%) and downstream (365 individuals; 53%) of the Jimmawarruda-Robe confluence (Figure 12). Spangled perch were also present at all sites, with the majority recorded at upstream sites (145 individuals; 71%) (Figure 12). Of the remaining freshwater species, Pilbara tandan (34 individuals) were recorded at upstream sites RRU1, RRU2, RRU3, RRU5, and downstream sites RRD2, RRD3 and RRD4; barred grunter (47 individuals) were recorded at upstream sites RRU5 and RRU6, and at downstream sites RRD3, RRD4 and RRD5. Terapontidae hybrids (12 individuals) were recorded at upstream sites RRU1, RRU3, RRU5 and RRU6, and downstream sites RRD2 and RRD5 (Figure 12). Bony bream (5 individuals) were only recorded at upstream site RRU2.

Of the estuarine/marine fish species, tarpon (39 individuals) (Plate 8) were recorded at upstream sites RRU2, RRU4 and RRU5, and all sites downstream of the Jimmawarruda-Robe confluence (Figure 12). Mullet (33 individuals) were recorded at upstream sites RRU2 and RRU4, and downstream sites RRD1 and RRD5 (Figure 12). Banded scat (53 individuals) (Plate 8) were only recorded downstream of the confluence, but were present at all sites within that reach (Figure 12). Milkfish (7 individuals) were only recorded from downstream sites RRD4 and RRD6 (Figure 12).

Plate 8. The banded scat *Selenotoca multifaciata* (left) and the tarpon *Megalops cyprinoides* (right), captured downstream of the Jimmawarruda-Robe confluence.

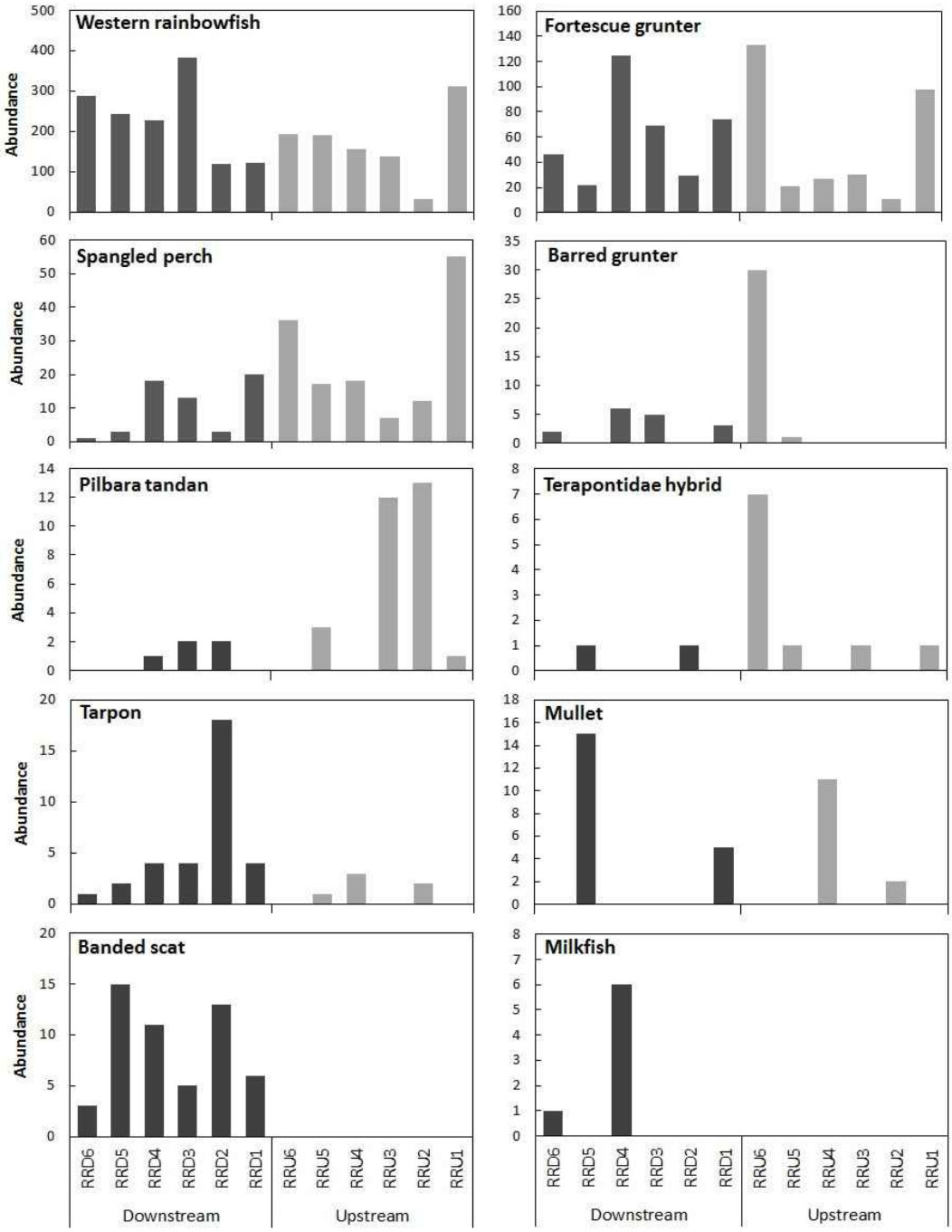


Figure 12. Abundance of each fish species recorded from upstream (RRU1 to 6) and downstream (RRD1 to 6) of the Jimmawurrada-Robe confluence. Note: bony bream (*Nematalosa erebi*) were also recorded from the Project area, but were not plotted due to low overall abundance of this species.

5.5.2 Conservation significance of fish species

One conservation listed freshwater fish species was recorded from the Project area; the Pilbara endemic Fortescue grunter (*Leipotherapon aheneus*). Currently, the Fortescue grunter is listed on the IUCN Red List of Threatened Species as Lower Risk/Near Threatened (IUCN 2016), and as a Priority 4 (P4) species on the Department of Parks and Wildlife (Parks and Wildlife) Priority Fauna List (Parks and Wildlife 2016). This species is only known from the Fortescue, Robe and Ashburton River systems (Allen *et al*. 2002, Morgan and Gill 2004); however, it is considered to be common within this range, as is evidenced

by the ubiquitousness of this species across the current Project area, being the second most abundant fish collected (685 individuals) and occurring at all sites both upstream and downstream of the Jimmawarruda-Robe confluence (Table 12 and Figure 12).

The following species are not listed for conservation significance, but are of some scientific interest:

Individuals which appeared to be hybridised forms of two of the three co-occurring Robe River Terapontidae species (spangled perch, barred grunter and/or Fortescue grunter; Plate 9) were recorded from RRU1, RRU3, RRU5, RRU6, RRD2 and RRD5 (Table 12 and Figure 12). Hybridised grunters have been recorded from other Pilbara systems by the authors and others, including the Fortescue, Murchison and Ashburton rivers (Morgan and Gill 2006, Morgan *et al.* 2009, WRM 2016, WRM unpub. data). Morgan and Gill (2006) propose hybridisation between closely related fish species is not uncommon; however, the hybridisation of grunters in Pilbara river systems is not fully understood, and is of some interest, particularly if hybridisation results in the loss of species through replacement with reproductively unviable individuals, or if there is evidence of incipient speciation (the formation of a new species). Loss or replacement of a species is especially important in the case of the Fortescue grunter, as it is a nationally and internationally listed species of conservation significance.

A.

B.

C.

D.

Plate 9. Terapontid hybridisation, illustrating (A) Spangled perch *Leiopotherapon unicolor*, (B) barred grunter *Amniataba percoides*, (C) Fortescue grunter *Leiopotherapon aheneus*, and (D) Terapontidae hybrids from RRU6, possibly sharing the features of barred and Fortescue grunter. Photographs by Chris Hofmeester (A, B and C)/WRM (D) ©.

None of the estuarine/marine fish species recorded in the Project area are endemic to the Pilbara region or currently listed for conservation significance. Milkfish (*Chanos chanos*) were not reported from the freshwater reaches of the Robe River by either Streamtec/UWA, Morgan and Gill (2004) or Antao and Braimbridge (2010). As such, collection of this species during the current study (along with its collection from further downstream) likely establishes a new record for the system. *Chanos chanos* is widely distributed across tropical and sub-tropical climes of the Indo-West Pacific region (Bagarinao 1994, Swanson 1998, Allen *et al.* 2002). This species is known to utilise fresh, brackish, oceanic and hypersaline lagoon environments (*i.e.* are euryhaline), being extremely efficient at osmoregulation during all life-history stages (Swanson 1998, Lin *et al.* 2003). In Australian waters, adult milkfish are pelagic schooling fish, inhabiting shallow, off-shore marine habitats. Spawning typically takes place offshore, following which juveniles migrate to sheltered estuaries. Sub-adult milkfish occasionally penetrate further upstream into freshwater reaches, before returning to the ocean to undergo sexual maturation and spawning (Bagarinao 1994, Allen *et al.* 2002).

5.5.3 Fish population structure

The reproductive strategies of freshwater fish species in the Pilbara are 'opportunistic' and 'periodic', reflecting the seasonal yet unpredictable nature of rainfall and streamflow in the region (Beesley 2006). Breeding of many species occurs during the wet season and during this time, multiple spawning events are known to occur (Beesley 2006). Further, the volume, hydrological regime and habitat complexity of Pilbara waterbodies can have a marked influence on fish population structure, with larger pools and more complex habitat considered generally advantageous for fish communities (Allen *et al.* 2002, Morgan *et al.* 2002, Morgan *et al.* 2009). Therefore, anthropogenically-induced alterations to streamflow patterns, water levels and water quality can have a discernible impact on life-history strategies and assemblage composition of local fish populations (Allen *et al.* 2002). Analysing population structure provides one means of characterising the health of fish assemblages at each site, and by extension the ecological processes driving aquatic communities within the waterbody. The presence of newly recruited and juvenile fish, for example, indicates recent spawning activity (and conditions conducive to such). Conversely, the presence of only sub-adult and adult (larger) fish may indicate a higher amount of predatory pressure on juvenile fish, and/or that conditions in pools are not conducive to spawning.

In order to examine population structures of the most ubiquitous freshwater fish of the Pilbara region (western rainbowfish, spangled perch and Pilbara tandan), length-frequency data for age-classes were estimated from published literature (*i.e.* Lake 1971, Bishop *et al.* 2001, Allen *et al.* 2002, Morgan *et al*. 2002, Beesley 2006; Table 13).

Table 13. Age-classes used in length-frequency analysis of Western rainbowfish, spangled perch and Pilbara tandan from the Project area. Age-classes are adapted from Lake (1971), Bishop *et al.* (2001), Allen *et al.* (2002), Morgan *et al*. (2002) and Beesley (2006).

Species	Age-class	Size mm SL
Western rainbowfish	New recruit	< 30
(*Melanotaenia australis*)	Juvenile	31-40
	Sub-adult	41-50
	Adult	> 51
Spangled perch	New recruit	< 30
(*Leiopotherapon unicolor*)	Juvenile	31-50
	Sub-adult	51-70
	Adult	> 71
Pilbara tandan	New recruit	< 30
(*Neosilurus* sp.)	Juvenile	31-70
	Sub-adult	71-90
	Adult	> 91

Western rainbowfish

Western rainbowfish breed throughout the year, with multiple spawning bouts that take full advantage of the region's intermittent rainfall and streamflow (Beesley 2006). Rainbowfish of the family Melanotaeniidae are usually sexually mature by the end of their first year (Allen *et al.* 2002). The size at sexual maturity can vary between river systems (typically around 50 mm SL), though western rainbowfish generally attain a maximum size of 110 mm total length (TL) (Allen *et al.* 2002).

The population structure of western rainbowfish at most upstream and downstream sites appeared to be healthy, with a variety of age-classes (new recruits, juveniles, sub-adults and adults) represented at RRU1, RRU4, RRU5, and RRD2 – RRD6 (Figure 13). New recruits and juveniles were particularly abundant at upstream site RRU4, and downstream sites RRD2, RRD4 and RRD6 (Figure 13), indicating spawning activity and good recruitment at these waterbodies. No western rainbowfish new recruits were recorded at RRD1, where sub-adults and adults (50 – 90 mm SL) dominated the population (Figure 13). Relatively low numbers of new recruits and juveniles (and low western rainbowfish numbers in general) were also recorded at RRU2 (Figure 13). Low recruitment of rainbowfish at RRD1 was possibly due to the small size of this pool, which also contained piscivorous species such as spangled perch, Fortescue grunter and barred grunter. Reduced depth and volume of small pools such as RRD1 inherently increases the risk of juvenile fishes to teleost (fish) and avian predation (Morgan *et al.* 2009). Conversely, low western rainbowfish abundance (and concurrent low abundance of new recruits and juveniles) recorded at RRU2 may have been related to the large size and volume of this pool, which would enable fish to avoid capture in seine and gill nets. Relatively low abundances of all fish species were recorded at RRU2, with the exception of Pilbara tandan, which are more commonly caught while electrofishing, rather than in seine and gill nets.

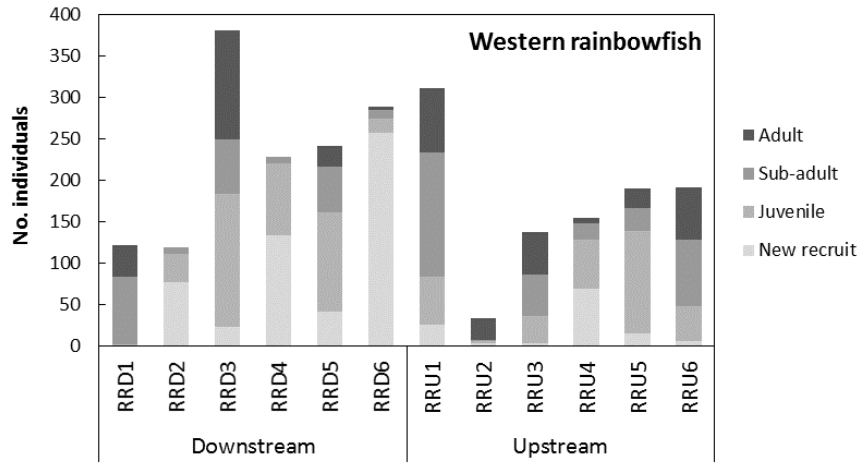


Figure 13. Abundance of western rainbowfish (*Melanotaenia australis*) age-classes recorded from each pool in the Project area.

Spangled Perch

Spangled perch are known to take advantage of wet season flooding to migrate upstream and breed (Bishop *et al.* 1995, Bishop *et al.* 2001, Pusey *et al.* 2004, Marsden and Power 2007). During this time, multiple spawning events are known to occur (Beesley 2006). In the Fitzroy River, Morgan *et al.* (2002) collected mature specimens at the beginning of the wet season, and larvae at the end of the wet season, indicating that spawning coincided with the flooding of the river. Spangled perch mature in their first year, at approximately 58 mm TL for males and 78 mm TL for females, and can reach a maximum size of 300 mm TL (Allen *et al.* 2002, Beesley 2006).

Spangled perch recruitment in the Project area appeared to be low, with new recruits (< 30 mm SL) only recorded at RRU1 and RRU2 upstream of the Jimmawarruda-Robe confluence, and RRD3 and RRD4 downstream of the confluence (Figure 14). Juveniles (31 - 60 mm SL) were also absent or recorded in low numbers at most sites (Figure 14). This reflects the high degree of variability in streamflow in the Project area, with low rainfall and streamflow leading up to the survey likely restricting spangled perch spawning activity. The exception was downstream site RRD3, where the spangled perch population comprised mainly juveniles (227 juveniles) (Figure 14). This suggests spangled perch may have spawned in or upstream of this pool recently following a flood event, with juveniles becoming isolated as waters

receded. RRD3 supported the highest abundance of spangled perch in the Project area (382 individuals), constituting 67% of all spangled perch caught during the survey; however, given the ubiquitousness of this species across the Pilbara, it is likely that larger populations reside at larger pools within the Project area. Catch per unit effort is likely reduced in these pools, such as RRU2, RRU4, RRU5, RRD4, RRD5 and RRD6, due to their size and depth, and presence of submerged debris (*e.g.* logs, branches, snags), which hinders seine and gill netting.

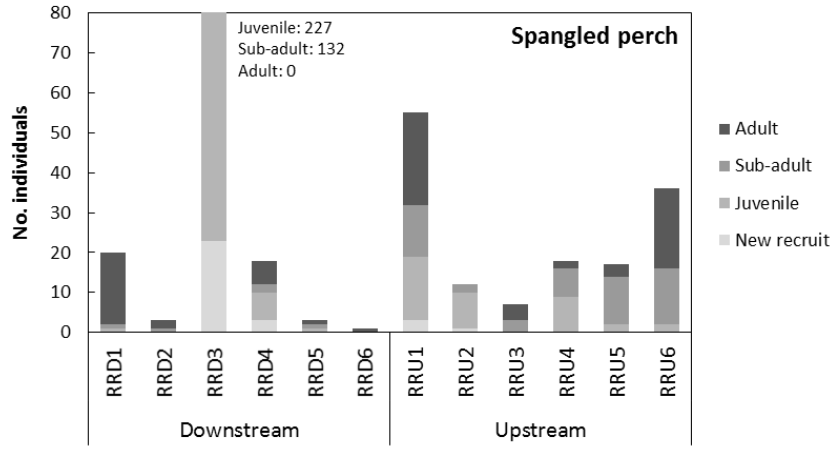


Figure 14. Abundance of spangled perch (*Leipotherapon unicolor*) age-classes recorded from each pool in the Project area. Note: column representing RRD3 is only partially displayed; the remainder of age-classes are given as text (new recruits are still displayed).

Pilbara tandan

Very little is known of the breeding ecology of the Pilbara tandan. Species of *Neosilurus* catfish usually attain a maximum size of only 200 mm SL, whereas similar species, such as *N. hyrtlii* and *N. ater*, can reach up to 400 mm TL (Lake 1971, Bishop *et al.* 2001). Breeding is thought to occur in the early wet season, where adults (> 91 mm SL) build their nests under large cobbles in flowing riffle zones (Bishop *et al*. 2001, Morgan *et al.* 2002). It is at this time when flooding increases the area and diversity of aquatic habitat available, while also initiating increases in plankton and other food sources (Bishop *et al.* 2001).

Pilbara tandan were collected in relatively low abundance throughout the Project area, with no new recruits (< 30 mm SL) recorded (Figure 15). Juvenile Pilbara tandan (31 – 70 mm SL) were only recorded at RRD2, RRU1 and RRU2 (Figure 15). Similar to spangled perch, low Pilbara tandan recruitment likely reflects the lack of streamflow in the Project area prior to the survey. Further, low overall catch rates of Pilbara tandan was likely due to the inherent difficulties in sampling this species. Like most other catfish, the Pilbara tandan is a benthic feeder, with techniques such as gill and seine netting generally limited in their ability to collect specimens due to the bottom-dwelling nature of these fish.

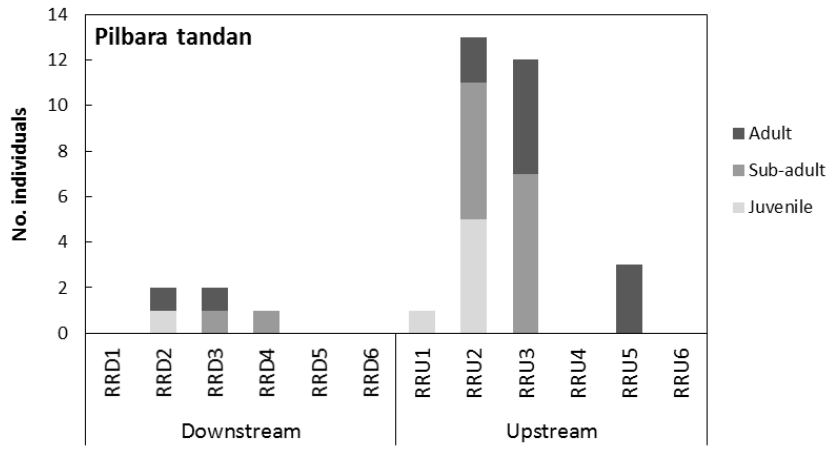


Figure 15. Abundance of Pilbara tandan (*Neosilurus* sp.) age-classes recorded from each pool in the Project area.

5.6 Other Fauna

No frogs or tadpoles were observed at any site in the current study. Although it is expected that some frogs do utilise pools within the Project area, the presence of large predatory fish, waterbirds and other predators (*e.g.* snakes) at these waterbodies would likely reduce survival rates of tadpoles in remnant pools.

No turtles were captured or observed in the Project area. EPA (1991) noted the native flat-shelled turtle, *Chelodina steindachneri,* was present at Gnieraoora and Martangkuna, but do not state the source of the records, which was possibly the 1991 survey by Streamtec/UWA for the Mesa J Project area.

6 SUMMARY AND CONCLUSIONS

This report summarises the results of wet season baseline sampling of aquatic ecosystems of the Robe River, both upstream and downstream of the proposed Mesa H development. The aim of the sampling program was to document the current ecological condition of the Robe River prior to the Mesa H development, which will require mine dewatering and surplus water discharge and may result in a surface discharge footprint along the Robe River. The current sampling program documents "current" ecological condition, moreso than "natural" condition due to the existing mine operations. In general, both water quality and aquatic fauna (microinvertebrate, hyporheic invertebrate, macroinvertebrate and fish) data indicated little ecological difference between "reference" sites upstream of the proposed development, and downstream sites that may be potentially exposed to dewatering discharge.

Water quality was highly variable amongst sites, with salinity levels ranging from fresh (592 μS/cm) to brackish (1,700 μS/cm), pH from circum-neutral (6.9) to slightly alkaline (7.9) and dissolved oxygen from hypoxic (14.5%) to supersaturated (134.9%). There were no obvious longitudinal gradients upstream or downstream of the Jimmawurrada-Robe confluence. Site RRU6, (~1 km upstream of the confluence) and the downstream sites, tended to have higher salinity (as EC and TDS), alkalinity, hardness and concentrations of associated ions, than sites upstream. This inter-site variability was attributed to differences in volume of the remnant pools sampled and evapoconcentration effects under recessional flows.

Exceedances of ANZECC/ARMCANZ default 95% TVs were recorded for nitrogen nutrients (N-total, N-NO_x and N-NH_3) at most sites upstream and downstream of the Jimmawurrada-Robe confluence. Elevated background levels of N-NO_3 and N-NH_3 within the Project area are unsurprising, given that the Robe River catchment is already effected by current and historic pastoral practices, with groundwaters also appearing to be enriched. Cattle, or evidence of high cattle use, were observed at a number of pools. Elevated N-total and N-NO_x downstream of the Jimmawurrada-Robe confluence may also reflect discharge of nitrogen-enriched groundwater from existing mine operations, though the relative contribution of anthropogenic and natural sources to nitrogen enrichment in surface waters of the Project area is unknown. With the exception of dissolved zinc at RRU5 and RRD3, no heavy metal analyte exceeded ANZECC/ARMCANZ default 95% TVs in the Project area.

A total of 81 microinvertebrate taxa were recorded from the Project area, of which 46 were present at potentially exposed sites downstream of the Jimmawurrada-Robe confluence, and 69 were recorded at upstream reference sites. The microinvertebrate fauna was generally typical of that commonly recorded from tropical/sub-tropical freshwater systems, comprising protists, rotifers, copepods, cladocerans (water fleas) and ostracods (seed shrimp), with Lecanidae dominating within the Rotifera. There were no significant differences in total mean microinvertebrate taxa richness between reference and potentially exposed sites, nor was there any significant difference in richness of any of the major microinvertebrate groups (protists, rotifers, micro-crustaceans) between these reaches.

Hyporheic sampling collected 59 taxa in total, the majority of which were species not specially adapted to groundwater environments (stygoxene); however, 8% were considered stygobitic (obligate groundwater inhabitants), 31% occasional hyporheic stygophiles (species that use the hyporheic zone seasonally or during early life history stages), and 2% possible hyporheic taxa. There were no obvious longitudinal gradients or patterns in hyporheic taxa richness between reference and potentially exposed sites, though hyporheic taxa richness was relatively high at RRD1, RRU6, RRD2 and RRU4, suggesting strong connectivity between ground- and surface- waters at these sites.

A total of 148 macroinvertebrate taxa were recorded from surface waters, with composition typical of freshwater systems throughout the world, being dominated by Insecta, in particular Diptera (true flies) and Coleoptera (aquatic beetles). There were no clear upstream/downstream gradients in

macroinvertebrate richness within the Project area, with no significant difference in mean total taxa richness, and mean richness of most major macroinvertebrate groups, between reference and potentially exposed sites. Similarly, multivariate analysis detected no distinguishable separation of reference or potentially exposed sites based on macroinvertebrate species assemblage structure.

3,515 individual fish, representing 11 species, were captured, measured and released in the Project area. True freshwater species included western rainbowfish, spangled perch, Pilbara tandan (eel-tailed catfish), Fortescue grunter, barred grunter, Terapontidae (grunter) hybrids and bony bream. Estuarine/marine vagrant fish species included milkfish, tarpon/ox-eye herring, mullet and banded scat/striped butterfish, the majority of which were recorded at downstream sites. The conservation listed Fortescue grunter (*Leipotherapon aheneus*; IUCN Lower Risk/Near Threatened; Parks and Wildlife Priority 4) was the second most abundant fish species of the Project area, recorded at all upstream and downstream sites. Similar to other fauna indices, there was no significant difference in mean total abundance of fish between upstream and downstream sites, nor was there any significant difference in mean abundance of each individual species between the reaches. Healthy (breeding) populations of western rainbowfish, the most abundant fish species of the Project area, were recorded from both the upstream and downstream reaches; however, spangled perch and Pilbara tandan recruitment appeared to be low throughout the Project area.

Including the Fortescue grunter, four species of conservation significance were recorded in the Project area, all of which were present at sites potentially exposed to dewatering discharge. These are summarised in Table 14 below:

Table 14. Summary of aquatic species of conservation significance (conservation listed or short range endemic) recorded from the Project area.

Species	Common name	Conservation significance	Occurrence within the Project area	Occurrence elsewhere
Microinvertebrates				
Eodiaptomus lumholtzi	Calanoid copepod	IUCN Vulnerable	RRD6	Koodaderi Spring, Homestead Trib., Mindy Mindy Ck., Cane R., NT & QLD.
Stygal / SRE invertebrates				
Nedsia spp.	Stygal amphipod	Potential short range endemic (data deficient)	RRD1 – 4, RRU3, RRU4 and RRU5	Uncertain, possibly bores within the Yarraloola Area
Macroinvertebrates				
Eurysticta coolawanyah	Pilbara pin damselfly	IUCN Near Threatened, Pilbara endemic	RRD3 and RRD4	Widespread throughout the Pilbara, though infrequently collected
Fish				
Leipotherapon aheneus	Fortescue grunter	IUCN Near Threatened, Parks and Wildlife Priority 4, Pilbara endemic	All sites	Robe R. catchment, Fortescue R. (below Fortescue Marsh); Ashburton R.

Current results indicate little ecological difference between "reference" sites upstream of the proposed Mesa H development, and downstream sites that may be potentially exposed to dewatering discharge operations. As such, these results provide a good starting point to enable the detection of potential ecological changes downstream of the Mesa H development caused by an altered abstraction and dewatering discharge regime. Data collected from reference sites upstream of Mesa H serve as the "control" for potentially exposed sites, while April/May 2016 data provide a snapshot of the "before"

condition, against which any future changes following mine development can be assessed. The premise being that if the degree of similarity between exposed and reference sites differs significantly over time (compared with pre-mine similarity), this would indicate mine-related response rather than stochastic variability due to factors such as climatic change.

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8 APPENDICES

Appendix 1. Photographs of sampled sites

Potential impact sites downstream of the Jimmawurrada-Robe confluence in April-May 2016.

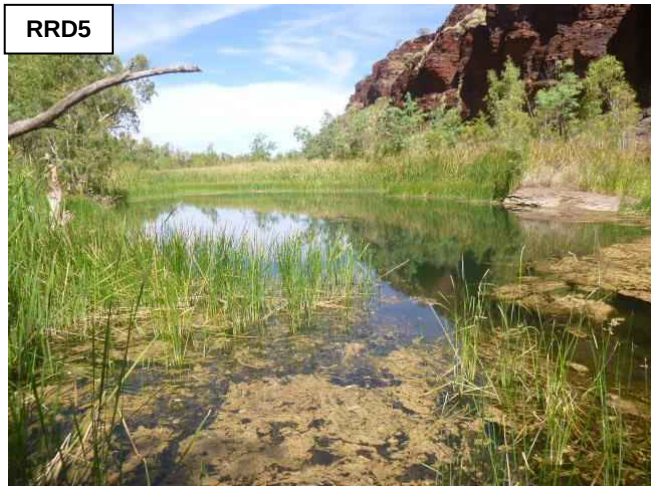
RRD1

RRD2

RRD3

RRD4

RRD5



RRD6

Reference sites upstream of the Jimmawurrada-Robe confluence in April-May 2016

RRU1

RRU2

RRU3

RRU4

RRU5

RRU6

Appendix 2. ANZECC/ARMCANZ (2000) trigger values

Table A2-1. ANZECC/ARMCANZ (2000) default trigger values for some physical and chemical stressors for tropical Australia for slightly disturbed ecosystems (TP = total phosphorus; FRP = filterable reactive phosphorus; TN = total nitrogen; NOx = total nitrates/nitrites; NH4+ = ammonium). Data derived from trigger values supplied by Australian states and territories, for the Northern Territory and regions north of Carnarvon in the west and Rockhampton in the east.

	TP ($\mu g\ L^{-1}$)	*FRP ($\mu g\ L^{-1}$)*	*TN ($\mu g\ L^{-1}$)*	*NOx ($\mu g\ L^{-1}$)*	*NH_4^+ ($\mu g\ L^{-1}$)*	*DO % saturation[f]*	*pH*
Aquatic Ecosystem							
Upland River[e]	10	5	150	30	6	90-120	6.0-7.5
Lowland River[e]	10	4	200-300[h]	10[b]	10	85-120	6.0-8.0
Lakes & Reservoirs	10	5	350[c]	10[b]	10	90-120	6.0-8.0
Wetlands[3]	10-50[g]	5-25[g]	350-1200[g]	10	10	90[b]-120[b]	6.0-8.0

b = Northern Territory values are 5µgL-1 for NOx, and <80 (lower limit) and >110% saturation (upper limit) for DO;
c = this value represents turbid lakes only. Clear lakes have much lower values;
e = no data available for tropical WA estuaries or rivers. A precautionary approach should be adopted when applying default trigger values to these systems;
f = dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability;
g = higher values are indicative of tropical WA river pools;
h = lower values from rivers draining rainforest catchments.

Table A2-2. ANZECC/ARMCANZ (2000) Default trigger values for salinity and turbidity for the protection of aquatic ecosystems, applicable to tropical systems in Australia.

Aquatic Ecosystem		*Comments*
Salinity	***(µs/cm)***	
Upland & lowland rivers	20-250	Conductivity in upland streams will vary depending on catchment geology. The fist flush may result in temporarily high values
Lakes, reservoirs & wetlands	90-900	Higher conductivities will occur during summer when water levels are reduced due to evaporation
Turbidity	***(NTU)***	
Upland & lowland rivers	2-15	Can depend on degree of catchment modification and seasonal rainfall runoff
Lakes, reservoirs & wetlands	2-200	Most deep lakes have low turbidity. However, shallow lakes have higher turbidity naturally due to wind-induced re-suspension of sediments. Wetlands vary greatly in turbidity depending on the general condition of the catchment, recent flow events and the water level in the wetland.

Table A2-3. ANZECC/ARMCANZ (2000) default trigger values for toxicants at alternative levels of protection (μg/L).

	Trigger values for freshwater Level of protection (% species)			
Compound	***99%***	***95%***	***90%***	***80%***
METALS & METALLOIDS				
Aluminium pH > 6.5	27	55	80	150
Aluminium pH < 6.5	ID	ID	ID	ID
Arsenic (As III)	1	24	94	360
Arsenic (As IV)	0.9	13	42	140
Boron	90	370	680	1300
Cadmium	0.06	0.2	0.4	0.8
Cobalt	ID	ID	ID	ID
Chromium (Cr III)	ID	ID	ID	ID
Chromium (Cr VI)	0.01	1	6	40
Copper	1	1.4	1.8	2.5
Iron	ID	ID	ID	ID
Manganese	1200	1900	2500	3600
Molybdenum	ID	ID	ID	ID
Nickel	8	11	13	17
Lead	1	3.4	5.6	9.4
Selenium (Se total)	5	11	18	34
Selenium (Se IV)	ID	ID	ID	ID
Uranium	ID	ID	ID	ID
Vanadium	ID	ID	ID	ID
Zinc	2.4	8	15	31
NON-METALLIC INORGANICS				
Ammonia	320	900	1430	2300
Chlorine	0.4	3	6	13
Nitrate	17	700	3400	17000

Appendix 3. Water quality data

Results from spot measurement of surface water quality taken in conjunction with aquatic fauna sampling. ANZECC/ARMCANZ (2000) default TV for protection of 95% of freshwater species is also provided for comparison; ☐ ≥ default TV, ☐ ≥ 2x default TV, ☐ ≥ 10x default TV; note, for DO, values highlighted are less than the lower default TV.

Water Quality Parameter	Method Code	*LOR*	Units	ANZECC TV	RRD1 30-04-16 0815hr	RRD2 30-04-16 1345hr	RRD3 30-04-16 1530hr	RRD4 29-04-16 1415hr	RRD5 29-04-16 1200hr	RRD6 30-04-16 1230hr	RRU1 05-05-16 0845hr	RRU2 28-04-16 1130hr	RRU3 28-04-16 0830hr	RRU4 28-04-16 1500hr	RRU5 29-04-16 0715hr	RRU6 07-05-16 1015hr
Al	iMET1WCICP	*0.005*	mg/L	0.055	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Alkalinity	iALK1WATI	*1*	mg/L	NP	245	133	266	260	249	241	155	156	175	166	183	253
As	iMET1WCMS	*0.001*	mg/L	0.013[A]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B	iMET1WCICP	*0.02*	mg/L	0.37	0.29	0.18	0.2	0.28	0.36	0.28	0.19	0.19	0.22	0.2	0.21	0.33
Ba	iMET1WCICP	*0.002*	mg/L	NP	0.051	0.035	0.039	0.04	0.058	0.046	0.043	0.044	0.055	0.039	0.044	0.05
CO_3	iALK1WATI	*1*	mg/L	NP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ca	iMET1WCICP	*0.1*	mg/L	NP	81.5	48.9	78.5	74.2	65.6	66.8	46.5	46.3	51.1	48.4	51.8	100
Cd	iMET1WCMS	*0.0001*	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	iCO1WCDA	*1*	mg/L	NP	209	126	193	176	213	169	120	115	109	138	128	372
Co	iMET1WCMS	*0.0001*	mg/L	ID	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Cr	iMET1WCMS	*0.0005*	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cu	iMET1WCMS	*0.0001*	mg/L	0.0014	0.0002	0.0002	0.0002	0.0002	0.0002	0.0007	0.0003	0.0002	0.0002	0.0002	0.0002	0.0003
DO (field)	TPS WP-82Y logger	*0.01*	% sat.	90 - 120	72.7	44.6	94.6	79.2	37.4	134.9	37.2	38.5	16.1	74.1	14.5	77.8
DO (field)	TPS WP-82Y logger	*0.01*	mg/L	NP	5.8	3.6	8.0	5.8	2.7	8.4	2.4	2.9	1.2	5.8	0.9	5.3
EC	iEC1WZSE	*2*	µS/cm	250	1280	711	1260	1220	592	1130	772	748	824	782	802	1700
Fe	iMET1WCICP	*0.005*	mg/L	0.3*	0.007	0.013	<0.005	<0.005	0.012	0.036	0.058	0.022	0.099	0.059	0.061	0.018
HCO_3	iALK1WATI	*1*	mg/L	NP	299	162	324	317	303	294	190	191	214	202	223	309
Hardness	iHTOT2WACA	*1*	mg/L	NP	440	260	420	400	430	360	240	230	250	240	250	520
K	iMET1WCICP	*0.1*	mg/L	NP	9	6	8.6	8.2	9.7	8.7	5	5.8	6.2	6.1	6	4.4
Mg	iMET1WCICP	*0.1*	mg/L	NP	57.2	33.7	54.3	52.4	63.6	46.7	30.3	27	29.7	29.3	30.3	66.5
Mn	iMET1WCICP	*0.001*	mg/L	1.9	<0.001	0.002	<0.001	<0.001	0.003	0.004	0.002	0.009	0.099	0.002	0.004	0.004
Mo	iMET1WCMS	*0.001*	mg/L	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
N-NH_3	iAMMN1WFIA	*0.01*	mg/L	0.01[N]	0.02	0.05	<0.01	<0.01	<0.01	0.03	<0.01	0.02	0.01	0.01	0.01	0.07
N-NO_2	iNTRN1WFIA	*0.01*	mg/L	NP	<0.01	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
N-NO_3	iNTAN1WCALC	*0.01*	mg/L	NP	1.8	1.3	1.3	2	0.86	2.5	<0.01	1.2	0.95	0.38	1.1	3.7

Water Quality Parameter	Method Code	*LOR*	Units	ANZECC TV	RRD1 30-04-16 0815hr	RRD2 30-04-16 1345hr	RRD3 30-04-16 1530hr	RRD4 29-04-16 1415hr	RRD5 29-04-16 1200hr	RRD6 30-04-16 1230hr	RRU1 05-05-16 0845hr	RRU2 28-04-16 1130hr	RRU3 28-04-16 0830hr	RRU4 28-04-16 1500hr	RRU5 29-04-16 0715hr	RRU6 07-05-16 1015hr
N-NO_X	iNTAN1WFIA	*0.01*	mg/L	0.01	1.8	1.3	1.3	2	0.87	2.5	<0.01	1.2	0.96	0.38	1.1	3.8
N-total	iNP1WTFIA	*0.01*	mg/L	0.3	1.8	1.5	1.3	2	0.88	2.6	0.09	1.4	1	0.41	1.2	3.9
Na	iMET1WCICP	*0.1*	mg/L	NP	91.4	53.9	86.4	87.1	104	87.2	51.6	53.3	64.7	60.1	58.9	132
Ni	iMET1WCMS	*0.001*	mg/L	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
OH	iALK1WATI	*1*	mg/L	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
P-total	iPP1WTFIA	*0.005*	mg/L	0.01	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.011
Pb	iMET1WCMS	*0.0001*	mg/L	0.034	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
pH (field)	WTW pH330i field meter	*0.1*	[H+]	6.0 - 8.0	7.4	7.3	7.0	7.2	7.2	7.7	7.9	7.0	6.9	7.2	7.0	7.4
pH (lab)	iPH1WASE	*0.1*	[H+]	6.0 - 8.0	7.9	7.8	7.7	7.9	7.8	8	8	7.7	7.6	7.9	7.7	7.8
Redox (field)	WTW pH330i field meter	*-1999*	mV	NP	-27.2	-19.3	-3.8	-15.6	-13.5	-46.1	-56.8	-1.1	2.6	-19.4	-3.3	-22.9
S	iMET1WCICP	*0.1*	mg/L	NP	28	28	25	24	25	22	14	12	14	13	12	22
S-SO_4	iMET1WCICP	*0.1*	mg/L	NP	84	50	73.6	72	75.3	66.3	43.3	34.8	40.5	40	36.6	67.1
Se	iMET1WCMS	*0.001*	mg/L	0.011	0.002	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
TDS-calc	iSOL1WDCA	*5*	mg/L	NP	700	390	700	670	330	620	420	410	450	430	440	940
Temp (field)	TPS WP-82Y logger	*-5*	°C	NP	27.4	25.0	30.1	30.7	27.4	28.2	24.8	29.6	26.6	28.6	28.2	27.7
TSS	iSOL1WPGR	*1*	mg/L	NP	3	4	7	<1	34	2	4	4	<1	2	<1	19
U	iMET1WCMS	*0.0001*	mg/L	ID	0.0009	0.0004	0.0004	0.0004	0.001	0.0008	0.0002	0.0002	0.0001	0.0004	0.0003	0.0016
V	iMET1WCMS	*0.0001*	mg/L	ID	0.0017	0.0012	0.0008	0.0016	0.0015	0.0031	0.0019	0.0011	0.0003	0.0013	0.001	0.0027
Zn	iMET1WCMS	*0.001*	mg/L	0.008[H]	0.004	0.002	0.011	0.003	0.003	0.007	0.004	0.004	0.001	0.003	0.012	0.004

* ANZECC/ARMCANZ (2000) provide only a low reliability TV for iron (Fe);

[A] Default TV shown is for AsV, as no default TV is provided for total arsenic;

[B] For bioaccumulating chemicals, ANZECC/ARMCANZ (2000) recommend using the default 99% species protection level TV;

[H] Default TV should be modified for water hardness using algorithms provided in Table 3.4.3 of ANZECC/ARMCANZ (2000);

[N] Default TV shown is for ammonium nitrogen, as N-NH_4^+, for protection against eutrophication. Default TV for protection against toxic effects of ammonia, as N-NH_3, is 0.9 mg/L.

Appendix 4. Habitat data

Site	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
Date	30-04-16	30-04-16	30-04-16	29-04-16	29-04-16	30-04-16	05-05-16	28-04-16	28-04-16	28-04-16	29-04-16	07-05-16
Canopy cover (%)	0	25	5	15	35	5	2	20	2	5	50	5
Bedrock %	0	5	2	0	0	5	5	0	0	0	0	2
Boulders %	0	2	5	0	2	2	2	2	1	5	0	2
Cobbles %	10	3	5	5	10	3	10	10	19	15	5	35
Pebbles %	30	15	35	35	23	25	36	50	60	40	65	25
Gravel %	30	55	35	55	45	35	40	32	15	38	23	15
Sand %	5	20	13	5	15	5	5	3	3	2	5	0
Silt %	15	0	5	0	5	10	0	1	2	0	0	21
Clay %	10	0	0	0	0	15	2	2	0	0	2	0
Mineral %	45	41	41	36	49	5	5	49	53	12	10	20
Emergent veg %	10	10	20	35	20	20	5	25	0	60	43	40
Submergent veg %	0	30	15	5	15	30	25	15	0	10	20	5
Floating veg %	0	0	0	0	0	0	55	3	0	10	0	0
Algae %	5	2	10	5	10	3	5	2	15	5	10	3
Detritus %	40	10	10	15	2	38	0	2	5	2	5	30
Trailing veg %	0	5	2	2	2	2	0	3	0	0	5	0
LWD %	0	2	2	2	2	2	3	1	2	1	5	2
Other %	0	0	0	0	0	0	2	0	25	0	2	0
Max Pool Depth (m)	0.8	0.7	1	2	4	1.2	1.20	3	1	1	1.2	0.6
Pool Length (m)	7	12	25	150	45	20	100	60	3	120	40	40
Ave Pool Width (m)	3	6	5	20	25	30	20	10	5	20	10	12
Bed compaction*	2	3	3	2	3	1	3	2	2	2	3	3
Habitat diversity	4	7	7	7	7	7	7	8	5	7	8	6
Mean substrate size (phi)	-0.575	-1.750	-2.465	-2.900	-2.140	-0.025	-2.960	-3.405	-4.135	-3.945	-3.420	-2.515
Substrate diversity**	6	6	7	4	6	8	7	6	5	5	5	6

* Bed compaction categories range from 1 = loose, to 5 = armoured.

** Total number of substrate types present.

Appendix 5. Microinvertebrate data

Values are total abundance.

Phylum/Class/Order	Family	Lowest Taxon	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6
PROTISTA														
CILIOPHORA	**Stentoridae**	*Stentor* sp.	0	0	0	4	*	0	0	0	0	0	0	0
RHIZOPODA	**Arcellidae**	*Arcella discoides* Ehrenberg, 1843	*	0	13	3	0	0	0	1	0	1	0	1
		Arcella hemisphaerica Perty 1852	0	0	25	0	0	0	0	2	0	0	0	0
		Arcella megastoma Penard, 1902	0	0	0	2	0	0	0	0	0	0	0	0
		Arcella [sm]	*	0	0	0	0	0	0	0	0	0	0	0
	Centropyxidae	*Centropyxis aculeata* (Ehrenberg, 1838)	0	0	0	0	1	0	0	0	0	0	0	0
		Centropyxis cf. *aculeata* (Ehrenberg, 1838) [v. sm]	0	0	0	1	1	0	0	0	0	0	0	0
		Centropyxis ecornis (Ehrenberg, 1841)	0	*	0	5	11	0	0	1	0	1	2	2
	Difflugiidae	*Difflugia globulosa* Dujardin, 1837	*	1	1	6	2	0	0	3	0	0	0	3
		Difflugia gramen Penard, 1902	0	0	0	0	0	0	0	0	0	0	0	2
		Difflugia sp. [sm, pyriform]	0	0	0	1	4	0	0	0	0	0	0	*
	Lesquereusiidae	*Lesquereusia spiralis* (Ehrenberg, 1840)	0	0	1	0	3	0	0	0	1	0	0	2
	Trigonopyxidae	*Cyclopyxis* sp.	0	0	0	1	0	0	0	0	0	0	0	0
ANIMALIA														
ROTIFERA														
Bdelloidea		indet. bdell. [lg, bidentate]	0	0	0	0	20	4	0	0	0	0	0	4
		indet. bdell. [sm, likely more than one sp.]	0	1	8	4	14	2	0	0	0	0	0	4
		indet. bdell. [tiny]	0	0	0	0	*	0	0	0	0	1	0	0
Monogononta	**Asplanchnidae**	*Asplanchnopus hyalinus* (Harring, 1913)	0	0	0	0	0	0	0	0	0	0	0	*
	Brachionidae	*Brachionus angularis* Gosse, 1851	*	0	0	0	0	0	0	0	0	0	0	0
		Keratella procurva (Thorpe, 1912)	0	0	0	0	0	0	0	0	0	*	0	0
		Plationus patulus (Müller, 1786)	0	1	0	0	0	0	0	0	0	0	0	2
		Platyias quadricornis (Ehrenberg, 1832)	0	*	0	0	0	0	0	0	0	0	0	0
	Dicranophoridae	*Dicranophoroides caudatus* (Ehrenberg, 1834)	0	0	0	0	1	0	0	1	0	0	0	0
	Euchlanidae	*Euchlanis dilatata* Ehrenberg, 1832	0	*	0	0	0	0	0	0	0	0	0	1
		Tripleuchlanis plicata (Levander, 1894)	0	0	0	2	1	0	0	0	0	0	0	*
	Flosculariidae	*Sinantherina* sp. [solitary]	*	*	0	0	0	0	0	0	0	0	0	0
	Gastropodidae	*Ascomorpha* sp.	0	0	1	0	0	0	0	0	0	1	0	3
	Lecanidae	*Lecane bulla* (Gosse, 1851)	0	0	1	7	2	0	0	0	0	0	0	4
		Lecane curvicornis (Murray, 1913)	0	0	0	0	9	0	0	0	0	0	0	0
		Lecane hamata (Stokes, 1896)	0	0	1	0	0	0	0	0	0	0	0	1

Phylum/Class/Order	Family	Lowest Taxon	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6
		Lecane ludwigii (Eckstein, 1883)	0	0	0	0	0	0	0	0	0	1	0	0
		Lecane **n. sp.**	0	0	0	0	1	0	0	0	0	0	0	2
		Lecane stenroosi (Meissner, 1908)	2	0	0	0	0	1	0	0	0	1	0	0
		Lecane thalera(Harring & Myers, 1926)	0	0	0	11	9	0	0	0	0	1	0	1
		Lecane (s. str.) a	0	0	0	0	12	0	0	0	0	0	0	0
		Lecane (s. str.) b [v. sm]	0	0	0	0	1	0	0	0	0	0	0	0
		Lecane (*M.*) sp. a	0	0	0	1	4	0	0	0	0	0	0	0
		Lecane (*M.*) sp. b	0	0	0	0	3	0	0	0	0	0	0	0
		Lecane (*M.*) sp. c	0	0	0	0	1	1	0	0	0	0	0	0
	Lepadellidae	*Colurella* sp. [tiny]	0	0	0	0	2	0	0	0	0	0	0	0
		Lepadella cf. *rhomboides* (Gosse, 1886)	0	0	0	0	1	0	0	0	0	0	0	0
		Lepadella sp.	0	0	1	1	2	0	0	0	0	0	0	0
		Squatinella rostrum (Schmarda, 1846)	0	0	0	0	1	0	0	0	0	0	0	1
	Lindiidae	*Lindia* sp.	0	0	0	0	3	0	0	0	0	0	0	0
	Notommatidae	*Cephalodella gibba* (Ehrenberg, 1830)	0	0	1	0	0	0	0	0	0	0	0	0
		Cephalodella sp.	*	0	0	0	0	0	0	0	0	0	0	0
		notommatid, indet.	0	0	0	0	0	0	0	0	0	0	0	1
	Proalidae	*Proales* sp.	0	0	0	1	0	0	0	0	0	0	0	3
	Scaridiidae	*Scaridium* sp.	0	0	0	0	1	0	0	0	0	0	0	0
	Synchaetidae	*Polyarthra* sp.	5	145	6	0	0	0	0	0	0	0	0	39
		indet. contr. blob	*	0	3	2	0	0	0	0	0	0	0	0
		maybe rotifer	0	0	0	1	0	0	0	0	0	0	0	0
ARTHROPODA														
CLADOCERA	**Bosminidae**	*Bosmina meriodionalis* Sars, 1904	0	0	0	2	0	0	0	0	0	0	0	0
	Chydoridae	*Anthalona harti* Van Damme, Sinev & Dumont, 2011	0	0	0	0	0	0	0	1	0	0	0	0
		Chydorus sp.	0	0	0	1	0	0	0	0	0	0	0	0
		Dunhevedia crassa King, 1853	0	*	0	0	0	0	0	0	0	0	0	0
		Ephemeroporus barroisi (Richard, 1894)	0	0	0	2	0	0	0	1	2	0	0	0
		Karualona karua (King, 1853)	0	0	0	1	0	0	0	4	0	0	0	0
		indet. alonine	*	0	*	0	0	0	0	1	1	0	0	0
	Daphnidae	*Ceriodaphnia cornuta* Sars, 1885	*	0	0	0	0	0	0	0	0	0	0	0
		Ceriodaphnia sp.	0	*	0	0	0	0	0	0	0	0	0	0
	Ilyocryptidae	*Ilyocryptus* sp. [juv.]	0	0	0	0	0	1	0	0	0	0	0	0
	Moinidae	*Moina micrura*	0	*	0	0	0	0	0	0	0	0	0	0
	Sididae	*Diaphanosoma excisum* Sars, 1885	0	*	0	0	0	0	0	0	0	0	0	*
COPEPODA	**Calanoida**	*Eodiaptomus lumholtzi* (Sars, 1889)	0	0	0	0	0	0	0	0	0	0	0	1
		calanoid copepodite	0	0	0	0	0	0	0	0	0	0	0	1

Phylum/Class/Order	Family	Lowest Taxon	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6
		calanoid nauplii	0	0	0	0	0	0	0	0	0	0	0	3
	Cyclopoida	*Mesocyclops darwini* Dussart & Fernando, 1988	0	0	0	1	0	0	0	0	1	0	0	*
		Mesocyclops sp. [other]	0	0	0	0	*		0	0	0	0	0	0
		Tropocyclops cf. *prasinus* (Fischer, 1860)	0	0	0	0	0	0	0	0	0	9	0	3
		indet. cyclopoid sp. [3-seg. P1-4]	0	0	0	0	0	0	0	2	0	0	0	0
		indet. cyclopoid lg	*	*	0	0	0	0	0	0	0	0	0	0
		indet. cyclopoid sm	*	2	1	0	0	0	0	8	0	0	0	0
		cyclopoid copepodites	11	2	35	14	5	1	2	76	0	21	0	26
		cyclopoid nauplii	184	56	106	93	97	2	0	13	0	168	0	85
OSTRACODA	**Cyprididae**	*Cypretta* sp.	*	*	0	1	0	0	0	3	0	0	0	*
		cf. *Cypridopsis* sp.	0	0	*	1	0	valves	0	0	0	*	0	0
		Heterocypris sp.	0	*	0	0	0	0	0	0	0	0	0	0
		Sarscypridopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0
	Darwinulidae	*Vestalenula marmonieri*	0	*	0	1	3	valves	2	70	13	0	0	*
	Limnocytheridae	*Limnocythere* sp.	0	0	0	0	*	0	valves	2	2	0	0	*
	Notodromadidae	indet. juv.	0	0	0	0	2	0	1	3	1	0	0	3
		Taxa Richness	**16**	**19**	**18**	**27**	**33**	**7**	**3**	**17**	**7**	**12**	**1**	**33**

*found after initial count of ~200 cells

Appendix 6. Hyporheic invertebrate data

Values are log_{10} abundance categories, where 1= 1 individual, 2 = 2-10 individuals, 3 = 11-100, 4 = 101-1000, and so on. Hyporheic fauna classifications (Class) followed those of Boulton (2001), where: X = stygoxene, O = occasional hyporheic stygophile, P = possible hyporheic taxa, S = stygobite and U = Unclassified.

Phylum/Class/Order	Family	Lowest Taxon	Class	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
PLATYHELMINTHES															
TURBELLARIA		Turbellaria spp.	X	0	0	0	0	1	1	0	0	0	0	0	2
NEMATODA		Nematoda spp.	O	0	0	0	0	3	2	2	0	0	1	0	0
MOLLUSCA															
GASTROPODA															
Cerithimorpha	**Thiaridae**	*Melanoides* spp.	X	2	0	0	3	2	0	0	0	0	0	0	0
Hygrophila	**Planorbidae**	*Gyraulus* spp.	X	0	0	0	2	0	0	0	0	0	0	0	0
ANNELIDA															
OLIGOCHAETA		Oligochaeta spp. (imm./dam.)	U	0	0	2	0	2	0	0	0	2	2	0	0
Tubificida	**Naididae**	Naididae spp. (imm./dam.)	O	1	3	0	0	3	0	0	0	0	2	2	0
		Allonais pectinata	O	0	0	0	0	0	0	0	0	0	1	0	0
		Branchiura sowerbyi	O	0	2	0	0	0	0	0	0	0	3	0	0
		Pristina aequiseta	O	0	3	0	0	0	0	0	0	0	0	0	0
		Pristina leidyi	O	0	0	0	0	0	0	0	0	0	0	2	0
		Pristina longiseta	O	1	0	2	0	1	3	0	0	0	1	0	1
	Phreodrilidae	Phreodrilidae spp.	O	0	0	0	2	0	0	0	0	1	0	0	0
ARTHROPODA															
CRUSTACEA															
MALACOSTRACA															
Amphipoda		Amphipoda spp. (stygofauna)	S	3	2	3	0	0	0	1	0	2	0	2	3
	Eriopisidae	*Nedsia* spp.	S	3	2	1	1	0	0	0	0	2	1	0	3

Phylum/Class/Order	Family	Lowest Taxon	Class	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
Thermosbaenacea	**Halosbaenidae**	*Halosbaena tulki*	S	0	2	2	1	0	0	0	0	2	0	0	0
MAXILLIPODA															
Cyclopoida		cyclopoid copepodites	U	2	3	1	0	1	3	2	0	3	0	2	3
	Cyclopidae	*Halicyclops calm*	O	0	0	0	0	0	0	1	1	0	0	0	0
		Mesocyclops darwini	O	0	0	0	0	0	0	0	0	2	0	0	0
		Microcyclops varicans	O	1	0	0	0	0	2	0	0	0	0	0	2
OSTRACODA															
	Candonidae	*Candonopsis* cf. *tenuis*	S	0	0	0	0	0	0	0	0	0	0	0	1
	Cyprididae	*Cypridopsis* sp.	O	2	0	0	1	0	0	0	0	0	0	0	0
		Cyprinotus cingalensis	O	1	0	0	0	0	0	0	0	0	0	0	0
		Stenocypris major	X	0	0	0	1	0	0	0	0	0	0	0	0
	Darwinulidae	*Vestalenula marmonieri*	S	3	0	0	0	1	0	2	0	0	0	0	0
ARACHNIDA		Acarina spp.	P	2	3	0	2	2	3	2	0	2	2	1	2
HEXAPODA															
ENTOGNATHA															
Entomobryomorpha		Entomobryoidea spp.	O	2	1	0	0	3	1	0	1	2	2	2	3
Poduromorpha		Poduroidea spp.	O	1	0	0	2	0	0	0	0	0	0	0	0
Symphypleona		Symphypleona spp.	O	0	0	0	0	0	0	2	0	0	0	0	1
INSECTA															
Ephemeroptera	**Caenidae**	*Tasmanocoenis* sp. P/*arcuata*	X	0	0	0	0	0	0	0	0	1	0	0	0
Coleoptera		Coleoptera spp. (L)	U	0	2	0	0	0	0	0	0	0	2	0	2
	Carabidae	Carabidae sp.	X	0	0	0	0	0	0	0	0	0	1	0	0
	Dytiscidae	Bidessini sp. (L)	X	0	0	0	0	0	0	0	0	0	1	0	0
	Elmidae	*Austrolimnius* spp. (L)	X	2	0	2	0	0	0	0	0	0	0	0	0
	Hydraenidae	Hydraenidae sp. (L)	O	0	0	0	0	1	0	0	0	0	0	0	1
		Hydraena spp.	O	2	0	0	0	0	0	0	0	0	0	0	0
	Hydrophilidae	Hydrophilidae spp. (L)	X	0	0	1	0	0	0	0	0	0	0	1	0

Phylum/Class/Order	Family	Lowest Taxon	Class	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
		Chaetarthria nigerrima (L)	X	0	0	0	0	2	0	0	0	0	0	0	0
		Enochrus sp. (L)	X	0	0	0	0	1	0	0	0	0	0	0	0
		Helochares sp. (L)	X	0	0	0	0	0	0	1	0	0	0	0	0
	Ptiliidae	Ptiliidae sp.	X	0	0	1	0	0	0	0	0	0	0	0	0
	Scirtidae	Scirtidae spp. (L)	X	2	1	0	0	0	1	0	0	0	1	2	2
	Staphylinidae	Staphylinidae sp.	X	0	1	0	0	0	0	0	0	0	0	0	0
Diptera	**Ceratopogonidae**	Ceratopogonidae spp. (P)	X	1	2	0	0	2	0	3	0	0	2	1	2
		Ceratopogoninae spp.	X	3	3	3	2	4	3	0	3	3	4	2	4
		Dasyheleinae spp.	X	0	3	3	2	3	1	3	2	1	2	0	0
		Forcipomyiinae spp.	X	0	0	0	0	2	0	0	0	0	0	0	0
	Chironomidae	Chironomidae sp. (P)	X	0	1	0	0	0	0	0	0	0	0	0	0
	Chironominae														
	Chironomini	*Paratendipes* sp. K1	X	0	1	0	0	3	0	0	0	0	0	0	0
		Polypedilum sp. 1	X	0	0	0	0	0	0	0	0	0	2	0	0
	Tanytarsini	*Cladotanytarsus* sp. (WWTS4)	X	0	0	0	0	1	0	0	0	0	0	0	0
		Tanytarsus sp. (WWTS1)	X	1	1	0	0	1	0	2	0	1	1	0	0
		Paratanytarsus sp. (WWTS2)	X	1	2	0	0	2	0	2	0	0	0	0	0
	Orthocladiinae	Orthocladiinae sp. (WWO7)	X	0	2	0	0	0	0	0	0	0	0	0	0
		Orthocladiinae sp. (WWO8)	X	0	0	2	0	0	2	0	0	2	0	0	2
	Tanypodinae	*Paramerina* sp. (WWT1)	X	2	0	0	0	0	0	0	0	1	0	0	0
	Dolichopodidae	Dolichopodidae spp.	X	0	2	2	0	0	0	0	1	0	0	0	0
	Empididae	Empididae spp.	X	0	0	2	0	0	0	0	0	0	0	0	0
	Tabanidae	Tabanidae sp.	X	0	0	0	0	0	0	1	0	0	0	0	0
	Tipulidae	Tipulidae spp.	X	0	1	0	0	3	0	2	1	0	0	0	0
		Taxa richness		**21**	**22**	**14**	**11**	**22**	**11**	**14**	**6**	**15**	**18**	**10**	**16**

(imm./dam) = taxa were too immature / damaged to be accurately identified to a lower taxonomic level.

(P) = taxa were in pupal form.

(L) = taxa were in larval form.

NB: some chironomid taxa are followed by their unique morphotype code (in parentheses).

Appendix 7. Macroinvertebrate data

Values are log_{10} abundance categories, where 1= 1 individual, 2 = 2-10 individuals, 3 = 11-100, 4 = 101-1000, and so on.

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
CNIDARIA														
HYDROZOA														
Anthoathecata	**Hydridae**	*Hydra* sp.	1	0	0	0	0	0	0	0	0	0	0	0
MOLLUSCA														
GASTROPODA		Gastropoda spp. (imm./dam.)	0	0	0	0	0	0	0	0	0	0	2	0
Cerithimorpha	**Thiaridae**	*Melanoides* spp.	3	0	3	3	2	3	4	4	2	2	3	4
Hygrophila	**Lymnaeidae**	*Bullastra vinosa*	2	2	0	0	3	3	2	2	1	0	0	0
	Planorbidae	*Amerianna* spp.	0	0	0	0	0	0	0	2	0	0	0	0
		Ferrissia petterdi	2	2	0	0	0	0	0	0	0	0	2	0
		Gyraulus spp.	3	3	0	3	2	3	4	3	0	0	2	2
BIVALVIA														
Unionoida	**Hyriidae**	*Velesunio* spp.	0	0	0	0	0	0	0	0	0	0	0	2
ANNELIDA														
OLIGOCHAETA		Oligochaeta spp.	3	3	3	3	3	0	3	3	3	3	4	2
ARTHROPODA														
CRUSTACEA														
MALACOSTRACA														
Amphipoda		Amphipoda spp. (stygofauna)	0	0	3	2	0	0	0	0	0	0	0	0
	Eriopisidae	*Nedsia* spp.	0	0	2	3	0	0	0	0	0	0	0	0
Decapoda	**Atyidae**	Atyidae spp. (imm./dam.)	2	0	2	0	0	0	0	0	0	0	2	2
		Caridina indistincta	3	3	3	2	3	3	3	4	3	2	3	1
CHELICERATA														
ARACHNIDA		Acarina spp.	3	3	0	2	2	0	4	3	3	0	3	2
HEXAPODA														
ENTOGNATHA														
Entomobryomorpha		Entomobryoidea spp.	2	2	0	0	0	0	2	0	0	0	0	0
Symphypleona		Symphypleona sp.	0	0	0	0	0	0	1	0	0	0	0	0
INSECTA														
Odonata														
Anisoptera		Anisoptera spp. (imm./dam.)	2	2	2	0	1	2	2	3	2	2	0	0
	Aeshnidae	*Hemianax papuensis*	0	0	0	0	0	1	0	0	0	0	0	0
	Libellulidae	*Crocothemis nigrifrons*	0	2	0	0	0	0	1	0	0	0	1	0

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
		Diplacodes bipunctata	0	0	0	0	0	1	0	0	2	2	0	1
		Diplacodes haematodes	0	0	0	0	0	0	1	0	0	1	0	0
		Orthetrum caledonicum	2	0	0	1	0	1	1	0	0	0	0	0
		Rhodothemis lieftincki	0	0	0	0	1	0	0	2	2	3	2	0
		Rhyothemis graphiptera	0	0	1	2	1	0	0	0	0	0	0	0
		Zyxomma elgneri	0	0	1	0	0	0	0	1	2	0	1	0
	Lindeniidae	*Ictinogomphus dobsoni*	1	0	0	1	0	2	0	0	1	0	0	0
Zygoptera		Zygoptera spp. (imm./dam.)	1	2	1	2	0	2	2	2	0	3	0	3
	Coenagrionidae	*Argiocnemis rubescens*	2	2	0	0	0	0	2	0	2	0	1	0
		Ischnura aurora	0	2	0	0	2	2	3	2	0	2	0	2
		Ischnura heterosticta	0	0	0	0	0	0	0	0	0	2	0	0
		Pseudagrion aureofrons	0	0	0	0	0	0	2	1	0	1	0	0
		Pseudagrion microcephalum	0	0	0	0	0	1	0	0	0	2	0	0
	Isostictidae	*Eurysticta coolawanyah*	0	0	1	2	0	0	0	0	0	0	0	0
Ephemeroptera	**Baetidae**	Baetidae spp. (imm./dam.)	2	3	3	3	2	3	1	3	0	2	0	2
		Cloeon fluviatile	0	3	2	2	2	0	3	0	0	0	0	0
		Cloeon sp. Red Stripe	2	4	3	3	2	2	3	3	1	3	2	3
	Caenidae	Caenidae spp. (imm./dam.)	0	3	3	2	0	2	1	0	2	0	0	0
		Tasmanocoenis sp. M	0	0	2	0	0	0	0	0	0	0	0	0
		Tasmanocoenis sp. P/*arcuata*	2	3	2	2	0	2	1	0	0	0	1	0
Hemiptera	**Belostomatidae**	Belostomatidae spp. (imm./dam.)	0	2	0	0	0	2	3	2	0	2	2	2
		Diplonychus spp.	0	2	1	0	1	0	0	2	0	0	2	1
		Lethocerus distinctifemur	0	0	0	0	0	0	0	0	1	0	0	0
	Corixidae/Micronectidae	Corixidae/Micronectidae spp. (imm./dam.)	0	2	0	2	0	2	2	3	0	0	0	0
	Gelastocoridae	*Nerthra* spp. (imm./dam.)	0	0	0	1	0	0	1	0	0	0	0	0
	Gerridae	Gerridae spp. (imm./dam.)	0	2	0	0	0	0	2	2	0	0	1	0
		Limnogonus fossarum gilguy	0	2	0	0	2	0	2	1	0	2	0	0
	Hebridae	Hebridae spp. (imm./dam.)	1	1	0	0	2	2	0	2	0	0	1	2
		Hebrus axillaris	0	0	0	0	0	2	0	0	0	0	0	0

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
		Merragata hackeri	0	0	0	0	0	0	0	2	0	0	2	0
	Hydrometridae	*Hydrometra papuana*	0	0	0	0	0	0	0	0	0	0	1	0
	Mesoveliidae	Mesoveliidae spp. (imm./dam.)	2	3	0	0	1	2	3	0	0	2	0	2
		Mesovelia spp. (imm./dam.)	0	0	0	2	0	0	0	0	0	0	0	0
		Mesovelia hackeri	0	1	0	0	0	2	0	0	0	0	0	0
		Mesovelia hungerfordi	0	0	0	2	0	0	0	0	0	0	0	0
		Mesovelia vittigera	0	2	0	2	0	0	2	0	0	0	1	0
	Micronectidae	*Micronecta* spp. (imm./dam.)	0	0	0	0	0	0	0	2	0	0	0	0
		Micronecta paragoga	0	0	0	0	0	2	0	0	0	0	0	0
	Nepidae	Nepidae spp. (imm./dam.)	1	0	0	0	0	0	0	0	0	0	0	0
		Laccotrephes tristis	0	0	1	0	0	0	0	1	0	0	0	0
		Ranatra diminuta	1	2	0	0	0	0	1	0	0	0	0	0
	Pleidae	*Paraplea* spp.	3	2	1	2	2	3	4	3	0	3	0	3
Coleoptera		Coleoptera spp. (L)	2	0	0	0	0	0	0	0	0	0	0	0
		Unknown spp. (L)	0	0	0	0	0	0	2	0	0	0	0	0
	Dytiscidae	*Allodessus bistrigatus*	0	0	0	0	0	2	0	0	0	0	0	0
		Bidessini spp. (L)	0	0	0	0	0	0	1	0	0	2	1	0
		Copelatus nigrolineatus	0	0	0	0	0	0	1	0	0	0	0	1
		Cybister tripunctatus	0	0	0	0	0	1	0	0	1	0	0	0
		Hydaticus consanguineus	0	2	0	0	0	0	0	0	0	0	0	0
		Hydaticus daemeli	0	0	0	0	0	0	0	1	0	0	0	0
		Hydroglyphus godeffroyi	0	0	0	0	0	2	0	1	0	0	0	0
		Hydroglyphus grammopterus	0	0	0	0	0	2	0	0	0	0	0	0
		Hydroglyphus leai	0	0	0	0	0	0	2	0	0	0	0	0
		Hydroglyphus orthogrammus	0	0	0	0	0	2	2	2	0	0	0	0
		Hydrovatus spp. (L)	2	0	0	0	0	0	4	0	2	0	1	0
		Hydrovatus opacus	2	0	0	0	0	0	2	0	2	0	0	0
		Hyphydrus lyratus	0	1	0	0	0	2	0	2	0	0	0	1
		Laccophilus sharpi	0	0	0	0	0	0	0	2	0	0	0	0
		Limbodessus compactus	2	1	0	0	0	2	2	0	0	1	0	0

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
		Necterosoma darwini	0	0	0	0	0	0	0	0	0	0	0	1
		Necterosoma regulare	0	0	0	0	0	0	0	0	0	0	0	2
		Onychohydrus atratus	1	0	0	0	0	0	0	0	2	0	0	0
		Platynectes decempunctatus var. *decempunc.*	0	0	0	0	0	2	0	1	2	0	0	1
		Rhantaticus congestus	0	1	0	0	0	0	1	0	0	0	0	0
		Tiporus tambreyi	2	0	0	0	0	0	0	0	2	2	0	3
	Elmidae	*Austrolimnius* spp. (L)	2	0	2	0	0	0	0	0	0	0	0	0
	Haliplidae	*Haliplus pilbaraensis*	0	0	0	0	0	0	2	0	0	0	0	0
	Hydraenidae	*Hydraena* spp.	2	0	0	0	0	2	4	3	0	0	0	0
		Limnebius spp.	0	0	0	0	0	2	0	2	0	0	0	0
	Hydrochidae	*Hydrochus* spp.	3	2	0	2	0	3	3	1	2	1	0	3
	Hydrophilidae	Hydrophilidae spp. (L)	0	0	0	0	0	0	3	0	0	0	0	0
		Anacaena horni	2	2	0	0	0	0	0	0	0	0	0	0
		Berosus dallasae	0	0	0	0	0	2	0	1	0	0	0	2
		Enochrus deserticola	0	1	0	0	0	1	3	2	2	0	0	0
		Helochares spp. (L)	0	2	0	2	2	2	3	0	0	3	0	2
		Helochares tatei	0	0	0	0	1	1	1	0	0	0	0	0
		Laccobius sp.	0	0	0	0	0	0	0	0	0	1	0	0
		Paracymus spenceri	0	2	0	0	0	0	3	2	0	2	0	0
		Regimbartia attenuata	1	0	0	0	0	2	2	0	0	0	0	0
		Regimbartia attenuata (L)	0	0	0	0	0	0	0	1	0	0	0	0
		Sternolophus marginicollis	2	3	1	0	0	0	0	3	3	0	1	0
	Noteridae	*Neohydrocoptus subfasciatus* (L)	2	1	0	0	0	0	0	0	0	0	0	0
	Scirtidae	Scirtidae spp. (L)	0	0	0	0	2	0	1	0	1	0	1	0
Diptera	**Ceratopogonidae**	Ceratopogonidae spp. (P)	0	2	2	2	2	0	2	0	0	3	0	2
		Ceratopogoninae spp.	2	0	3	2	1	2	3	2	1	2	3	3
		Dasyheleinae spp.	2	3	3	2	3	1	4	3	0	3	3	2
		Forcipomyiinae spp.	0	1	0	0	0	0	3	0	0	0	0	0
	Chironomidae	Chironomidae spp. (P)	2	2	2	2	2	2	3	2	0	1	2	0
	Chironominae													

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
	Chironomini	*Chironomus* sp. (WWC3)	0	2	0	0	3	0	0	2	3	3	2	0
		Cladopelma curtivalva	3	2	3	2	0	3	2	0	0	0	0	0
		Cryptochironomus griseidorsum	2	0	0	0	0	0	0	0	0	0	0	0
		Dicrotendipes sp. (WWC17)	0	0	0	2	0	0	0	0	0	0	0	0
		Dicrotendipes sp. 1	0	0	2	2	0	0	0	0	0	0	0	0
		Dicrotendipes sp. 2	3	0	3	0	0	1	3	3	2	0	0	0
		Kiefferulus intertinctus	0	0	0	2	2	0	0	2	3	0	0	0
		Parachironomus sp. K2	0	0	0	0	0	0	2	0	0	0	0	0
		Paratendipes sp. K1	3	2	0	0	0	0	0	0	0	0	0	0
		Polypedilum (Pentapedilum) leei	2	0	0	0	0	3	2	0	0	0	0	2
		Polypedilum sp. 1	3	3	0	2	2	2	0	3	2	3	3	3
		Polypedilum sp. 2	0	0	0	0	2	0	0	0	0	0	0	2
		Skusella subvittata	2	0	0	0	0	0	0	0	0	0	0	0
	Tanytarsini	*Cladotanytarsus* sp. (WWTS4)	3	2	3	3	0	1	2	3	0	0	0	3
		Paratanytarsus sp. (WWTS2)	0	0	2	0	0	0	0	0	0	2	3	2
		Tanytarsus sp. (WWTS1)	0	3	2	0	3	0	3	3	3	3	3	2
	Orthocladiinae	*Nanocladius* sp. (WWO6)	0	0	0	0	0	0	3	0	0	0	0	0
	Tanypodinae	*Ablabesmyia hilli*	0	0	0	2	2	0	0	2	0	2	0	0
		Fittkauimyia disparipes	0	0	0	0	0	0	0	0	2	0	0	0
		Larsia albiceps	4	3	3	3	3	3	3	4	2	3	3	3
		Paramerina sp. (WWT1)	3	3	2	2	2	0	3	3	3	2	0	3
		Procladius sp. (WWT5)	3	0	3	3	3	0	0	0	0	2	0	3
	Culicidae	Culicidae spp. (P)	0	0	0	0	0	0	3	1	0	0	0	0
		Anopheles spp.	0	2	0	0	2	0	3	3	0	2	2	2
		Culex spp.	0	2	0	0	0	0	4	2	0	0	0	2
	Dolichopodidae	Dolichopodidae sp.	1	0	0	0	0	0	0	0	0	0	0	0
	Ephydridae	Ephydridae spp.	0	0	0	0	0	0	0	0	0	0	0	2
	Sciomyzidae	Sciomyzidae spp.	0	0	0	0	0	0	2	0	0	0	0	0
	Stratiomyidae	Stratiomyidae spp.	2	0	0	0	0	2	3	0	0	1	0	0
		Stratiomyidae sp. (P)	0	0	0	0	1	0	0	0	0	0	0	0

Phylum/Class/Order	Family	Lowest Taxon	RRD1	RRD2	RRD3	RRD4	RRD5	RRD6	RRU1	RRU2	RRU3	RRU4	RRU5	RRU6
	Tabanidae	Tabanidae spp.	0	2	0	0	0	1	3	0	0	0	0	0
	Thaumaleidae	Thaumaleidae spp.	0	0	0	0	0	0	0	0	0	0	0	2
	Tipulidae	Tipulidae sp. (P)	0	0	0	0	0	0	1	0	0	0	0	0
Trichoptera	**Ecnomidae**	*Ecnomus* spp.	1	0	2	0	1	0	0	0	0	0	0	0
	Hydroptilidae	*Hellyethira* spp.	0	0	2	0	0	0	0	0	0	0	0	0
	Leptoceridae	Leptoceridae spp. (imm./dam.)	0	0	0	0	2	0	0	0	1	0	0	0
		Leptocerus souta	0	0	0	0	0	0	2	0	0	0	0	0
		Oecetis sp.	1	0	0	0	0	0	0	0	0	0	0	0
		Triplectides ciuskus seductus	0	0	2	0	0	0	0	0	0	0	0	0
Lepidoptera	**Crambidae**	*Acentropinae* spp.	0	2	0	0	0	0	0	1	0	0	0	0
		Parapoynx spp.	0	1	0	0	0	2	2	2	0	2	0	0
		Taxa richness	**54**	**56**	**38**	**39**	**38**	**52**	**72**	**56**	**34**	**40**	**34**	**42**

(imm./dam) = taxa were too immature / damaged to be accurately identified to a lower taxonomic level.

(P) = taxa were in pupal form.

(L) = taxa were in larval form.

NB: some chironomid taxa are followed by their unique morphotype code (in parentheses)

Appendix B: Geology, Land Systems and Pre-European Vegetation Mapping of the Survey Area

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410000 415000 420000 425000 430000

7600000 7595000 7590000

Legend

Mesa H Riparian Community Survey Area

Surface Geological Unit (Stewart et al. 2008)

QUATERNARY
- Qa
- Qrc

CENOZOIC
- Czlr

CRETACEOUS
- Kswn

PALEOPROTEROZOIC
- Lsy
- Lchk
- Lfhw
- Lchb

ARCHEAN
- Ashm
- Abfm
- Awfj
- Achm

Lchk Kswn Abfm Qrc Ashm Awfj Qrc Achm Czlr Abfm Lchb Czlr Qa Qrc Lfhw Qa Lchk Lchb Achm Czlr Lfhw Czlr Awfj Lfhw Ashm Czlr Qa Qrc Czlr Lchk Achm Qrc Qrc Ashm Lsy Achm Qrc

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure B.1: Geological Units of the Mesa H Riparian Community Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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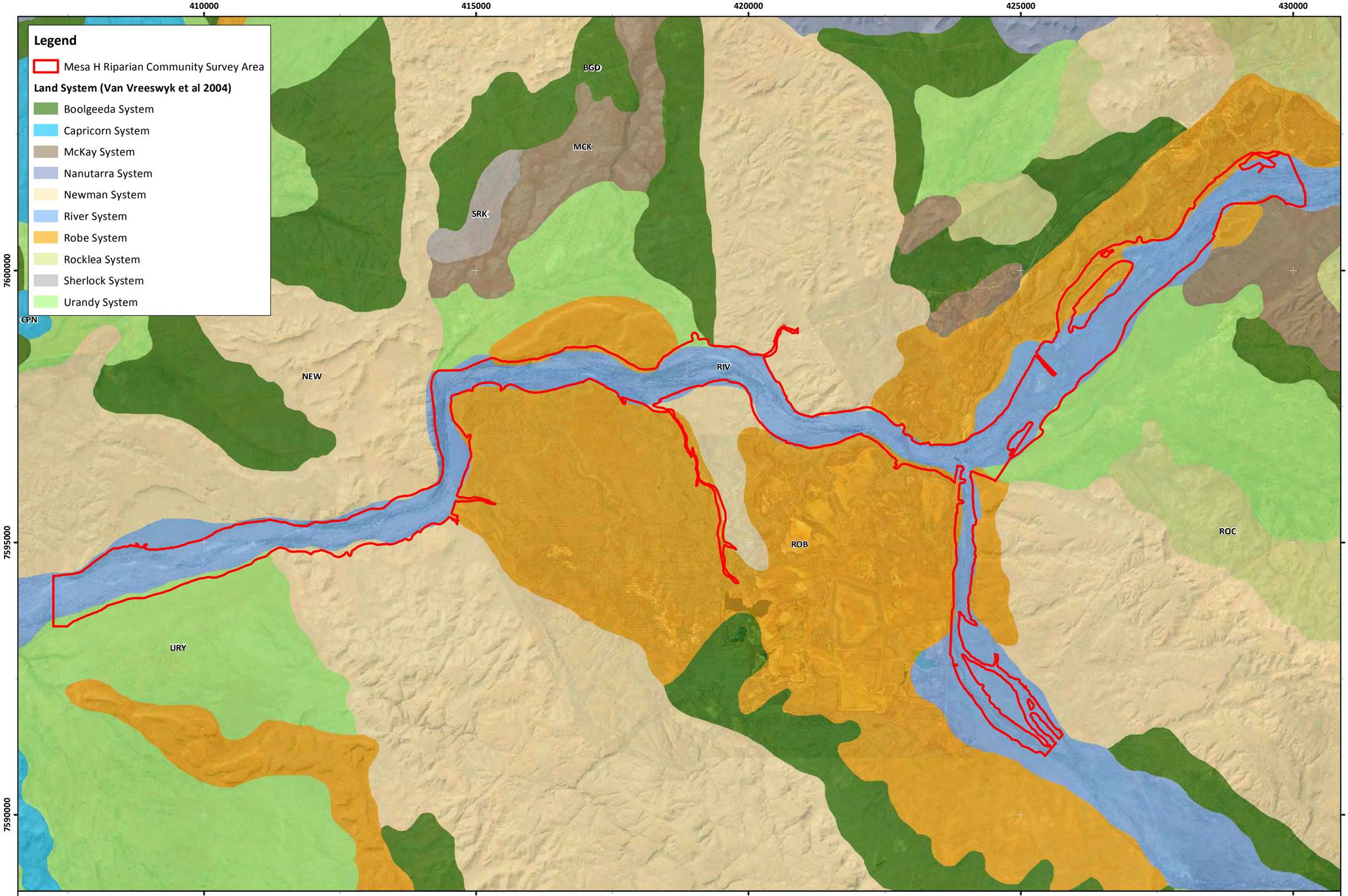
Author: D. Roocke | Drawn: W. An | Date: 05-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigB1_GeoUnits



Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure B.2: Land Systems of the Mesa H Riparian Community Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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Author: D. Roocke | Drawn: W. An | Date: 05-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigB2_LandSystems

410000 415000 420000 425000 430000

7600000 7595000 7590000

Legend

Mesa H Riparian Community Survey Area

Vegetation Association (Shepherd et al. 2002)

- 82 Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*
- 173 Hummock grasslands, shrub steppe; kanji over soft spinifex & *Triodia wiseana* on basalt
- 603 Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* over hard spinifex
- 605 Hummock grasslands, shrub steppe; *Acacia pachycarpa* & waterwood over soft spinifex
- 609 *Triodia* open hummock grassland - Mosaic: Hummock grasslands, open low tree steppe; bloodwood with sparse kanji shrubs over soft spinifex/Hummock grasslands, open low tree steppe; snappy gum over *Triodia wiseana* on a lateritic crust
- 620 Hummock grasslands, shrub steppe; snakewood over soft spinifex

609 603 82 173 620

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure B.3: Pre-European Vegetation of the Mesa H Riparian Community Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

astron delivering environmental intelligence™

Author: D. Roocke | Drawn: W. An | Date: 05-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigB3_PreEuroVeg

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Appendix C: Conservation Categories for Flora, Fauna and Ecological Communities, and Categories for Introduced Flora

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Table C.1: Categories and definitions for EPBC Act listed flora and fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation category	Definition
Extinct	Taxa with no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa known to survive only in cultivation, in captivity or as a naturalized population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriated seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (E)	Taxa are not critically endangered; and are facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (V)	Taxa are not critically endangered or endangered; and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent (CD)	Taxa are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or the following subparagraphs are satisfied: i) the taxa is a species of fish; ii) the taxa is the focus of a management plan that provides management actions necessary to stop the decline of, and support the recovery of, the taxa so that its chances of long term survival in nature are maximized; iii) the management plan is in force under a law of the Commonwealth or of a State or Territory; iv) Cessation of the management plan would adversely affect the conservation status of the taxa Fish includes all taxa of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals/reptiles.

Three categories exist for listing threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Table C.2: Definitions and criteria for threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Categories of ecological communities	
Critically endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Table C.3: Categories of threatened ecological communities (Department of Parks and Wildlife 2015b).

PD: Presumed Destroyed
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or** B) All occurrences recorded within the last 50 years have since been destroyed.
CR : Critically Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

En: Endangered

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

VU: Vulnerable

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Table C.4: Definitions and criteria for priority ecological communities (Department of Parks and Wildlife 2015b).

P1: Priority One – Poorly-known ecological communities
Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two – Poorly-Known ecological communities
Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three – Poorly-Known ecological communities
(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4: Priority Four
Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5: Priority Five – Conservation dependent ecological communities
Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table C.5: Conservation codes for Western Australian flora and fauna under the *Wildlife Conservation Act 1950*.

Code	Conservation category	Definition
S1	Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice and Wildlife Conservation (Rare Flora) Notice under the Wildlife Conservation Act 1950.	Taxa that is rare or likely to become extinct, as critically endangered taxa.
S2	Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice and Wildlife Conservation (Rare Flora) Notice under the Wildlife Conservation Act 1950.	Taxa that is rare or likely to become extinct, as endangered taxa.
S3	Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice and Wildlife Conservation (Rare Flora) Notice under the Wildlife Conservation Act 1950.	Taxa that is rare or likely to become extinct, as vulnerable taxa.
S4	Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice and Wildlife Conservation (Rare Flora) Notice under the Wildlife Conservation Act 1950.	Taxa that is presumed to be extinct.
S5	Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Birds that are subject to international agreements relating to the protection of migratory birds.
S6	Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that are of special conservation need being species dependent on ongoing conservation intervention.
S7	Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned.

Note: Schedules 5, 6, and 7 are only related to conservation significant fauna.

Threatened fauna and flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

- CR: Critically Endangered - considered to be facing an extremely high risk of extinction in the wild.
- EN: Endangered - considered to be facing a very high risk of extinction in the wild.
- VU: Vulnerable - considered to be facing a high risk of extinction in the wild.

Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These taxa require regular monitoring. Conservation Dependent species are placed in Priority 5.

Table C.6: Priority species under Western Australian *Wildlife Conservation Act 1950*.

P1: Priority One – Poorly known taxa
Taxa that are known from one or a few collections or sight records (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves, and active mineral leases; or otherwise 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. Such taxa are in urgent need of further survey.
P2: Priority Two – Poorly known taxa
Taxa that are known from one or a few collections (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves, and other lands with secure tenure being managed for conservation. 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. Such taxa are in urgent need of further survey.
P3: Priority Three – Poorly known taxa
Taxa that are known from several localities and does not appear 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. Such taxa are in urgent need of further survey.
P4: Priority Four: 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.
P5: Priority Five: Conservation dependent taxa
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.

The management of introduced flora species in Western Australia is regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). A list of declared pests, including 'pest' plants is provided under the BAM Act, which has been updated to incorporate a number of other Acts that are administered by DAFWA (2015). Declared pests can fall into two categories: one that relates to the prevention of introducing the species or eradicating it; and the other relates to managing the species and whether it can be kept (i.e. for scientific purposes, education or other purpose).

The threat and risk posed to site-specific biodiversity values, influences to rehabilitation success, primary production, infrastructure assets or human health will differ depending on the unique characteristics of each site and the associated land management practice or operation. Therefore site or project specific weed assessments and priorities should be reviewed for each project.

As per introduced flora species, the BAM Act seeks to establish a modern biosecurity regulatory scheme to prevent serious animal pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State. Declared animal pests fall into three categories as Gazetted under the BAM Act (DAFWA 2015). These categories are outlined in Table C.7.

Table C.7: Declared pests categories as gazetted under the *Biosecurity and Agriculture Management Act 2007* (Department of Agriculture and Food 2016).

Category	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table C.8: IUCN Red List Conservation Categories of Threatened Species.

Category	Description
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Appendix D: Database Search Results

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Government of Western Australia
Department of Parks and Wildlife

Your Ref: **14269-15**
Our Ref: **40-0915FL**
Enquiries: Jessica Donaldson
Phone: (08) 9219 8760
Email: flora.data@dpaw.wa.gov.au

Astron Environmental Services
129 Royal Street
East Perth WA 6004

Attention: Natalie Cadd

Dear Natalie Cadd,

REQUEST FOR THREATENED AND PRIORITY FLORA INFORMATION

I refer to your request of 14 September 2015 for Threatened (Declared Rare) and Priority Flora information in the Pannawonica area. The search was conducted within the area of the coordinates you submitted with an additional 20km buffer.

A search was undertaken for this area of **(1)** the Department's *Threatened (Declared Rare) and Priority Flora* database (for results, see "TPFL" – coordinates are GDA94), **(2)** the *Western Australian Herbarium Specimen* database for Threatened and Priority flora species opportunistically collected in the area of interest (for results, see "WAHERB"- coordinates are GDA94 – see condition number 4 in the attached 'Conditions in Respect of Supply') and **(3)**, the Department's *Threatened and Priority Flora List* [this list is searched using 'place names'. This list, which may also be used as a species target list, contains species that are declared rare (Conservation Code R or X for those presumed to be extinct), poorly known (Conservation Codes 1, 2 or 3), or require monitoring (Conservation Code 4) – for results, *if any*, see "TP List"]. The results are attached electronically to this email.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the ninth point, which refers to the requirement to undertake field investigations for the accurate determination of Threatened and Priority flora occurrence at a site. *The information supplied should be regarded as an indication only of the Threatened and Priority flora that may be present and may be used as a target list in any surveys undertaken.*

The information provided does not preclude you from obtaining and complying with, where necessary, land clearing approvals from other agencies.

An invoice for $ 300 (plus GST) to supply this information will be forwarded.

It would be appreciated if any populations of Threatened and Priority flora you encounter in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss Threatened and Priority flora management, please contact Dr Ken Atkins, Manager, Species and Communities Branch, on (08) 9334 0455.

Yours faithfully

Jessica Donaldson
.....
THREATENED FLORA DATABASE OFFICER
for the Director General

29 September 2015

Species and Communities Branch
17 Dick Perry Avenue, Technology Park, Kensington
Phone: (08) 9334 0455 Fax: (08) 9334 0278 Teletype: (08) 9334 0546
Postal Address: Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
www.dpaw.wa.gov.au

Government of **Western Australia**
Department of **Parks and Wildlife**

THREATENED AND PRIORITY FLORA INFORMATION

Conditions with Respect to the Supply of Information

- The data supplied may not be provided to any other organisations, nor be used for any purpose other than for the project for which it has been originally provided for; without the prior consent of the Executive Director, Department of Parks and Wildlife.
- Specific locality information for threatened flora is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for threatened flora may not be used in reports without the written permission of the Executive Director, Department of Parks and Wildlife. Reports may only show generalised locations at a low resolution or, where necessary, show specific locations without identifying species. Species and Communities Branch is to be contacted for guidance on the presentation of threatened flora information.
- The Department of Parks and Wildlife respects the privacy of private landowners who may have threatened and priority flora on their property. Threatened and priority flora locations identified in the data as being on private property should be treated in confidence, and contact with property owners must only be made through the Department of Parks and Wildlife.
- The development of the Perth Herbarium database was not originally intended for electronic mapping (eg. GIS ArcView). The latitude and longitude coordinates for each entry are not verified prior to being data based. It is only in recent times that collections have been submitted with GPS coordinates. Therefore, be aware when using this data in ArcView that some records may not plot to the locality description given with each collection.
- Acknowledgment of the Department of Parks and Wildlife as the source of data is to be made in any published material and cited as Parks and Wildlife (2015) Threatened and Priority Flora Database Search for [search area] accessed on the [date of search]. Prepared by the Species and Communities Branch for [Requesters name and company] for [purpose of search].
- Copies of all such publications are to be forwarded to the Department of Parks and Wildlife, Attention; the Manager, Species and Communities Branch.

Disclaimers with Respect to the Supply of Information

- Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data, they may be present. The Department of Parks and Wildlife accepts no responsibility for this.
- Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.
- It should be noted that the supplied data does not necessarily represent a comprehensive listing of the threatened flora of the area in question. Its comprehensiveness is dependent on the amount of surveys carried out within a specified area. The receiving organisation should consider engaging a botanist, if required, to undertake a survey of the area under consideration.

Species and Communities Branch
17 Dick Perry Avenue, Technology Park, Kensington
Phone: (08) 9334 0455 Fax: (08) 9334 0278 Teletype: (08) 9334 0546
Postal Address: Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
www.dpaw.wa.gov.au

Department of Parks and Wildlife

ABBREVIATIONS USED IN THREATENED AND PRIORITY FLORA DATABASE

VESTING

AAP	Aboriginal Planning Authority
AGR	Chief Executive, Dep. of Agriculture
ALT	Aboriginal Land Trust
APB	Agricultural Protection Board of WA
BGP	Botanical Gardens & Parks Authority
BSA	Boy Scouts Association
CC	Conservation Commission – NPNCA - LFC
CGT	Crown Grant in Trust
COM	Commonwealth of Australia
CRO	Crown Freehold-Govt Ownership
CRW	Crown
DAG	Dep. of Agriculture
DOW	Dep. of Water
DPI	Dep. of Planning
EXD	Exec Direc CALM
FES	Fire and Emergency Services Aust.
HOW	Dep. of Housing/State Housing Commission
ILD	Industrial Lands Develop. Auth
LAC	LandCorp
LGA	Shire/LGA
MAG	Minister for Agriculture
MCB	Metropolitan Cemeteries Board
MED	Ministry of Education
MHE	Minister for Health
MIN	Minister for Mines
MPL	Ministry for Planning
MPR	Minister for Prisons
MRD	Main Roads WA
MTR	Minister for Transport
MWA	Minister for Water Resources
MWO	Minister for Works
NAT	Natural Trust of Australia WA
NON	Not Vested
PLB	Pastoral Lands Board
PRI	Private/Freehold
RAI	Public Transport Authority
REL	Religious Organisation
SPC	State Planning Commission
SYN	Synergy (ex Western Power)
SWA	State of Western Australia
TEL	Telstra
UNK	Unknown
WAT	Water Corporation
WEL	Minister Community Welfare
WRC	Water & Rivers Commission
XPL	Ex-Pastoral Lease

PURPOSES

ABR	Aboriginal Reserve
ACC	Access Track
AER	Aerodrome
AIR	Airport
ARS	Agricultural Research Station
BAP	Baptist Union of WA
CAM	Camping
CAR	Caravan park
CEM	Cemetery
CFA	Conservation of Fauna
CFF	Conservation Of Flora & Fauna
CFL	Conservation of Flora
CHU	Church
CMN	Communications
COM	Common
CON	Conservation Park
CPK	Car Park
CRM	Conservation & Resource Management
DEF	Defence
DRA	Drain
EDE	Educational Endowment
EDU	Educational purposes
UWA	
ENE	Enjoyment of Natural Environ.
EPL	Ex-pastoral Lease (Sect 33(2) CALM Act)
EPS	Explosives
EXC	Excepted from sale
EXL	Exploration Lease
EXP	Experimental Farm
FIR	Firing Range
FOR	State Forest
FP	Foreshore Purposes
GE	General Lease
GHA	Grain Handling
GOL	Golf
GRA	Gravel Pit
GVT	Government Requirements
HAR	Harbour Purposes
HEP	Heritage Purposes
HER	Heritage trail
HOS	Hospital
KEN	Kennels
LGA	LGA/Shire Requirements
LPR	Landscape Protection
MIN	Mining lease
MUN	Municipal Purposes
NPK	National Park
NRE	Nature Reserve
OTH	Other
PAR	Parkland (& Recreation)
PAS	Pastoral lease
PCR	Proposed for Conservation
PFF	Protection of Flora & Fauna
PFL	Protection of Flora
PIC	Picnic ground
PLA	Plantation
PMC	Protection of Meteorite Crater
POS	Public Open Space
PPA	Public parkland
PRS	Prison site
PUR	Purchase Lease
PUT	Public Utility
QUA	Quarry
RAC	Racecourse
RAD	Radio Station
REC	Recreation
REH	Rehabilitation/Re-establish Native Plants
RRE	Railway Reserve
RUB	Rubbish
SAL	Saleyards
SAN	Sand
SCH	School-site
SET	Settlers requirements
SHO	Showgrounds
SNN	Sanitary
SOI	Soil Conservation
STO	Stopping place
STK	Stock Route
TIM	Timber
TOU	Tourism
TOW	Town-site
TRA	Training Ground
TRI	Trig station
UCL	Unallocated Crown Land
UNK	Unknown
VER	Road Verge
VPF	Vermin Proof Fence
WAT	Water
WLS	Wildlife Sanctuary
WOO	Firewood

ABBREVIATIONS USED IN THE WESTERN AUSTRALIAN HERBARIUM DATABASE

Geocode Method - The method that was used to record the latitude and longitude.

Auto - Indicates that the coordinate data in the record was created automatically (i.e. by software), usually by creating a coordinate from information provided in the Nearest Named Place or Locality textual description fields.

GAP - Acronym for "Generalised Arbitrary Point" as used in HISPID. GAP indicates that the coordinate data was obtained manually from the Nearest Named Place or Locality textual description fields.

GPS - Acronym for "Global Positioning System". GPS indicates that the coordinate data in the record was obtained from a GPS unit by the collector of the specimen.

MAN - Shorthand for manual. MAN indicates that the coordinate data was created by hand using some method not allowed for by one of the other manual Geocode Method values, in particular, TOPO, GAP, or GPS.

TOPO - Shorthand for topographic map. TOPO indicates that the coordinate data was obtained by plotting textual locality details against a topographic map.

None - Indicates that no coordinate data has been supplied by the collector.

Unknown - Indicates that there is no known method for determining the coordinate data. Should be used if the collector provided no indication of how they sampled the specimen's coordinate data.

PREC (Precision) - precision ratings for coordinates.

Precision 1: Absolutely precise (to nearest 100m or nearest second) and must be GPS determined. For example 35°26'42"S 123°40'26"E

Precision 2: Falling within a diameter of 3km (ca 2 minutes) or if no GPS mentioned in collecting notes. (The location must be able to be pinpointed on a 1:250 000 map, a spot locality. For example 35°26'42"S 123°40'26"E

Precision 3: Falling within a diameter of 10km (ca 7 minutes) or for degrees and minutes, where seconds have not been given. For example 35°26'_"S 123°40'_"E

Precision 4: Falling within a diameter of ca 50km (30 minutes). For example 35°26'_"S 123°40'_"E

Precision 5: Where a location is a prescribed large geographical area within a state or only the state is given. Diameter is greater than 50km. For example 35°_'_"S 123°_'_"E

Precision 6: used when localities are New Holland, Eastern Australia or Not given. Fields will be left blank.

Department of Parks and Wildlife

CONSERVATION CODES

For Western Australian Flora and Fauna

T Threatened species

Listed as Specially Protected under the *Wildlife Conservation Act 1950,* published under Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

- Fauna that is rare or likely to become extinct are declared to be fauna that is in need of special protection
- Flora that are extant and considered likely to become extinct, or rare and therefore in need of special protection, are declared to be rare flora

Species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.
The assessment of the conservation status of these species is based on their national extent.

X Presumed extinct species

Listed as Specially Protected under the *Wildlife Conservation Act 1950,* published under Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora).

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.

IA Migratory birds protected under an international agreement

Listed as Specially Protected under the *Wildlife Conservation Act 1950,* listed under Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), relating to the protection of migratory birds.

S Other specially protected fauna

Listed as Specially Protected under the *Wildlife Conservation Act 1950.* Fauna declared to be in need of special protection, otherwise than for the reasons mentioned for Schedules 1, 2 or 3, are published under Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Threatened Fauna and Flora are ranked according to their level of threat using IUCN Red List categories and criteria. *For example:* Carnaby's Cockatoo (*Calyptorynchus latirostris*) is listed as 'Specially Protected' under the *Wildlife Conservation Act 1950,* published under Schedule 1, and referred to as a 'Threatened' species with a ranking of 'Endangered'.

CR Critically Endangered - considered to be facing an extremely high risk of extinction in the wild.

EN Endangered - considered to be facing a very high risk of extinction in the wild.

VU Vulnerable - considered to be facing a high risk of extinction in the wild.

A list of the current rankings can be downloaded from the Parks and Wildlife Threatened Species and Communities webpage at http://dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/

P Priority species

Species that maybe threatened or near threatened but are data deficient, have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Specially Protected Fauna) Notice or the Wildlife Conservation (Rare Flora) Notice, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation dependent species that are subject to a specific conservation program are placed in Priority 5.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1: Priority One: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: Priority Two: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3: Priority Three: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4: Priority Four: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species 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 species are usually represented on conservation lands.
(b) Near Threatened. Species 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) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

5: Priority Five: Conservation Dependent species

Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma).

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES INFORMATION

CONDITIONS IN RESPECT OF SUPPLY OF INFORMATION

1. All requests for data are to be made in writing to the Director General, Department of Environment and Conservation Attention: Species and Communities Branch

2. The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided, without the prior written consent of the data custodian (Val English), Species and Communities Branch.

3. Specific locality information for threatened and priority ecological communities (TECs/PECs) is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for TECs/PECs may not be used in public reports without the written permission of the Director General, Department of Environment and Conservation. Publicly available reports may only show generalised locations (ie buffer locations). The TEC database manager is to be contacted for guidance on the presentation of TEC/PEC information.

4. Note that the Department of Environment and Conservation respects the privacy of private landowners who may have threatened and priority ecological communities on their property. Locations of TECs/PECs identified in the data as being on private property should be treated in confidence, and contact with property owners made through the Department of Environment and Conservation.

5. Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data provided, they may be present. The Department of Environment and Conservation accepts no responsibility for this.

6. Receiving organisations must also recognise that the Threatened Ecological Communities database is subject to continual updating and amendment, and such considerations should be taken into account by the user.

7. It should be noted that the supplied data do not necessarily represent a comprehensive listing of the threatened and priority ecological communities of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area. Private property has been relatively little surveyed. The receiving organisation should employ a consultant, if there is any likelihood of the presence of any threatened or priority ecological community, to undertake a survey of the area under consideration.

8. Acknowledgment of the Department of Environment and Conservation as source of the data is to be made in any published material. Copies of all such publications are to be forwarded to the Department of Environment and Conservation, Attention: Manager, Species and Communities Branch.

NatureMap Species Report

Created By Guest user on 25/07/2016

Kingdom Plantae
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 116° 11' 50" E,21° 44' 11" S
Buffer 40km
Group By Family

Family	Species	Records
Acanthaceae	1	1
Aizoaceae	3	7
Amaranthaceae	26	73
Apiaceae	1	1
Araliaceae	3	6
Arecaceae	1	4
Asphodelaceae	1	1
Asteraceae	20	39
Boraginaceae	7	11
Brassicaceae	1	1
Campanulaceae	2	4
Capparaceae	1	4
Caryophyllaceae	4	15
Celastraceae	2	2
Chenopodiaceae	9	13
Cleomaceae	1	5
Combretaceae	3	5
Convolvulaceae	6	10
Cucurbitaceae	3	8
Cyperaceae	23	51
Dilleniaceae	2	2
Droseraceae	1	1
Euphorbiaceae	15	35
Fabaceae	86	256
Frankeniaceae	1	1
Gentianaceae	1	2
Goodeniaceae	14	31
Haloragaceae	3	6
Hydrocharitaceae	5	15
Lamiaceae	4	8
Lauraceae	1	2
Lentibulariaceae	1	1
Loranthaceae	4	5
Lythraceae	4	13
Malvaceae	58	174
Marsileaceae	3	3
Menispermaceae	1	2
Molluginaceae	3	7
Moraceae	2	4
Myrtaceae	15	36
Nyctaginaceae	5	12
Oleaceae	1	4
Onagraceae	1	3
Oxalidaceae	1	1
Papaveraceae	1	1
Pedaliaceae	1	1
Phrymaceae	2	2
Phyllanthaceae	5	8
Plantaginaceae	1	1
Poaceae	74	183
Portulacaceae	6	12
Potamogetonaceae	3	7
Proteaceae	7	9
Pteridaceae	4	10
Rubiaceae	5	6
Ruppiaceae	1	1
Sapindaceae	1	1
Scrophulariaceae	5	8
Solanaceae	16	38
Stylidiaceae	2	2
Surianaceae	1	1
Thymelaeaceae	1	1
Violaceae	1	2
Zygophyllaceae	8	24
TOTAL	**495**	**1203**

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Acanthaceae					
1.	12088	*Rostellularia adscendens var. clementii*			
Aizoaceae					
2.	44241	*Trianthema glossostigmum*			
3.	44305	*Trianthema pilosum*			
4.	44362	*Trianthema triquetrum*			
Amaranthaceae					
5.	2647	*Alternanthera angustifolia*			
6.	2651	*Alternanthera nana (Hairy Joyweed)*			
7.	2653	*Alternanthera pungens (Khaki Weed)*	Y		
8.	31076	*Amaranthus cochleitepalus*			
9.	2660	*Amaranthus cuspidifolius*			
10.	2663	*Amaranthus interruptus (Native Amaranth)*			
11.	2666	*Amaranthus mitchellii (Boggabri Weed)*			
12.		*Amaranthus sp.*			
13.	20018	*Amaranthus undulatus*			
14.	18361	*Gomphrena affinis subsp. pilbarensis*			
15.	2680	*Gomphrena cunninghamii*			
16.	2690	*Ptilotus aervoides*			
17.	2694	*Ptilotus appendiculatus*			
18.	2696	*Ptilotus astrolasius*			
19.	2698	*Ptilotus auriculifolius*			
20.	2699	*Ptilotus axillaris (Mat Mulla Mulla)*			
21.	2704	*Ptilotus calostachyus (Weeping Mulla Mulla)*			
22.	2711	*Ptilotus clementii (Tassel Top)*			
23.	2725	*Ptilotus fusiformis*			
24.	2728	*Ptilotus gomphrenoides*			
25.	2734	*Ptilotus incanus*			
26.	2738	*Ptilotus latifolius (Tangled Mulla Mulla)*			
27.	41001	*Ptilotus nobilis subsp. nobilis (Yellow Tails)*			
28.	2747	*Ptilotus obovatus (Cotton Bush)*			
29.		*Ptilotus sp.*			
30.	2766	*Ptilotus villosiflorus*			
Apiaceae					
31.	6218	*Daucus glochidiatus (Australian Carrot)*			
Araliaceae					
32.	6202	*Astrotricha hamptonii (Ironplant)*			
33.	6278	*Trachymene oleracea*			
34.	19043	*Trachymene oleracea subsp. oleracea*			
Arecaceae					
35.	1042	*Phoenix dactylifera (Date Palm)*	Y		
Asphodelaceae					
36.	1364	*Asphodelus fistulosus (Onion Weed)*	Y		
Asteraceae					
37.	7822	*Angianthus acrohyalinus (Hook-leaf Angianthus)*			
38.	7866	*Blumea tenella*			
39.	14090	*Calocephalus beardii*			
40.	7893	*Calocephalus knappii*			
41.	7899	*Calotis breviradiata*			
42.	7906	*Calotis plumulifera*			
43.	19762	*Centipeda minima subsp. macrocephala*			
44.	35558	*Flaveria trinervia (Speedy Weed)*	Y		
45.	29594	*Helichrysum luteoalbum (Jersey Cudweed)*			
46.	13494	*Pentalepis trichodesmoides*			
47.	42160	*Pentalepis trichodesmoides subsp. trichodesmoides*			
48.	17817	*Pluchea dunlopii*			
49.	17816	*Pluchea ferdinandi-muelleri*			
50.	43944	*Pluchea longiseta*			
51.	8168	*Pluchea rubelliflora*			
52.	8192	*Pterocaulon sphacelatum (Apple Bush)*			
53.	8193	*Pterocaulon sphaeranthoides*			
54.	13310	*Rhodanthe margarethae*			
55.	8238	*Streptoglossa liatroides*			
56.	8240	*Streptoglossa odora*			
Boraginaceae					
57.	6706	*Heliotropium cunninghamii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
58.	6712	*Heliotropium heteranthum*			
59.	6713	*Heliotropium ovalifolium*			
60.	17309	*Heliotropium pachyphyllum*			
61.		*Heliotropium sp.*			
62.	17031	*Heliotropium transforme*			
63.	11750	*Trichodesma zeylanicum var. zeylanicum*			
Brassicaceae					
64.	3037	*Lepidium phlebopetalum (Veined Peppercress)*			
Campanulaceae					
65.	37480	*Lobelia arnhemiaca*			
66.	36880	*Lobelia heterophylla subsp. pilbarensis*			
Capparaceae					
67.	11670	*Capparis spinosa var. nummularia (Coastal Caper)*			
Caryophyllaceae					
68.	2898	*Polycarpaea corymbosa*			
69.	12075	*Polycarpaea corymbosa var. corymbosa*			
70.	2901	*Polycarpaea holtzei*			
71.	2903	*Polycarpaea longiflora*			
Celastraceae					
72.	4731	*Stackhousia intermedia*			
73.	18405	*Stackhousia sp. swollen gynophore (W.R. Barker 2041)*			
Chenopodiaceae					
74.	11632	*Dysphania glomulifera subsp. eremaea*			
75.	2544	*Maireana georgei (Satiny Bluebush)*			
76.	2551	*Maireana melanocoma (Pussy Bluebush)*			
77.	2604	*Sclerolaena costata*			
78.	2607	*Sclerolaena densiflora*			
79.	2611	*Sclerolaena eriacantha (Tall Bindii)*			
80.	2638	*Suaeda arbusculoides*			
81.	31616	*Tecticornia auriculata*			
82.	33220	*Tecticornia pterygosperma subsp. denticulata*			
Cleomaceae					
83.	2988	*Cleome viscosa (Tickweed, Tjinduwadhu)*			
Combretaceae					
84.	5300	*Terminalia canescens (Joolal)*			
85.	45698	*Terminalia circumalata*			
86.	5313	*Terminalia supranitifolia*		P3	
Convolvulaceae					
87.	6608	*Bonamia pannosa*			
88.	44782	*Bonamia pilbarensis*			
89.	6633	*Ipomoea muelleri (Poison Morning Glory, Yumbu)*			
90.	11312	*Ipomoea pes-caprae subsp. brasiliensis*			
91.	6637	*Ipomoea polymorpha*			
92.		*Polymeria sp.*			
Cucurbitaceae					
93.	7369	*Citrullus colocynthis*	Y		
94.	41721	*Cucumis variabilis*			
95.	7381	*Trichosanthes cucumerina*			
Cyperaceae					
96.	750	*Bulbostylis barbata*			
97.	774	*Cyperus bifax (Downs Nutgrass)*			
98.	786	*Cyperus cunninghamii*			
99.	12811	*Cyperus cunninghamii subsp. cunninghamii*			
100.	788	*Cyperus dactylotes*			
101.	789	*Cyperus difformis (Rice Sedge)*			
102.	12808	*Cyperus hesperius*			
103.	798	*Cyperus iria*			
104.	799	*Cyperus ixiocarpus*			
105.	12807	*Cyperus microcephalus subsp. microcephalus*			
106.	810	*Cyperus rotundus (Nut Grass)*	Y		
107.	814	*Cyperus squarrosus*			
108.	818	*Cyperus vaginatus (Stiffleaf Sedge)*			
109.	823	*Eleocharis atropurpurea*			
110.	826	*Eleocharis dulcis (Chinese Water Chestnut)*			
111.	827	*Eleocharis geniculata*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
112.	831	*Eleocharis sphacelata (Tall Spikerush, Djabren)*			
113.	851	*Fimbristylis dichotoma (Eight Day Grass)*			
114.	862	*Fimbristylis microcarya*			
115.	12159	*Fimbristylis simulans*			
116.	963	*Schoenoplectus laevis*			
117.	964	*Schoenoplectus lateriflorus*			
118.	16257	*Schoenoplectus subulatus*			
Dilleniaceae					
119.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
120.	5146	*Hibbertia montana*		P4	
Droseraceae					
121.	43544	*Drosera finlaysoniana*			
Euphorbiaceae					
122.	17422	*Adriana tomentosa var. tomentosa*			
123.	4617	*Euphorbia australis (Namana)*			
124.	42843	*Euphorbia australis var. glabra*		P2	
125.	35303	*Euphorbia australis var. subtomentosa*			
126.	4620	*Euphorbia boophthona (Gascoyne Spurge)*			
127.	9048	*Euphorbia careyi*			
128.	4629	*Euphorbia hirta (Asthma Plant)*	Y		
129.		*Euphorbia sp.*			
130.	4647	*Euphorbia tannensis*			
131.	12097	*Euphorbia tannensis subsp. eremophila (Desert Spurge)*			
132.	42879	*Euphorbia trigonosperma*			
133.	13281	*Euphorbia vaccaria*			
134.	42877	*Euphorbia vaccaria var. erucoides*			
135.	42876	*Euphorbia vaccaria var. vaccaria*			
136.	4650	*Euphorbia wheeleri*			
Fabaceae					
137.	3209	*Acacia ampliceps*			
138.	44586	*Acacia ampliceps x sclerosperma subsp. sclerosperma*			
139.	3214	*Acacia ancistrocarpa (Fitzroy Wattle)*			
140.	37260	*Acacia aptaneura*			
141.	3223	*Acacia arida*			
142.	3228	*Acacia atkinsiana*			
143.	3241	*Acacia bivenosa*			
144.	3260	*Acacia citrinoviridis*			
145.	17013	*Acacia colei var. colei*			
146.	17014	*Acacia colei var. ileocarpa*			
147.	3300	*Acacia dictyophleba (Sandhill Wattle, Ngarkalya)*			
148.	16174	*Acacia elachantha*			
149.	3360	*Acacia hamersleyensis*			
150.	3377	*Acacia inaequilatera (Baderi)*			
151.	3419	*Acacia ligulata (Umbrella Bush, Watarka)*			
152.	3471	*Acacia orthocarpa (Needleleaf Wattle)*			
153.	3500	*Acacia pruinocarpa (Gidgee)*			
154.	3501	*Acacia ptychophylla*			
155.	3506	*Acacia pyrifolia (Ranji Bush, Kandji)*			
156.	29016	*Acacia pyrifolia var. morrisonii*			
157.	29015	*Acacia pyrifolia var. pyrifolia*			
158.	3519	*Acacia rhodophloia*			
159.	13078	*Acacia sclerosperma subsp. sclerosperma*			
160.	29135	*Acacia sericophylla*			
161.		*Acacia sp.*			
162.	3553	*Acacia spondylophylla*			
163.	13070	*Acacia synchronicia*			
164.	3577	*Acacia tetragonophylla (Kurara, Wakalpuka)*			
165.	3579	*Acacia trachycarpa (Minni Ritchi, Balgali)*			
166.	23521	*Acacia trudgeniana*			
167.	3585	*Acacia tumida (Pindan Wattle, Walgali)*			
168.	20319	*Acacia tumida var. pilbarensis*			
169.	3598	*Acacia wanyu*			
170.	3606	*Acacia xiphophylla*			
171.	3680	*Aeschynomene indica (Budda Pea)*			
172.	17147	*Alysicarpus muelleri*			
173.	11055	*Cajanus cinereus*			
174.	3783	*Crotalaria medicaginea*			
175.	11231	*Crotalaria novae-hollandiae subsp. novae-hollandiae*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
176.	17439	*Cullen lachnostachys*			
177.	17118	*Cullen leucanthum*			
178.	17119	*Cullen leucochaites*			
179.	17120	*Cullen pogonocarpum*			
180.	3871	*Erythrina vespertilio (Yulbah)*			
181.	3971	*Indigofera boviperda*			
182.	17113	*Indigofera boviperda subsp. boviperda*			
183.	45436	*Indigofera chamaeclada subsp. pubens*			
184.	3973	*Indigofera colutea (Sticky Indigo)*			
185.	45473	*Indigofera fractiflexa subsp. fractiflexa*			
186.	3980	*Indigofera linifolia*			
187.	3982	*Indigofera monophylla*			
188.	3985	*Indigofera rugosa*			
189.	20317	*Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)*		P3	
190.	3987	*Indigofera trita*			
191.	3989	*Isotropis atropurpurea (Poison Sage)*			
192.	4061	*Lotus cruentus (Redflower Lotus)*			
193.	4105	*Mirbelia viminalis*			
194.	3675	*Petalostylis labicheoides (Slender Petalostylis)*			
195.	20862	*Rhynchosia bungarensis*		P4	
196.	4191	*Rhynchosia minima (Rhynchosia)*			
197.	12280	*Senna artemisioides subsp. oligophylla*			
198.	12305	*Senna glutinosa subsp. chatelainiana*			
199.	12307	*Senna glutinosa subsp. glutinosa*			
200.	12309	*Senna glutinosa subsp. pruinosa*			
201.	12308	*Senna glutinosa subsp. x luerssenii*			
202.	12312	*Senna notabilis*			
203.		*Senna sp.*			
204.	12319	*Senna venusta*			
205.	4198	*Sesbania formosa (White Dragon Tree)*			
206.	13596	*Swainsona complanata*			
207.	12356	*Swainsona formosa*			
208.	4234	*Swainsona maccullochiana (Ashburton Pea)*			
209.	4280	*Tephrosia rosea (Flinders River Poison, Bungoo'dah)*			
210.	41825	*Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)*			
211.		*Tephrosia sp.*			
212.	15947	*Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)*			
213.	17768	*Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)*			
214.	41811	*Tephrosia sp. Fortescue (A.A. Mitchell 606)*			
215.	42442	*Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)*			
216.	40060	*Tephrosia sp. clay soils (S. van Leeuwen et al. PBS 0273)*			
217.	4285	*Tephrosia supina*			
218.	4286	*Tephrosia uniovulata*			
219.	4287	*Tephrosia virens*			
220.		*Vigna benthamii*			
221.	4323	*Vigna lanceolata (Maloga Vigna, Wega)*			
222.	11576	*Vigna lanceolata var. lanceolata*			
Frankeniaceae					
223.	5188	*Frankenia ambita*			
Gentianaceae					
224.	41646	*Schenkia clementii*			
Goodeniaceae					
225.	7424	*Dampiera candicans*			
226.	7490	*Goodenia armitiana*			
227.	7509	*Goodenia forrestii*			
228.	7521	*Goodenia lamprosperma*			
229.	7526	*Goodenia microptera*			
230.	12552	*Goodenia muelleriana*			
231.	7530	*Goodenia nuda*		P4	
232.	7544	*Goodenia ramelii*			
233.		*Goodenia sp.*			
234.	10982	*Goodenia stobbsiana*			
235.	7556	*Goodenia tenuiloba*			
236.	7644	*Scaevola spinescens (Currant Bush, Maroon)*			
237.	7654	*Velleia connata (Cup Velleia)*			
238.	7658	*Velleia discophora (Cabbage Poison)*			
Haloragaceae					
239.	6174	*Haloragis gossei*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
240.	23464	*Haloragis gossei var. inflata*			
241.	6201	*Myriophyllum verrucosum (Red Water Milfoil)*			
Hydrocharitaceae					
242.	17955	*Najas graminea var. graminea*			
243.	138	*Najas marina (Prickly Water Nymph)*			
244.	139	*Najas tenuifolia (Water Nymph)*			
245.	17868	*Vallisneria nana*			
246.		*Vallisneria sp.*			
Lamiaceae					
247.	6830	*Basilicum polystachyon*			
248.	13692	*Clerodendrum floribundum var. angustifolium*			
249.	13691	*Clerodendrum floribundum var. ovatum*			
250.	6907	*Ocimum basilicum (Basil)*	Y		
Lauraceae					
251.	2949	*Cassytha capillaris*			
Lentibulariaceae					
252.	7125	*Utricularia australis*			
Loranthaceae					
253.	13700	*Amyema bifurcata*			
254.	2383	*Amyema preissii (Wireleaf Mistletoe)*			
255.	2385	*Amyema sanguinea*			
256.	2396	*Lysiana casuarinae*			
Lythraceae					
257.	5276	*Ammannia auriculata*			
258.	5277	*Ammannia baccifera*			
259.	5285	*Rotala diandra*			
260.	5286	*Rotala mexicana*			
Malvaceae					
261.	4891	*Abutilon fraseri (Lantern Bush)*			
262.	16919	*Abutilon hannii*			
263.	4895	*Abutilon lepidum*			
264.	4898	*Abutilon macrum*			
265.	4901	*Abutilon otocarpum (Desert Chinese Lantern)*			
266.	4902	*Abutilon oxycarpum (Flannel Weed)*			
267.		*Abutilon sp.*			
268.	42920	*Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)*			
269.		*Abutilon sp. Dioicum (A.A.Mitchell PRP 1618)*			
270.	14113	*Abutilon sp. Pilbara (W.R. Barker 2025)*			
271.	13659	*Corchorus laniflorus*			
272.	18408	*Corchorus lasiocarpus subsp. parvus*			
273.	4862	*Corchorus parviflorus*			
274.	4864	*Corchorus sidoides (Flannel Weed)*			
275.	18415	*Corchorus sidoides subsp. sidoides*			
276.	18414	*Corchorus sidoides subsp. vermicularis*			
277.		*Corchorus sp.*			
278.	20242	*Corchorus sp. Hamersley Range hilltops (S. van Leeuwen 3826)*			
279.	17661	*Corchorus tectus*			
280.	4865	*Corchorus tridens*			
281.	4910	*Gossypium australe (Native Cotton)*			
282.	4918	*Gossypium robinsonii (Wild Cotton)*			
283.		*Gynatrix pulchella*			
284.	29317	*Hibiscus austrinus var. austrinus*			
285.	4922	*Hibiscus brachychlaenus*			
286.	4925	*Hibiscus coatesii*			
287.	4930	*Hibiscus goldsworthii*			
288.	4933	*Hibiscus leptocladus*			
289.	4941	*Hibiscus solanifolius*			
290.	11651	*Hibiscus sturtii var. campylochlamys*			
291.	11385	*Hibiscus sturtii var. grandiflorus*			
292.	11477	*Hibiscus sturtii var. platychlamys*			
293.	5024	*Keraudrenia nephrosperma*			
294.	5051	*Melhania oblongifolia*			
295.		*Melhania sp.*			
296.	5053	*Melochia pyramidata*	Y		
297.	31758	*Sida arsiniata*			
298.	4971	*Sida cardiophylla*			
299.	4972	*Sida clementii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
300.	4976	*Sida echinocarpa*			
301.	4977	*Sida fibulifera (Silver Sida)*			
302.	4988	*Sida rohlenae*			
303.	18149	*Sida rohlenae subsp. rohlenae*			
304.		*Sida sp.*			
305.	31859	*Sida sp. Articulation below (A.A. Mitchell PRP 1605)*			
306.	33698	*Sida sp. Pilbara (A.A. Mitchell PRP 1543)*			
307.		*Sida sp. Pilbara (A.A.Mitchell PRP1543)*			
308.	31852	*Sida sp. Supplejack Station (T.S. Henshall 2345)*			
309.	16617	*Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)*			
310.	16948	*Sida sp. verrucose glands (F.H. Mollemans 2423)*			
311.	4989	*Sida spinosa (Spiny Sida)*			
312.	4875	*Triumfetta chaetocarpa (Urchins)*			
313.	14694	*Triumfetta clementii*			
314.	4878	*Triumfetta johnstonii*			
315.	14942	*Triumfetta maconochieana*			
316.		*Triumfetta sp.*			
317.	17529	*Triumfetta tenuiseta*			
318.	5106	*Waltheria indica*			
Marsileaceae					
319.	74	*Marsilea drummondii (Common Nardoo)*			
320.	76	*Marsilea hirsuta (Nardoo)*			
321.		*Marsilea sp.*			
Menispermaceae					
322.	2942	*Tinospora smilacina (Snakevine, Oondala)*			
Molluginaceae					
323.	2835	*Glinus lotoides (Hairy Carpet Weed)*			
324.	2836	*Glinus oppositifolius*			
325.	29851	*Mollugo molluginea*			
Moraceae					
326.	31578	*Ficus aculeata var. indecora (Ranji)*			
327.	19648	*Ficus brachypoda*			
Myrtaceae					
328.	16783	*Corymbia candida*			
329.	16782	*Corymbia candida subsp. candida*			
330.	16780	*Corymbia candida subsp. dipsodes*			
331.	17077	*Corymbia ferriticola*			
332.	17093	*Corymbia hamersleyana*			
333.		*Corymbia terminalis*			
334.	17084	*Corymbia zygophylla*			
335.	5580	*Eucalyptus camaldulensis (River Gum, Yabalinyba)*			
336.	35345	*Eucalyptus camaldulensis subsp. obtusa (Blunt-budded River Red Gum)*			
337.	35343	*Eucalyptus camaldulensis subsp. refulgens*			
338.	18088	*Eucalyptus leucophloia subsp. leucophloia*			
339.	5875	*Melaleuca argentea (Silver Cadjeput, Bandaran)*			
340.	5879	*Melaleuca bracteata (River Teatree)*			
341.	5915	*Melaleuca glomerata*			
342.	6081	*Verticordia forrestii (Forrest's Featherflower)*			
Nyctaginaceae					
343.	2769	*Boerhavia burbidgeana*			
344.	2770	*Boerhavia coccinea (Tar Vine, Wituka)*			
345.	2772	*Boerhavia gardneri*			
346.	2774	*Boerhavia repleta*			
347.	2775	*Boerhavia schomburgkiana*			
Oleaceae					
348.	12059	*Jasminum didymum subsp. lineare (Desert Jasmine)*			
Onagraceae					
349.	6136	*Ludwigia perennis*			
Oxalidaceae					
350.	4349	*Oxalis corniculata (Yellow Wood Sorrel)*	Y		
Papaveraceae					
351.	17797	*Argemone ochroleuca subsp. ochroleuca*	Y		
Pedaliaceae					
352.	43521	*Josephinia sp. Style-topped fruit (M. Maier BES MM 1017)*			Y

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Phrymaceae					
353.	7060	*Glossostigma diandrum*			
354.	12486	*Peplidium aithocheilum*			
Phyllanthaceae					
355.	12013	*Flueggea virosa subsp. melanthesoides (Dogwood, Guwal)*			
356.	9056	*Phyllanthus baccatus*			
357.	17626	*Phyllanthus erwinii*			
358.	4680	*Phyllanthus maderaspatensis*			
359.		*Phyllanthus sp.*			
Plantaginaceae					
360.	7098	*Stemodia grossa (Marsh Stemodia, Mindjaara)*			
Poaceae					
361.	172	*Acrachne racemosa*			
362.	204	*Aristida burbidgeae*			
363.	207	*Aristida contorta (Bunched Kerosene Grass)*			
364.	210	*Aristida holathera*			
365.	12063	*Aristida holathera var. holathera*			
366.	213	*Aristida ingrata*			
367.	215	*Aristida latifolia (Feathertop Wiregrass)*			
368.	217	*Aristida nitidula (Flat-awned Threeawn)*			
369.		*Aristida sp.*			
370.	239	*Bothriochloa bladhii (Forest Bluegrass)*			
371.	16355	*Bothriochloa decipiens var. cloncurrensis*		P1	
372.	241	*Brachyachne convergens (Spider Grass)*			
373.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
374.	259	*Cenchrus echinatus (Burrgrass)*	Y		
375.	29721	*Cenchrus setiger (Birdwood Grass)*	Y		
376.	266	*Chloris barbata (Purpletop Chloris)*	Y		
377.	270	*Chloris pumilio*			
378.	279	*Cymbopogon ambiguus (Scentgrass)*			
379.		*Cymbopogon sp.*			
380.	283	*Cynodon dactylon (Couch)*	Y		
381.	290	*Dactyloctenium radulans (Button Grass)*			
382.	303	*Dichanthium fecundum (Curly Bluegrass)*			
383.	13741	*Dichanthium sericeum subsp. humilius*			
384.	310	*Digitaria brownii (Cotton Panic Grass)*			
385.	313	*Digitaria ctenantha (Comb Finger Grass)*			
386.	328	*Echinochloa colona (Awnless Barnyard Grass)*	Y		
387.	355	*Elytrophorus spicatus (Spikegrass)*			
388.	357	*Enneapogon caerulescens (Limestone Grass)*			
389.		*Enneapogon sp.*			
390.	375	*Eragrostis cumingii (Cuming's Love Grass)*			
391.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
392.	380	*Eragrostis eriopoda (Woollybutt Grass, Wangurnu)*			
393.	16731	*Eragrostis exigua*			
394.	381	*Eragrostis falcata (Sickle Lovegrass)*			
395.	388	*Eragrostis leptocarpa (Drooping Lovegrass)*			
396.	38505	*Eragrostis surreyana*		P3	
397.	398	*Eragrostis tenellula (Delicate Lovegrass)*			
398.	399	*Eragrostis xerophila (Knotty-butt Neverfail)*			
399.	400	*Eriachne aristidea*			
400.	403	*Eriachne benthamii (Swamp Wanderrie)*			
401.	407	*Eriachne festucacea (Plains Wandarrie Grass)*			
402.	411	*Eriachne helmsii (Buck Wanderrie Grass)*			
403.	413	*Eriachne mucronata (Mountain Wanderrie Grass)*			
404.	16485	*Eriachne pulchella subsp. dominii*			
405.	16486	*Eriachne pulchella subsp. pulchella*			
406.	421	*Eriachne tenuiculmis*			
407.	426	*Eriochloa pseudoacrotricha (Perennial Cupgrass)*			
408.	11011	*Eulalia aurea*			
409.	443	*Heteropogon contortus (Bunch Speargrass)*			
410.	464	*Iseilema membranaceum (Small Flinders Grass)*			
411.	471	*Leptochloa digitata (Whorled Cane Grass)*			
412.	19061	*Leptochloa fusca*			
413.	505	*Panicum laevinode*			
414.	518	*Paspalidium clementii (Clements Paspalidium)*			
415.	519	*Paspalidium constrictum (Knottybutt Grass)*			
416.	523	*Paspalidium rarum (Rare Paspalidium)*			
417.	525	*Paspalidium tabulatum*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
418.	606	*Setaria dielsii (Diels' Pigeon Grass)*			
419.	629	*Sporobolus australasicus (Fairy Grass)*			
420.	17819	*Themeda sp. Mt Barricade (M.E. Trudgen 2471)*			
421.	673	*Themeda triandra*			
422.	679	*Triodia angusta*			
423.	13131	*Triodia epactia*			
424.	17877	*Triodia melvillei*			
425.		*Triodia sp.*			
426.	45373	*Triodia sp. Pannawonica (B.M. Anderson & M.D. Barrett BMA 89)*		P1	Y
427.	43220	*Triodia sp. Peedamulla (A.A. Mitchell PRP 1636)*			
428.	35843	*Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)*		P3	
429.	704	*Triodia wiseana (Limestone Spinifex)*			
430.	717	*Urochloa piligera*			
431.	729	*Xerochloa barbata (Rice Grass)*			
432.	730	*Xerochloa imberbis (Rice Grass)*			
433.	732	*Yakirra australiensis*			
434.	11894	*Yakirra australiensis var. australiensis*			
Portulacaceae					
435.	2864	*Calandrinia ptychosperma*			
436.	2878	*Portulaca conspicua*			
437.	2882	*Portulaca intraterranea*			
438.	2884	*Portulaca oleracea (Purslane, Wakati)*			
439.	2886	*Portulaca pilosa (Djanggara)*	Y		
440.		*Portulaca sp.*			
Potamogetonaceae					
441.		*Potamogeton sp.*			
442.	20426	*Potamogeton tepperi*			
443.	113	*Potamogeton tricarinatus (Floating Pondweed)*			
Proteaceae					
444.	19570	*Grevillea pyramidalis subsp. leucadendron*			
445.	2121	*Grevillea wickhamii (Wickham's Grevillea)*			
446.	13440	*Grevillea wickhamii subsp. aprica*			
447.	19478	*Grevillea wickhamii subsp. hispidula*			
448.	19074	*Grevillea wickhamii subsp. macrodonta*			
449.	2138	*Hakea chordophylla*			
450.	19137	*Hakea lorea subsp. lorea*			
Pteridaceae					
451.	30	*Ceratopteris thalictroides*			
452.	32	*Cheilanthes brownii*			
453.	37	*Cheilanthes lasiophylla (Woolly Cloak Fern)*			
454.	12818	*Cheilanthes sieberi subsp. sieberi*			
Rubiaceae					
455.	7338	*Oldenlandia crouchiana*			
456.	7339	*Oldenlandia galioides*			
457.		*Oldenlandia sp.*			
458.	12964	*Pomax rupestris*			
459.	13339	*Synaptantha tillaeacea var. tillaeacea*			
Ruppiaceae					
460.		*Ruppia sp.*			
Sapindaceae					
461.	4759	*Dodonaea coriacea*			
Scrophulariaceae					
462.	7192	*Eremophila cuneifolia (Pinyuru, T'iranju)*			
463.	15052	*Eremophila forrestii subsp. forrestii*			
464.	16696	*Eremophila fraseri subsp. fraseri*			
465.	7234	*Eremophila longifolia (Berrigan, Tulypurpa)*			
466.	23997	*Eremophila tietkensii*			
Solanaceae					
467.	6971	*Nicotiana benthamiana (Tjuntiwari)*			
468.	11331	*Nicotiana occidentalis subsp. obliqua*			
469.	11856	*Nicotiana occidentalis subsp. occidentalis*			
470.		*Nicotiana sp.*			
471.	20652	*Physalis angulata*	Y		
472.	6989	*Solanum ashbyae*			
473.	6995	*Solanum centrale (Desert Raisin, Kampurarpa)*			
474.	6998	*Solanum cleistogamum*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
475.	7002	*Solanum diversiflorum*			
476.	7009	*Solanum gabrielae*			
477.	7014	*Solanum horridum*			
478.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
479.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
480.	7029	*Solanum phlomoides*			
481.		*Solanum sp.*			
482.	7036	*Solanum sturtianum (Thargomindah Nightshade)*			
Stylidiaceae					
483.	7729	*Stylidium fluminense*			
484.	18123	*Stylidium weeliwolli*		P2	
Surianaceae					
485.	3182	*Stylobasium spathulatum (Pebble Bush)*			
Thymelaeaceae					
486.	5230	*Pimelea ammocharis*			
Violaceae					
487.	5215	*Hybanthus aurantiacus*			
Zygophyllaceae					
488.	4368	*Tribulopis angustifolia*			
489.	4374	*Tribulus astrocarpus*			
490.	4377	*Tribulus hirsutus*			
491.	4379	*Tribulus macrocarpus*			
492.	4380	*Tribulus occidentalis (Perennial Caltrop)*			
493.	4381	*Tribulus platypterus (Cork Hopbush)*			
494.		*Tribulus sp.*			
495.	4383	*Tribulus terrestris (Caltrop)*	Y		

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

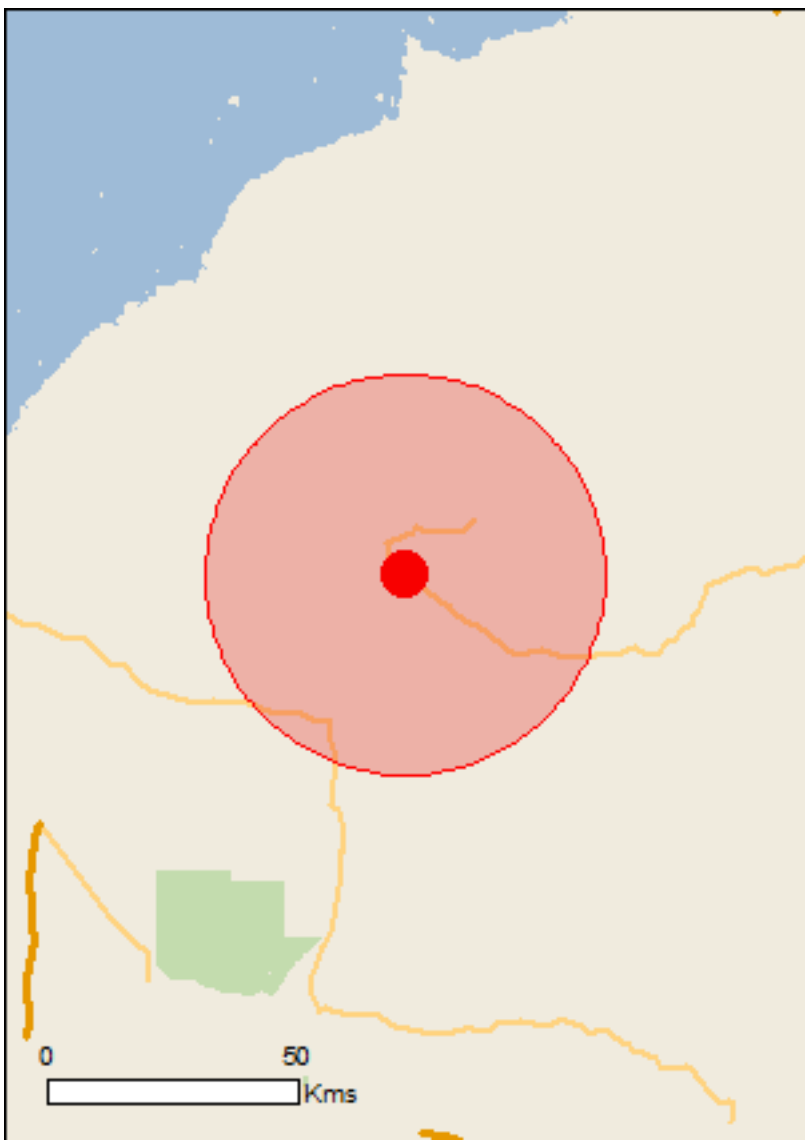
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 25/07/16 16:03:50

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



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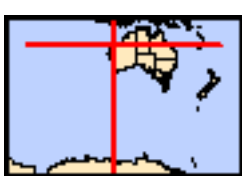
Coordinates

Buffer: 40.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	8
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	12
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	10
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Lepidium catapycnon Hamersley Lepidium, Hamersley Catapycnon [9397]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat known to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Capra hircus		
Goat [2]		Species or species habitat likely to occur within area
Equus asinus		
Donkey, Ass [4]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.73639 116.19722

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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NatureMap Species Report

Created By Guest user on 22/09/2015

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	116°12' 02" E,21°44' 47" S
Buffer	40km
Group By	Family

Family	Species	Records
Acanthaceae	1	1
Acanthizidae	5	33
Acariformes	7	470
Accipitridae	10	108
Actinopodidae	1	1
Aegothelidae	1	2
Aeolosomatidae	1	3
Aeshnidae	1	2
Agamidae	12	217
Aizoaceae	3	7
Alaudidae	1	1
Amaranthaceae	26	52
Ameiridae	4	14
Ameroseiidae	1	1
Amphipoda	1	2
Amphisopodidae	1	3
Anatidae	6	34
Ancylidae	1	3
Anhingidae	2	2
Apiaceae	1	1
Araliaceae	3	6
Araneidae	1	1
Arcellidae	3	3
Ardeidae	6	32
Arecaceae	1	4
Arrenuridae	10	22
Artamidae	5	40
Ascidae	3	15
Asphodelaceae	1	1
Asteraceae	19	32
Atrochidae	1	1
Aturidae	4	5
Atyidae	1	4
Baetidae	3	7
Bathynellidae	1	1
Bdelloidea	2	14
Belostomatidae	2	4
Bogidiellidae	2	7
Boidae	5	15
Boraginaceae	5	6
Bovidae	1	15
Brachionidae	6	6
Brassicaceae	1	1
Bufonidae	1	4
Burhinidae	1	3
Caenidae	5	13
Camelidae	1	1
Campanulaceae	2	4
Campephagidae	3	80
Candonidae	29	80
Canidae	4	11
Canthocamptidae	1	4
Capparaceae	1	4
Caprimulgidae	1	5
Carangidae	1	1
Carphodactylidae	5	14
Caryophyllaceae	3	10
Casuariidae	1	22
Celastraceae	1	1
Centropodidae	1	5
Centropyxidae	1	1
Ceratopogonidae	14	36
Charadriidae	2	2
Chenopodiaceae	7	10
Chironomidae	51	120
Chrysomelidae	1	1
Chthoniidae	3	9
Chydoridae	7	9
Cinclosomatidae	1	1
Cirolanidae	4	7
Cleomaceae	1	5
Clupeidae	1	1
Coenagrionidae	8	19
Columbidae	8	192
Combretaceae	2	4
Conochilidae	1	1
Convolvulaceae	5	8

Copepoda	3	20
Corinnidae	1	1
Corixidae	6	9
Corvidae	3	70
Cracticidae	4	53
Cuculidae	2	12
Cucurbitaceae	3	7
Culicidae	6	10
Cyclopidae	16	55
Cyperaceae	22	42
Cyprididae	9	12
Cypridopsidae	1	1
Daphniidae	1	1
Darwinulidae	4	6
Dasyuridae	10	281
Diaptomidae	1	4
Diatom Family	65	116
Dicaeidae	1	2
Dicruridae	5	155
Difflugiidae	3	3
Diosaccidae	1	5
Diplodactylidae	12	158
Diplopoda	1	1
Dolichopodidae	2	5
Droseraceae	1	1
Dytiscidae	23	49
Ecnomidae	1	7
Ectinosomatidae	2	9
Elapidae	15	80
Elmidae	4	4
Elopidae	1	2
Emballonuridae	2	50
Enchytraeidae	2	4
Ephydridae	1	3
Equidae	1	1
Estrildidae	5	224
Euchlanidae	3	9
Euglyphiidae	1	3
Euphorbiaceae	12	24
Fabaceae	77	221
Falconidae	5	60
Felidae	1	11
Floscullariacea	1	1
Flosculariidae	1	1
Frankeniaceae	1	1
Gekkonidae	6	121
Gelastocoridae	1	1
Gentianaceae	1	1
Gerridae	5	8
Glareolidae	1	1
Gomphidae	1	5
Goodeniaceae	13	23
Hadziidae	4	19
Halcyonidae	4	49
Haliplidae	3	3
Haloragaceae	2	3
Hebridae	2	3
Hemicorduliidae	3	4
Hersiliidae	1	2
Hipposideridae	1	2
Hirudinea	1	1
Hirundinidae	4	7
Hubbardiidae	5	280
Hydrachnidae	2	4
Hydraenidae	5	9
Hydridae	1	3
Hydrobiidae	1	3
Hydrocharitaceae	3	6
Hydrochidae	6	14
Hydrodromidae	1	3
Hydrophilidae	15	22
Hydropsychidae	1	2
Hydroptilidae	2	8
Hydryphantidae	1	4
Hygrobatidae	4	7
Hylidae	2	38
Hyriidae	1	3
Ilyocryptidae	1	1
Isopoda	1	3
Isostictidae	1	4
Lamiaceae	4	7
Lamponidae	9	25
Lauraceae	1	1
Lecanidae	17	33
Lentibulariaceae	1	1
Lepadellidae	6	10
Leporidae	1	1
Leptoceridae	8	16
Lesquereusidae	1	3
Libellulidae	5	11
Limnesiidae	3	15
Limnichidae	1	2
Limnocytheridae	2	11
Lindeniidae	1	3
Loranthaceae	3	3
Lutjanidae	1	1
Lycosidae	2	4
Lymnaeidae	1	6
Lythraceae	4	8
Macropodidae	4	60
Maluridae	5	63
Malvaceae	46	112
Marsileaceae	2	2
Megadermatidae	1	14
Meliphagidae	8	236

Melitidae	1	2
Menispermaceae	1	2
Meropidae	1	83
Mesoveliidae	2	3
Microcerberidae	1	1
Mideopsidae	5	8
Molluginaceae	3	5
Molossidae	2	5
Moraceae	2	4
Motacillidae	1	1
Mugilidae	2	3
Muridae	8	301
Myobatrachidae	2	70
Myrtaceae	13	22
Mytilinidae	1	2
NO FAMILY	1	7
Naididae	11	28
Nematoda	8	13
Nemertini	1	1
Nemesiidae	1	14
Neoniphargidae	1	1
Nepidae	2	3
Nereidae	1	2
Noteridae	1	1
Notommatidae	5	5
Notonectidae	1	1
Nyctaginaceae	5	9
Ochteridae	1	2
Oleaceae	1	4
Olibrinidae	1	3
Oligochaeta	1	1
Olpiidae	1	1
Onagraceae	1	2
Oonopidae	2	2
Ostracoda	1	7
Otididae	1	19
Oxidae	4	10
Pachycephalidae	3	88
Papaveraceae	1	1
Parabathynellidae	3	12
Paramelitidae	3	13
Parasitiformes	1	1
Parastenocarididae	2	3
Pardalotidae	3	29
Pedaliaceae	1	1
Pelecanidae	1	3
Peritrichidae	1	1
Petroicidae	2	13
Pezidae	2	3
Phalacrocoracidae	4	17
Phalangeridae	1	3
Phasianidae	1	2
Philodinidae	1	4
Philopotamidae	1	2
Pholcidae	1	1
Phreodrilidae	5	16
Phrymaceae	2	2
Phyllanthaceae	5	6
Pionidae	1	2
Planorbidae	4	10
Plantaginaceae	1	1
Pleidae	3	6
Poaceae	62	138
Podargidae	1	1
Podicipedidae	3	18
Polycentropodidae	1	1
Pomatostomidae	3	13
Portulacaceae	5	9
Potamogetonaceae	1	3
Prodidomidae	2	2
Proteaceae	6	8
Psittacidae	9	281
Pteridaceae	4	9
Ptilonorhynchidae	2	7
Pygopodidae	10	53
Pyralidae	4	6
Rallidae	4	8
Recurvirostridae	1	3
Ridgewayiidae	1	16
Rubiaceae	3	4
Salticidae	2	2
Sapindaceae	1	1
Scaridiidae	1	1
Scatophagidae	1	1
Scincidae	42	504
Sciomyzidae	1	2
Scirtidae	2	3
Scolopacidae	3	7
Scolopendridae	5	27
Scorpaenidae	1	1
Scrophulariaceae	4	5
Scutigeridae	1	7
Sididae	1	2
Sillaginidae	1	1
Simuliidae	1	2
Solanaceae	14	25
Sparassidae	1	1
Spongillidae	1	1
Staphylinidae	1	1
Stratiomyidae	1	6
Strigidae	3	7
Stylidiaceae	2	2
Surianaceae	1	1
Syarinidae	2	11
Sylviidae	4	35

Synchaetidae	1	2
Tabanidae	1	5
Tachyglossidae	1	3
Terapontidae	2	4
Testudinellidae	3	4
Tetraodontidae	1	1
Thermosbaenacea	1	2
Thermosbaenacidae	2	16
Thiaridae	2	3
Threskiornithidae	2	11
Thymelaeaceae	1	1
Tipulidae	5	5
Trichocercidae	4	4
Trichotriidae	1	2
Trochanteriidae	1	3
Trochanteriidae?	1	4
Turbellaria	2	5
Turnicidae	1	11
Tytonidae	1	1
Unionicolidae	12	32
Urodacidae	1	1
Varanidae	13	67
Veliidae	1	2
Vespertilionidae	5	53
Violaceae	1	2
Zygophyllaceae	6	19
TOTAL	**1376**	**7383**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Acanthaceae					
1.	12088	*Rostellularia adscendens var. clementii*			
Acanthizidae					
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
3.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
4.	25530	*Gerygone fusca (Western Gerygone)*			
5.	24271	*Gerygone fusca subsp. fusca (Western Gerygone)*			
6.	30948	*Smicrornis brevirostris (Weebill)*			
Acariformes					
7.		*Acariformes sp.*			
8.		*Acarina sp.*			
9.		*Oribatida group 1 (PSS)*			
10.		*Oribatida group 4 (PSS)*			
11.		*Oribatida group 5 (PSS)*			
12.		*Oribatida sp. 4 (PSW)*			
13.		*Trombidioidea sp.*			
Accipitridae					
14.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
15.	25536	*Accipiter fasciatus (Brown Goshawk)*			
16.	24283	*Accipiter fasciatus subsp. didimus (Brown Goshawk)*			
17.	24285	*Aquila audax (Wedge-tailed Eagle)*			
18.	25538	*Aquila morphnoides (Little Eagle)*			
19.	24289	*Circus assimilis (Spotted Harrier)*			
20.	25540	*Elanus caeruleus (Black-shouldered Kite)*			
21.	24293	*Haliaeetus leucogaster (White-bellied Sea-Eagle)*		IA	
22.	24295	*Haliastur sphenurus (Whistling Kite)*			
23.	25542	*Milvus migrans (Black Kite)*			
Actinopodidae					
24.		*Missulena rutraspina*			
Aegothelidae					
25.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
Aeolosomatidae					
26.		*Aeolosoma sp. 1 (PSS)*			
Aeshnidae					
27.		*Hemianax papuensis*			
Agamidae					
28.	30833	*Amphibolurus longirostris (Long-nosed Dragon)*			
29.	25458	*Ctenophorus caudicinctus (Ring-tailed Dragon)*			
30.	24865	*Ctenophorus caudicinctus subsp. caudicinctus (Ring-tailed Dragon)*			
31.	24872	*Ctenophorus femoralis (Dune Dragon)*			
32.	25459	*Ctenophorus isolepis (Crested Dragon, Military Dragon)*			
33.	24874	*Ctenophorus isolepis subsp. citrinus (Crested Dragon, Military Dragon)*			
34.	24876	*Ctenophorus isolepis subsp. isolepis (Crested Dragon, Military Dragon)*			
35.	24882	*Ctenophorus nuchalis (Central Netted Dragon)*			
36.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
37.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
38.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
Aizoaceae					
39.	44241	*Trianthema glossostigmum*			
40.	44305	*Trianthema pilosum*			
41.	44362	*Trianthema triquetrum*			
Alaudidae					
42.	25545	*Mirafra javanica (Horsfield's Bushlark, Singing Bushlark)*			
Amaranthaceae					
43.	2647	*Alternanthera angustifolia*			
44.	2648	*Alternanthera denticulata (Lesser Joyweed)*			
45.	2651	*Alternanthera nana (Hairy Joyweed)*			
46.	2653	*Alternanthera pungens (Khaki Weed)*	Y		
47.	31076	*Amaranthus cochleitepalus*			
48.	2660	*Amaranthus cuspidifolius*			
49.	2663	*Amaranthus interruptus (Native Amaranth)*			
50.	2666	*Amaranthus mitchellii (Boggabri Weed)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
51.	20018	*Amaranthus undulatus*			
52.	18361	*Gomphrena affinis subsp. pilbarensis*			
53.	2680	*Gomphrena cunninghamii*			
54.	2690	*Ptilotus aervoides*			
55.	2694	*Ptilotus appendiculatus*			
56.	2696	*Ptilotus astrolasius*			
57.	2698	*Ptilotus auriculifolius*			
58.	2699	*Ptilotus axillaris (Mat Mulla Mulla)*			
59.	2704	*Ptilotus calostachyus (Weeping Mulla Mulla)*			
60.	2711	*Ptilotus clementii (Tassel Top)*			
61.	2725	*Ptilotus fusiformis*			
62.	2728	*Ptilotus gomphrenoides*			
63.	2734	*Ptilotus incanus*			
64.	2738	*Ptilotus latifolius (Tangled Mulla Mulla)*			
65.	41001	*Ptilotus nobilis subsp. nobilis (Yellow Tails)*			
66.	2747	*Ptilotus obovatus (Cotton Bush)*			
67.	11396	*Ptilotus obovatus var. obovatus*			
68.	2766	*Ptilotus villosiflorus*			
Ameiridae					
69.		*Inermipes sp. 2 (PSS)*			Y
70.		*Stygonitocrella sp.*			
71.		*Stygonitocrella trispinosa*			
72.		*Stygonitocrella unispinosa*			
Ameroseiidae					
73.		*Amerosius pulmosus*			Y
Amphipoda					
74.		*Amphipoda sp.*			
Amphisopodidae					
75.		*Pilbarophreatoicus platyarthricus*			
Anatidae					
76.	24312	*Anas gracilis (Grey Teal)*			
77.	24316	*Anas superciliosa (Pacific Black Duck)*			
78.	24318	*Aythya australis (Hardhead)*			
79.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
80.	24322	*Cygnus atratus (Black Swan)*			
81.	24325	*Dendrocygna eytoni (Plumed Whistling Duck)*			
Ancylidae					
82.		*Ferrissia sp.*			
Anhingidae					
83.	25553	*Anhinga melanogaster (Darter)*			
84.	24332	*Anhinga melanogaster subsp. novaehollandiae (Darter)*			
Apiaceae					
85.	6218	*Daucus glochidiatus (Australian Carrot)*			
Araliaceae					
86.	6202	*Astrotricha hamptonii (Ironplant)*			
87.	6278	*Trachymene oleracea*			
88.	19043	*Trachymene oleracea subsp. oleracea*			
Araneidae					
89.		*Backobourkia collina*			
Arcellidae					
90.		*Arcella gibbosa (ex P2)*			
91.		*Arcella sp.*			
92.		*Arcella sp. P1*			
Ardeidae					
93.	25557	*Ardea garzetta (Little Egret)*			
94.	25559	*Ardea intermedia (Intermediate Egret)*			
95.	41324	*Ardea modesta (Eastern Great Egret)*		IA	
96.	24340	*Ardea novaehollandiae (White-faced Heron)*			
97.	24341	*Ardea pacifica (White-necked Heron)*			
98.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
Arecaceae					
99.	1042	*Phoenix dactylifera (Date Palm)*	Y		
Arrenuridae					

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
100.		*Arrenurus ensifer*			
101.		*Arrenurus harveyi*			
102.		*Arrenurus liliaceus*			
103.		*Arrenurus purpureus*			
104.		*Arrenurus rouxi*			
105.		*Arrenurus sp.*			
106.		*Arrenurus sp. 9 (nr pseudaffinis) (PSW)*			
107.		*Arrenurus sp. nov. 2 (PSS)*			
108.		*Arrenurus tripartitus*			
109.		*Arrenurus vanderpalae*			
Artamidae					
110.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
111.	24352	*Artamus cinereus subsp. melanops (Black-faced Woodswallow)*			
112.	25567	*Artamus leucorynchus (White-breasted Woodswallow)*			
113.	24355	*Artamus minor (Little Woodswallow)*			
114.	24356	*Artamus personatus (Masked Woodswallow)*			
Ascidae					
115.		*Protogamasellus dispar*			Y
116.		*Protogamasellus massula*			Y
117.		*Protogamasellus mica*			
Asphodelaceae					
118.	1364	*Asphodelus fistulosus (Onion Weed)*	Y		
Asteraceae					
119.	7822	*Angianthus acrohyalinus (Hook-leaf Angianthus)*			
120.	7866	*Blumea tenella*			
121.	14090	*Calocephalus beardii*			
122.	7893	*Calocephalus knappii*			
123.	7906	*Calotis plumulifera*			
124.	19762	*Centipeda minima subsp. macrocephala*			
125.	35558	*Flaveria trinervia (Speedy Weed)*	Y		
126.	29594	*Helichrysum luteoalbum (Jersey Cudweed)*			
127.	12635	*Olearia fluvialis*			
128.	13494	*Pentalepis trichodesmoides*			
129.	42160	*Pentalepis trichodesmoides subsp. trichodesmoides*			
130.	17817	*Pluchea dunlopii*			
131.	17816	*Pluchea ferdinandi-muelleri*			
132.	43944	*Pluchea longiseta*			
133.	8168	*Pluchea rubelliflora*			
134.	8192	*Pterocaulon sphacelatum (Apple Bush)*			
135.	8193	*Pterocaulon sphaeranthoides*			
136.	13310	*Rhodanthe margarethae*			
137.	8240	*Streptoglossa odora*			
Atrochidae					
138.		*Cupelopagis? n. sp.*			
Aturidae					
139.		*Austraturus sp. P2 (PSW)*			
140.		*Axonopsella nr truza (PSW)*			
141.		*Axonopsella sp.*			
142.		*Axonopsella sp. P2 (PSW)*			
Atyidae					
143.		*Caridina indistincta*			
Baetidae					
144.		*Baetid genus 1 WA sp. 1 (KIM_UWA)*			
145.		*Baetidae sp.*			
146.		*Cloeon sp.*			
Bathynellidae					
147.		*Bathynellidae sp.*			
Bdelloidea					
148.		*Bdelloidea sp.*			
149.		*Bdelloidea sp. 2:2*			
Belostomatidae					
150.		*Diplonychus eques*			
151.		*Lethocerus distinctifemur*			
Bogidiellidae					

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152.		*Bogidiellidae sp.*			
153.		*Bogidiellidae sp. 1 (PSS)*			
Boidae					
154.	25318	*Antaresia perthensis (Pygmy Python)*			
155.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
156.	25320	*Aspidites melanocephalus (Black-headed Python)*			
157.	25236	*Aspidites ramsayi (Woma)*		S	
158.	25238	*Liasis olivaceus subsp. barroni (Pilbara Olive Python)*		T	
Boraginaceae					
159.	6706	*Heliotropium cunninghamii*			
160.	6712	*Heliotropium heteranthum*			
161.	6713	*Heliotropium ovalifolium*			
162.	17031	*Heliotropium transforme*			
163.	11750	*Trichodesma zeylanicum var. zeylanicum*			
Bovidae					
164.	24251	*Bos taurus (European Cattle)*	Y		
Brachionidae					
165.		*Brachionus cf. nilsoni (CB)*			
166.		*Brachionus dichotomus*			
167.		*Brachionus sericus*			
168.		*Keratella procurva*			
169.		*Plationus patulus*			
170.		*Platyias quadricornis*			
Brassicaceae					
171.	3037	*Lepidium phlebopetalum (Veined Peppercress)*			
Bufonidae					
172.	42306	*Platyplectrum spenceri (Centralian Burrowing Frog)*			
Burhinidae					
173.	24359	*Burhinus grallarius (Bush Stone-curlew)*			
Caenidae					
174.		*Tasmanocoenis arcuata*			
175.		*Tasmanocoenis sp. E (PSW)*			
176.		*Tasmanocoenis sp. M (PSW)*			
177.		*Tasmanocoenis sp. P (PSW)*			
178.		*Wundacaenis dostini*			
Camelidae					
179.	24254	*Camelus dromedarius (Dromedary, Camel)*	Y		
Campanulaceae					
180.	37480	*Lobelia arnhemiaca*			
181.	36880	*Lobelia heterophylla subsp. pilbarensis*			
Campephagidae					
182.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
183.	24363	*Coracina novaehollandiae subsp. subpallida (Black-faced Cuckoo-shrike)*			
184.	24367	*Lalage tricolor (White-winged Triller)*			
Candonidae					
185.		*'Kencandona' 'verrucosa' (PSS)*			Y
186.		*Areacandona 'astrepte' (PSS)*			
187.		*Areacandona 'cylindrata' (PSS)*			
188.		*Areacandona 'fortescueiensis' (PSS)*			
189.		*Areacandona 'lepte' (PSS)*			
190.		*Areacandona 'triangulum' (PSS)*			
191.		*Areacandona cf. 'lepte' (PSS)*			
192.		*Areacandona sp.*			
193.		*Areacandona sp. 4' (PSS)*			Y
194.		*Candonid Genus 4 sp. 1 (PSS)*			Y
195.		*Candonopsis tenuis*			
196.		*Deminutiocandona 'aenigma' (PSS)*			
197.		*Deminutiocandona cf. 'atope' (PSS)*			
198.		*Humphreyscandona 'akaina' (PSS)*			
199.		*Humphreyscandona cf. 'capillus' (PSS)*			
200.		*Humphreyscandona cf. imperfecta (PSS)*			
201.		*Humphreyscandona cf. woutersi (PSS)*			
202.		*Humphreyscandona fovea*			
203.		*Humphreyscandona imperfecta*			

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204.		*Humphreyscandona pilbarae*			
205.		*Humphreyscandona sp. 2 (PSS)*			
206.		*Humphreyscandona waldockae*			
207.		*Humphreyscandona woutersi*			
208.		*Meridiescandona sp. 2' (PSS)*			
209.		*Origocandona 'posteriorecta' (PSS)*			
210.		*Origocandona sp. 2' (PSS)*			
211.		*Pilbaracandona 'rosa' (PSS)*			
212.		*Pilbaracandona 'temporaria' (PSS)*			
213.		*Pilbaracandona cf. 'rosa' (PSS)*			Y
Canidae					
214.	25454	*Canis lupus (Dog, Dingo)*	Y		
215.	24039	*Canis lupus subsp. dingo (Dingo)*	Y		
216.	30883	*Canis lupus subsp. familiaris (Dog)*	Y		
217.	24040	*Vulpes vulpes (Red Fox)*	Y		
Canthocamptidae					
218.		*Elaphoidella humphreysi*			
Capparaceae					
219.	11670	*Capparis spinosa var. nummularia (Coastal Caper)*			
Caprimulgidae					
220.	24368	*Eurostopodus argus (Spotted Nightjar)*			
Carangidae					
221.		*Caranx papuensis*			
Carphodactylidae					
222.	24969	*Nephrurus levis subsp. pilbarensis*			
223.	25498	*Nephrurus wheeleri*			
224.	24972	*Nephrurus wheeleri subsp. cinctus*			
225.	24973	*Nephrurus wheeleri subsp. wheeleri*			
Caryophyllaceae					
226.	12075	*Polycarpaea corymbosa var. corymbosa*			
227.	2901	*Polycarpaea holtzei*			
228.	2903	*Polycarpaea longiflora*			
Casuariidae					
229.	24470	*Dromaius novaehollandiae (Emu)*			
Celastraceae					
230.	18405	*Stackhousia sp. swollen gynophore (W.R. Barker 2041)*			
Centropodidae					
231.	25600	*Centropus phasianinus (Pheasant Coucal)*			
Centropyxidae					
232.		*Centropyxis sp.*			
Ceratopogonidae					
233.		*Alluaudomyia sp.*			
234.		*Atrichopogon sp. P1 (PSW)*			
235.		*Bezzia sp. 2 (SAP)*			
236.		*Bezzia sp. P1 (PSW)*			
237.		*Bezzia sp. P2 (PSW)*			
238.		*Culicoides sp.*			
239.		*Culicoides sp. P1 (PSW)*			
240.		*Dasyheleinae sp. P1 (PSW)*			
241.		*Dasyheleinae sp. P2 (PSW)*			
242.		*Lanatomyia sp.*			
243.		*Monohelea sp. P1 (PSW)*			
244.		*Nilobezzia sp.*			
245.		*Nilobezzia sp. P1 (PSW)*			
246.		*Nilobezzia sp. P2 (PSW)*			
Charadriidae					
247.	24373	*Charadrius melanops (Black-fronted Dotterel)*			
248.	24386	*Vanellus tricolor (Banded Lapwing)*			
Chenopodiaceae					
249.	11632	*Dysphania glomulifera subsp. eremaea*			
250.	2544	*Maireana georgei (Satiny Bluebush)*			
251.	2551	*Maireana melanocoma (Pussy Bluebush)*			
252.	2604	*Sclerolaena costata*			

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253.	2607	*Sclerolaena densiflora*			
254.	2611	*Sclerolaena eriacantha (Tall Bindii)*			
255.	33220	*Tecticornia pterygosperma subsp. denticulata*			
Chironomidae					
256.		*Ablabesmyia hilli*			
257.		*Ablabesmyia notabilis*			
258.		*Chironomini genus K2 sp. 1*			
259.		*Chironomus aff. alternans (V24) (CB)*			
260.		*Cladopelma curtivalva*			
261.		*Cladotanytarsus aff K4 (PSW)*			
262.		*Clinotanypus crux*			
263.		*Coelopynia pruinosa*			
264.		*Cryptochironomus griseidorsum*			
265.		*Dicrotendipes 'CA1' Pilbara type 3 (= 'K4', P3)) (PSW)*			
266.		*Dicrotendipes 'CA1' Pilbara type 1 (was lindae) (PSW)*			
267.		*Dicrotendipes conjunctus*			
268.		*Dicrotendipes jobetus*			
269.		*Fittkauimyia disparipes*			
270.		*Harrisius sp.*			
271.		*Kiefferulus intertinctus*			
272.		*Kiefferulus tumidus*			
273.		*Larsia albiceps*			
274.		*Microchironomus 'K1' (PSW)*			
275.		*Nanocladius sp. 1 (VCD7)*			
276.		*Orthocladiinae SO3 sp.*			
277.		*Orthocladiinae sp. G (SAP)*			
278.		*Parachironomus 'K1' (PSW)*			
279.		*Parachironomus 'K2' (PSW)*			
280.		*Parachironomus sp. 1 (VSCL35) (SAP)*			
281.		*Paramerina sp.A (parva?) (SAP)*			
282.		*Paratanytarsus sp. P3 (PSW)*			
283.		*Paratendipes sp. 'K1' (PSW)*			
284.		*Pentaneurini sp. P1 (PSW)*			
285.		*Polypedilum leei*			
286.		*Polypedilum nr. convexum (PSW)*			
287.		*Polypedilum nubifer*			
288.		*Polypedilum sp. S1 (PSW)*			
289.		*Polypedilum watsoni*			
290.		*Procladius Pilbara sp. 1 (PSW)*			
291.		*Procladius paludicola*			
292.		*Rheotanytarsus christinae*			
293.		*Rheotanytarsus juliae*			
294.		*Rheotanytarsus trivittatus*			
295.		*Skusella subvittata*			
296.		*Stenochironomus cf watsoni*			
297.		*Tanytarsus 'K12' (PSW)*			
298.		*Tanytarsus fuscithorax/semibarbitarsus*			
299.		*Tanytarsus sp. D (SAP)*			
300.		*Tanytarsus sp. H (SAP)*			
301.		*Tanytarsus sp. P1 (PSW)*			
302.		*Tanytarsus sp. P2 (PSW)*			
303.		*Tanytarsus sp. P5 (PSW)*			
304.		*Tanytarsus sp. P7 (PSW)*			
305.		*Tanytarsus sp. P9 (PSW)*			
306.		*Thienemanniella sp. P1 (PSW)*			
Chrysomelidae					
307.		*Chrysomelidae sp.*			
Chthoniidae					
308.		*Lagynochthonius asema*			Y
309.		*Tyrannochthonius aridus*			
310.		*Tyrannochthonius basme*			Y
Chydoridae					
311.		*Alona rigidicaudis*			
312.		*Armatalona macrocopa*			
313.		*Chydorus eurynotus*			
314.		*Dunhevedia crassa*			
315.		*Ephemeroporus barroisi s.l.*			
316.		*Karualona karua*			

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317.		*Pseudomonospilus diporus*			
Cinclosomatidae					
318.	24390	*Psophodes occidentalis (Western Wedgebill, Chiming Wedgebill)*			
Cirolanidae					
319.		*Haptolana sp.*			
320.		*Haptolana sp. nov. 1 (PSS)*			
321.		*Speocirolana sp.*			
322.		*Speocirolana? sp. nov. 1 (PSS)*			
Cleomaceae					
323.	2988	*Cleome viscosa (Tickweed, Tjinduwadhu)*			
Clupeidae					
324.		*Nematalosa erebi*			
Coenagrionidae					
325.		*Agriocnemis kunjina*			
326.		*Argiocnemis rubescens*			
327.		*Austroagrion pindrina/Ischnura heterosticta*			
328.		*Coenagrionidae sp.*			
329.		*Ischnura aurora aurora*			
330.		*Ischnura heterosticta heterosticta*			
331.		*Pseudagrion aureofrons*			
332.		*Pseudagrion microcephalum*			
Columbidae					
333.	24399	*Columba livia (Domestic Pigeon)*	Y		
334.	24401	*Geopelia cuneata (Diamond Dove)*			
335.	25585	*Geopelia striata (Zebra Dove)*			
336.	24403	*Geopelia striata subsp. placida (Peaceful Dove)*			
337.	24404	*Geophaps plumifera (Spinifex Pigeon)*			
338.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
339.	24409	*Phaps chalcoptera (Common Bronzewing)*			
340.	24411	*Phaps histrionica (Flock Bronzewing, Flock Pigeon)*			
Combretaceae					
341.	5300	*Terminalia canescens (Joolal)*			
342.	5313	*Terminalia supranitifolia*		P3	
Conochilidae					
343.		*Conochilus natans*			
Convolvulaceae					
344.	6608	*Bonamia pannosa*			
345.	44782	*Bonamia pilbarensis*			
346.	6633	*Ipomoea muelleri (Poison Morning Glory, Yumbu)*			
347.	11312	*Ipomoea pes-caprae subsp. brasiliensis*			
348.	6637	*Ipomoea polymorpha*			
Copepoda					
349.		*Calanoida sp.*			
350.		*Harpacticoida sp*			
351.		*Harpacticoida sp. 2 (SAP)*			
Corinnidae					
352.		*Supunna picta?*			Y
Corixidae					
353.		*Micronecta adelaidae (ex P4)*			
354.		*Micronecta annae illiesi*			
355.		*Micronecta annae s.l.*			
356.		*Micronecta nsp. P1 (PSW)*			
357.		*Micronecta nsp. P3 (PSW)*			
358.		*Micronecta sp.*			
Corvidae					
359.	24416	*Corvus bennetti (Little Crow)*			
360.	25593	*Corvus orru (Torresian Crow)*			
361.	24418	*Corvus orru subsp. cecilae (Western Crow)*			
Cracticidae					
362.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
363.	25595	*Cracticus tibicen (Australian Magpie)*			
364.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
365.	24424	*Cracticus torquatus subsp. torquatus (Grey Butcherbird)*			

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Cuculidae					
366.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
367.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
Cucurbitaceae					
368.	7369	*Citrullus colocynthis*	Y		
369.	41721	*Cucumis variabilis*			
370.	7381	*Trichosanthes cucumerina*			
Culicidae					
371.		*Anopheles annulipes s.l.*			
372.		*Culex (Culex) bitaeniorhynchus*			
373.		*Culex ?palpalis (SAP)*			
374.		*Culex nr. crinicauda (PSW)*			
375.		*Culex sp.*			
376.		*Culex starkae*			
Cyclopidae					
377.		*Apocyclops dengizicus*			
378.		*Australoeucyclops karaytugi*			
379.		*Diacyclops humphreysi s. str X unispinosus*			
380.		*Ectocyclops rubrescens*			
381.		*Eucyclops australiensis*			
382.		*Eucyclops nr australiensis*			
383.		*Halicyclops (Rochacyclops) calm*			
384.		*Halicyclops (Rochacyclops) roachi*			
385.		*Mesocyclops brooksi*			
386.		*Mesocyclops darwini*			
387.		*Mesocyclops notius*			
388.		*Microcyclops varicans*			
389.		*Orbuscyclops westaustraliensis*			
390.		*Paracyclops sp. 5 (SAP)*			
391.		*Paracyclops sp. 6 (PSW)*			
392.		*Paracyclops sp. 8 (PSW)*			
Cyperaceae					
393.	750	*Bulbostylis barbata*			
394.	774	*Cyperus bifax (Downs Nutgrass)*			
395.	786	*Cyperus cunninghamii*			
396.	12811	*Cyperus cunninghamii subsp. cunninghamii*			
397.	788	*Cyperus dactylotes*			
398.	789	*Cyperus difformis (Rice Sedge)*			
399.	12808	*Cyperus hesperius*			
400.	798	*Cyperus iria*			
401.	799	*Cyperus ixiocarpus*			
402.	810	*Cyperus rotundus (Nut Grass)*	Y		
403.	814	*Cyperus squarrosus*			
404.	818	*Cyperus vaginatus (Stiffleaf Sedge)*			
405.	823	*Eleocharis atropurpurea*			
406.	826	*Eleocharis dulcis (Chinese Water Chestnut)*			
407.	827	*Eleocharis geniculata*			
408.	831	*Eleocharis sphacelata (Tall Spikerush, Djabren)*			
409.	851	*Fimbristylis dichotoma (Eight Day Grass)*			
410.	862	*Fimbristylis microcarya*			
411.	12159	*Fimbristylis simulans*			
412.	963	*Schoenoplectus laevis*			
413.	964	*Schoenoplectus lateriflorus*			
414.	16257	*Schoenoplectus subulatus*			
Cypridae					
415.		*Cypretta seurati*			
416.		*Cypretta sp PSW074*			
417.		*Cypretta sp. BOS080*			
418.		*Cypretta sp. PSW018 (PSW)*			
419.		*Ilyodromus sp BOS25*			
420.		*Ilyodromus sp.*			
421.		*Ilyodromus sp. PB*			
422.		*Isocypris williamsi (ex Ilyodromus sp. 413)*			
423.		*Stenocypris major*			
Cypridopsidae					
424.		*Cypridopsis sp.*			

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Daphniidae					
425.		*Simocephalus heilongjiangensis*			
Darwinulidae					
426.		*Darwinula stevensoni*			
427.		*Penthesilenula brasiliensis*			
428.		*Vestalenula marmonieri*			
429.		*Vestalenula matildae*			
Dasyuridae					
430.	30903	*Dasycercus blythi (Brush-tailed Mulgara, Ampurta)*		P4	
431.	24091	*Dasykaluta rosamondae (Little Red Kaluta)*			
432.	24093	*Dasyurus hallucatus (Northern Quoll)*		T	
433.	24094	*Ningaui ridei (Wongai Ningaui)*			
434.	24095	*Ningaui timealeyi (Pilbara Ningaui)*			
435.	24101	*Planigale ingrami (Long-tailed Planigale)*			
436.	24102	*Planigale maculata (Common Planigale)*			
437.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
438.	24116	*Sminthopsis macroura (Stripe-faced Dunnart)*			
439.	24120	*Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)*			
Diaptomidae					
440.		*Eudiaptomus lumholtzi*			
Diatom Family					
441.		*Achnanthes exigua Grun.*			
442.		*Achnanthes exilis Kütz.*			
443.		*Achnanthidium minutissima (Kütz.) Czarnecki*			
444.		*Achnanthidium minutissima var. affinis (grun.) lange-bertalot*			
445.		*Amphora coffeaeformis (Ag.) Kütz.*			
446.		*Amphora pediculus (Kütz.) Grun.*			
447.		*Amphora veneta Kütz.*			
448.		*Anomoeoneis sphaerophora (Ehr.) Pfitzer*			
449.		*Anomoeoneis styriaca (Grun.) Hust.*			
450.		*Caloneis bacillum (Grun.) Cl.*			
451.		*Caloneis molaris (Grun.) Krammer*			
452.		*Caloneis silicula (Ehr.) Cl.*			
453.		*Craticula cuspidata (Grun. ex. Van Heurck) Mann*			
454.		*Cylotella menghiniana Kütz.*			
455.		*Cymbella affinis Kütz.*			
456.		*Cymbella aspera (Ehr.) Cl.*			
457.		*Cymbella cistula (Ehr.) Kirchner*			
458.		*Cymbella cymbiformis Ag.*			
459.		*Cymbella delicatula Kütz.*			
460.		*Cymbella falaisensis (Grun.) Krammer & Lange-Bertalot*			
461.		*Cymbella helvetica Kütz.*			Y
462.		*Cymbella microcephala Grun.*			
463.		*Cymbella silesiaca Bleisch*			
464.		*Diploneis elliptica (Kütz.) Cl.*			
465.		*Diploneis pseudovalis Hust.*			
466.		*Encyonema minutum (Hilse ex Rabh.) Mann*			
467.		*Epithemia smithii Carruthers*			
468.		*Eunotia bilunaris (Ehr.) Mills.*			
469.		*Fragilaria capucina Desm.*			
470.		*Fragilaria tenera (W. Sm.) Lange-Bertalot*			
471.		*Fragilaria ulna (Nitz.) Lange Bertalot*			
472.		*Gomphonema clevei Fricke*			
473.		*Gomphonema parvulum (Kütz.) Kütz.*			
474.		*Hantzschia amphioxys (Ehr.) Grun.*			
475.		*Hantzschia marina (Donk.) Cl.*			
476.		*Luticola mutica (Kütz.) Mann*			
477.		*Mastogloia elliptica (Ag.) Cl.*			
478.		*Mastogloia elliptica var. danseii (thwaites) grun.*			
479.		*Mastogloia smithii Thwaites*			
480.		*Navicula bryophila Petersen*			
481.		*Navicula cincta (Ehr.) Ralfs.*			
482.		*Navicula cryptocephala Kütz.*			
483.		*Navicula cryptonella Lange-Bertalot*			
484.		*Navicula erifuga Lange-Bertalot*			
485.		*Navicula kotschyi Grun.*			Y
486.		*Navicula leptostriata Jørgensen*			
487.		*Navicula subrhynchocephala Hust.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
488.		*Navicula tripunctata (O.F. Muller) Bory*			Y
489.		*Navicula veneta Kütz.*			
490.		*Nitzschia amphibia Grun.*			
491.		*Nitzschia angustata Grun.*			
492.		*Nitzschia dissipata (Kütz.) Grun.*			
493.		*Nitzschia filiformis (W. Sm.) Van Heurck*			
494.		*Nitzschia frustulum (Kütz.) Grun.*			
495.		*Nitzschia microcephala Grun.*			
496.		*Nitzschia obtusa W. Sm*			
497.		*Nitzschia palea (Kütz.) W. Sm.*			
498.		*Nitzschia sigma (Kütz.) W. Sm.*			
499.		*Pinnularia divergens W. Sm.*			
500.		*Pinnularia gibba Ehr.*			
501.		*Pinnularia subcapitata Greg.*			
502.		*Pinnularia subrostrata (A. Cl.) Cl.-Euler*			
503.		*Pleurosigma delicatulum W. Sm.*			
504.		*Rhopalodia gibberula (Ehr.) O. Müll.*			
505.		*Sellephora pupula (Kütz) Mereschkowsky*			
Dicaeidae					
506.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
Dicruridae					
507.	24443	*Grallina cyanoleuca (Magpie-lark)*			
508.	25613	*Rhipidura fuliginosa (Grey Fantail)*			
509.	24452	*Rhipidura fuliginosa subsp. preissi (Grey Fantail)*			
510.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
511.	24454	*Rhipidura leucophrys subsp. leucophrys (Willie Wagtail)*			
Difflugiidae					
512.		*Difflugia ampulla*			
513.		*Difflugia sp. P1*			
514.		*Difflugia sp. P2*			
Diosaccidae					
515.		*Schizopera roberiverensis*			
Diplodactylidae					
516.	24919	*Crenadactylus ocellatus subsp. horni (Clawless Gecko)*			
517.	24926	*Diplodactylus conspicillatus (Fat-tailed Gecko)*			
518.	41404	*Diplodactylus galaxias (Northern Pilbara Beak-faced Gecko)*			
519.	24937	*Diplodactylus mitchelli*			
520.	24944	*Diplodactylus savagei (Southern Pilbara Beak-faced Gecko)*			
521.	30933	*Lucasium stenodactylum*			
522.	30934	*Lucasium wombeyi*			
523.	24976	*Oedura marmorata (Marbled Velvet Gecko)*			
524.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
525.	25517	*Strophurus ciliaris*			
526.	24927	*Strophurus elderi*			
527.	24949	*Strophurus wellingtonae*			
Diplopoda					
528.		*Diplopoda sp.*			
Dolichopodidae					
529.		*Dolichopodidae sp.*			
530.		*Dolichopodidae sp. A (SAP)*			
Droseraceae					
531.	43544	*Drosera finlaysoniana*			
Dytiscidae					
532.		*Allodessus bistrigatus*			
533.		*Antiporus bakewelli*			
534.		*Bidessini sp.*			
535.		*Boongurrus occidentalis*			
536.		*Copelatus nigrolineatus*			
537.		*Cybister tripunctatus*			
538.		*Hydaticus consanguineus*			
539.		*Hydroglyphus grammopterus (=trilineatus)*			
540.		*Hydroglyphus leai*			
541.		*Hydroglyphus orthogrammus*			
542.		*Hydrovatus sp.*			
543.		*Hydrovatus weiri*			
544.		*Hyphydrus elegans*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
545.		*Hyphydrus lyratus*			
546.		*Laccophilus sharpi*			
547.		*Limbodessus compactus*			
548.		*Necterosoma regulare*			
549.		*Onychohydrus atratus*			
550.		*Platynectes decempunctatus var decempunctatus*			
551.		*Sternopriscus pilbarensis*			
552.		*Tiporus lachlani*			
553.		*Tiporus sp.*			
554.		*Tiporus tambreyi*			
Ecnomidae					
555.		*Ecnomus pilbarensis*			
Ectinosomatidae					
556.		*Pseudectinosoma galassiae*			
557.		*Pseudectinosoma sp.*			Y
Elapidae					
558.	25332	*Acanthophis wellsi (Pilbara Death Adder)*			
559.	25331	*Brachyurophis approximans (North-western Shovel-nosed Snake)*			
560.	25468	*Demansia psammophis (Yellow-faced Whipsnake)*			
561.	25295	*Demansia psammophis subsp. cupreiceps (Yellow-faced Whipsnake)*			
562.	25247	*Demansia psammophis subsp. psammophis (Yellow-faced Whipsnake)*			
563.	25297	*Demansia rufescens (Rufous Whipsnake)*			
564.	25301	*Furina ornata (Moon Snake)*			
565.	25254	*Parasuta monachus*			
566.	25261	*Pseudechis australis (Mulga Snake)*			
567.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
568.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
569.	25264	*Pseudonaja nuchalis (Gwardar, Northern Brown Snake)*			
570.	25305	*Simoselaps anomalus (Desert Banded Snake)*			
571.	25269	*Suta fasciata (Rosen's Snake)*			
572.	25307	*Suta punctata (Spotted Snake)*			
Elmidae					
573.		*Austrolimnius WA sp. 2 (= adult sp WA 2) (PSW)*			
574.		*Austrolimnius WA sp. 3 (larvae only) (PSW)*			
575.		*Elmidae sp. 1*			Y
576.		*Elmidae sp. 2*			Y
Elopidae					
577.		*Elops hawaiensis*			
Emballonuridae					
578.	24174	*Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat)*			
579.	24175	*Taphozous georgianus (Common Sheathtail-bat)*			
Enchytraeidae					
580.		*Enchytraeus Pilbara sp. 1 (PSS)*			
581.		*Enchytraeus Pilbara sp. 2 (PSS)*			
Ephydridae					
582.		*Ephydridae sp. 2 (SAP)*			
Equidae					
583.	24257	*Equus asinus (Donkey)*	Y		
Estrilidae					
584.	24631	*Emblema pictum (Painted Finch)*			
585.	25685	*Neochmia ruficauda (Star Finch)*			
586.	24639	*Neochmia ruficauda subsp. clarescens (Star Finch)*			
587.	30870	*Taeniopygia guttata (Zebra Finch)*			
588.	30871	*Taeniopygia guttata subsp. castanotis (Zebra Finch)*			
Euchlanidae					
589.		*Euchlanis dilatata*			
590.		*Euchlanis incisa*			
591.		*Euchlanis oropha*			
Euglyphiidae					
592.		*Euglypha sp.*			
Euphorbiaceae					
593.	17422	*Adriana tomentosa var. tomentosa*			
594.	4617	*Euphorbia australis (Namana)*			
595.	35303	*Euphorbia australis var. subtomentosa*			

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596.	4620	*Euphorbia boophthona (Gascoyne Spurge)*			
597.	9048	*Euphorbia careyi*			
598.	4629	*Euphorbia hirta (Asthma Plant)*	Y		
599.	4647	*Euphorbia tannensis*			
600.	12097	*Euphorbia tannensis subsp. eremophila (Desert Spurge)*			
601.	42879	*Euphorbia trigonosperma*			
602.	42877	*Euphorbia vaccaria var. erucoides*			
603.	42876	*Euphorbia vaccaria var. vaccaria*			
604.	4650	*Euphorbia wheeleri*			
Fabaceae					
605.	3209	*Acacia ampliceps*			
606.	44586	*Acacia ampliceps x sclerosperma subsp. sclerosperma*			
607.	3214	*Acacia ancistrocarpa (Fitzroy Wattle)*			
608.	37260	*Acacia aptaneura*			
609.	3223	*Acacia arida*			
610.	3228	*Acacia atkinsiana*			
611.	3241	*Acacia bivenosa*			
612.	3260	*Acacia citrinoviridis*			
613.	17013	*Acacia colei var. colei*			
614.	17014	*Acacia colei var. ileocarpa*			
615.	3300	*Acacia dictyophleba (Sandhill Wattle, Ngarkalya)*			
616.	16174	*Acacia elachantha*			
617.	3360	*Acacia hamersleyensis*			
618.	3377	*Acacia inaequilatera (Baderi)*			
619.	3419	*Acacia ligulata (Umbrella Bush, Watarka)*			
620.	3471	*Acacia orthocarpa (Needleleaf Wattle)*			
621.	3501	*Acacia ptychophylla*			
622.	29016	*Acacia pyrifolia var. morrisonii*			
623.	29015	*Acacia pyrifolia var. pyrifolia*			
624.	13078	*Acacia sclerosperma subsp. sclerosperma*			
625.	29135	*Acacia sericophylla*			
626.	3553	*Acacia spondylophylla*			
627.	13070	*Acacia synchronicia*			
628.	3577	*Acacia tetragonophylla (Kurara, Wakalpuka)*			
629.	3579	*Acacia trachycarpa (Minni Ritchi, Balgali)*			
630.	23521	*Acacia trudgeniana*			
631.	20319	*Acacia tumida var. pilbarensis*			
632.	3598	*Acacia wanyu*			
633.	3606	*Acacia xiphophylla*			
634.	3680	*Aeschynomene indica (Budda Pea)*			
635.	17147	*Alysicarpus muelleri*			
636.	11055	*Cajanus cinereus*			
637.	11150	*Cajanus pubescens*			
638.	3783	*Crotalaria medicaginea*			
639.	11231	*Crotalaria novae-hollandiae subsp. novae-hollandiae*			
640.	17439	*Cullen lachnostachys*			
641.	17118	*Cullen leucanthum*			
642.	17119	*Cullen leucochaites*			
643.	17120	*Cullen pogonocarpum*			
644.	3871	*Erythrina vespertilio (Yulbah)*			
645.	17113	*Indigofera boviperda subsp. boviperda*			
646.	3973	*Indigofera colutea (Sticky Indigo)*			
647.	3974	*Indigofera georgei (Bovine Indigo)*			
648.	3980	*Indigofera linifolia*			
649.	3982	*Indigofera monophylla*			
650.	3985	*Indigofera rugosa*			
651.	20317	*Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)*		P3	
652.	41782	*Indigofera sp. Fractiflexa (S. van Leeuwen 3773)*			
653.	3987	*Indigofera trita*			
654.	3989	*Isotropis atropurpurea (Poison Sage)*			
655.	4061	*Lotus cruentus (Redflower Lotus)*			
656.	3675	*Petalostylis labicheoides (Slender Petalostylis)*			
657.	20862	*Rhynchosia bungarensis*		P4	
658.	4191	*Rhynchosia minima (Rhynchosia)*			
659.	12280	*Senna artemisioides subsp. oligophylla*			
660.	12305	*Senna glutinosa subsp. chatelainiana*			
661.	12307	*Senna glutinosa subsp. glutinosa*			
662.	12309	*Senna glutinosa subsp. pruinosa*			
663.	12308	*Senna glutinosa subsp. x luerssenii*			
664.	12312	*Senna notabilis*			

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665.	12319	*Senna venusta*			
666.	4198	*Sesbania formosa (White Dragon Tree)*			
667.	13596	*Swainsona complanata*			
668.	12356	*Swainsona formosa*			
669.	4234	*Swainsona maccullochiana (Ashburton Pea)*			
670.	4280	*Tephrosia rosea (Flinders River Poison, Bungoo'dah)*			
671.	41825	*Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)*			
672.	15947	*Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)*			
673.	17768	*Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)*			
674.	41811	*Tephrosia sp. Fortescue (A.A. Mitchell 606)*			
675.	42442	*Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)*			
676.	40060	*Tephrosia sp. clay soils (S. van Leeuwen et al. PBS 0273)*			
677.	4285	*Tephrosia supina*			
678.	4286	*Tephrosia uniovulata*			
679.	4287	*Tephrosia virens*			
680.	4323	*Vigna lanceolata (Maloga Vigna, Wega)*			
681.	11576	*Vigna lanceolata var. lanceolata*			
Falconidae					
682.	25621	*Falco berigora (Brown Falcon)*			
683.	24471	*Falco berigora subsp. berigora (Brown Falcon)*			
684.	25622	*Falco cenchroides (Australian Kestrel)*			
685.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel)*			
686.	25623	*Falco longipennis (Australian Hobby)*			
Felidae					
687.	24041	*Felis catus (Cat)*	Y		
Floscullariacea					
688.		*Floscullariacea sp.*			
Floscullariidae					
689.		*Lacinularia cf. elliptica*			Y
Frankeniaceae					
690.	5188	*Frankenia ambita*			
Gekkonidae					
691.	24956	*Gehyra pilbara*			
692.	24958	*Gehyra punctata*			
693.	24959	*Gehyra variegata*			
694.	25232	*Hemidactylus frenatus (Asian House Gecko)*	Y		
695.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
696.	24962	*Heteronotia spelea (Desert Cave Gecko)*			
Gelastocoridae					
697.		*Nerthra luteovaria*			
Gentianaceae					
698.	41646	*Schenkia clementii*			
Gerridae					
699.		*Gerridae sp.*			
700.		*Limnogonus fossarum gilguy*			
701.		*Limnogonus luctuosus*			
702.		*Limnogonus sp.*			
703.		*Rhagadotarsus anomalus*			
Glareolidae					
704.	24481	*Glareola maldivarum (Oriental Pratincole)*		IA	
Gomphidae					
705.		*Austroepigomphus (Xerogomphus) gordoni*			
Goodeniaceae					
706.	7424	*Dampiera candicans*			
707.	7490	*Goodenia armitiana*			
708.	7509	*Goodenia forrestii*			
709.	7521	*Goodenia lamprosperma*			
710.	7526	*Goodenia microptera*			
711.	12552	*Goodenia muelleriana*			
712.	7530	*Goodenia nuda*		P4	
713.	7544	*Goodenia ramelii*			
714.	10982	*Goodenia stobbsiana*			
715.	7556	*Goodenia tenuiloba*			
716.	7644	*Scaevola spinescens (Currant Bush, Maroon)*			

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717.	7654	*Velleia connata (Cup Velleia)*			
718.	7658	*Velleia discophora (Cabbage Poison)*			
Hadziidae					
719.	33954	*Nedsia hurlberti (amphipod)*		T	
720.		*Nedsia nr sp. 24 (PSS)*			
721.	33957	*Nedsia sculptilis (amphipod)*		T	
722.		*Nedsia sp. 4 (PSS)*			
Halcyonidae					
723.	25547	*Dacelo leachii (Blue-winged Kookaburra)*			
724.	24304	*Dacelo leachii subsp. leachii (Blue-winged Kookaburra)*			
725.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
726.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
Haliplidae					
727.		*Haliplus halsei*			
728.		*Haliplus pilbarensis*			
729.		*Haliplus pinderi*			
Haloragaceae					
730.	23464	*Haloragis gossei var. inflata*			
731.	6201	*Myriophyllum verrucosum (Red Water Milfoil)*			
Hebridae					
732.		*Hebrus axillaris*			
733.		*Merragata hackeri*			
Hemicorduliidae					
734.		*Hemicordulia intermedia*			
735.		*Hemicordulia koomina*			
736.		*Hemicordulia sp.*			
Hersiliidae					
737.		*Tamopsis occidentalis*			
Hipposideridae					
738.	43368	*Rhinonicteris aurantia (Orange Leafnosed-bat)*		T	
Hirudinea					
739.		*Hirudinea sp.*			
Hirundinidae					
740.	24488	*Cheramoeca leucosternus (White-backed Swallow)*			
741.	24489	*Hirundo ariel (Fairy Martin)*			
742.	24491	*Hirundo neoxena (Welcome Swallow)*			
743.	25629	*Hirundo nigricans (Tree Martin)*			
Hubbardiidae					
744.	34152	*Draculoides mesozeirus (Middle Robe Draculoides)*		T	Y
745.	34153	*Paradraculoides anachoretus (Mesa A Paradraculoides)*		T	Y
746.	34154	*Paradraculoides bythius (Mesa B Paradraculoides)*		T	Y
747.	34155	*Paradraculoides gnophicola (Mesa G Paradraculoides)*		T	Y
748.	35956	*Paradraculoides kryptus (Mesa K Paradraculoides)*		T	Y
Hydrachnidae					
749.		*Hydrachna sp. 3 (PSW)*			
750.		*Hydrachna sp. 4/5 (PSW)*			
Hydraenidae					
751.		*Hydraena barbipes*			
752.		*Hydraena nr. rudallensis (PSW)*			
753.		*Limnebius sp.*			
754.		*Ochthebius sp. P1 (PSW)*			
755.		*Ochthebius sp. P2 (PSW)*			
Hydridae					
756.		*Hydra sp.*			
Hydrobiidae					
757.		*Hydrobiidae sp.*			
Hydrocharitaceae					
758.	138	*Najas marina (Prickly Water Nymph)*			
759.	139	*Najas tenuifolia (Water Nymph)*			
760.	17868	*Vallisneria nana*			
Hydrochidae					
761.		*Hydrochus eurypleuron*			

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762.		*Hydrochus interioris*			
763.		*Hydrochus lateviridus*			
764.		*Hydrochus obscuroaeneus*			
765.		*Hydrochus sp.*			
766.		*Hydrochus sp. P1 (PSW)*			
Hydrodromidae					
767.		*Hydrodroma sp.*			
Hydrophilidae					
768.		*Berosus dallasi*			
769.		*Berosus pulchellus*			
770.		*Berosus sp.*			
771.		*Cercyon sp.*			
772.		*Chaetarthria nigerrimus*			
773.		*Coelostoma fabricii*			
774.		*Enochrus deserticola*			
775.		*Georissus sp.*			
776.		*Helochares tatei*			
777.		*Paracymus pygmaeus*			
778.		*Paracymus spenceri*			
779.		*Paranacaena horni*			
780.		*Regimbartia attenuata*			
781.		*Sternolophus marginicollis*			
782.		*Sternolophus sp.*			
Hydropsychidae					
783.		*Cheumatopsyche wellsae*			
Hydroptilidae					
784.		*Hellyethira sp.*			
785.		*Orthotrichia sp.*			
Hydryphantidae					
786.		*Pseudohydryphantes sp. P1 (PSW)*			
Hygrobatidae					
787.		*Aspidiobates pilbara*			
788.		*Australiobates queenslandensis*			
789.		*Coaustraliobates longipalpis*			
790.		*Coaustraliobates minor*			
Hylidae					
791.	25375	*Cyclorana maini (Sheep Frog)*			
792.	25392	*Litoria rubella (Little Red Tree Frog)*			
Hyriidae					
793.		*Velesunio wilsoni*			
Ilyocryptidae					
794.		*Ilyocryptus raridentatus*			
Isopoda					
795.		*Oniscidea sp.*			
Isostictidae					
796.		*Eurysticta coolawanyah*			
Lamiaceae					
797.	6830	*Basilicum polystachyon*			
798.	13692	*Clerodendrum floribundum var. angustifolium*			
799.	13691	*Clerodendrum floribundum var. ovatum*			
800.	6907	*Ocimum basilicum (Basil)*	Y		
Lamponidae					
801.		*Asadipus barlee*			
802.		*Asadipus kunderang*			
803.		*Asadipus yundamindra*			
804.		*Bigenditia zuytdorp*			
805.		*Lampona ampeinna*			
806.		*Lampona quinqueplagiata*			
807.		*Lampona scutata*			Y
808.		*Notsodipus barlee*			
809.		*Notsodipus meedo*			
Lauraceae					
810.	2949	*Cassytha capillaris*			

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Lecanidae					
811.		*Lecane aculeata*			
812.		*Lecane batillifer*			
813.		*Lecane bulla*			
814.		*Lecane closterocerca*			
815.		*Lecane crepida*			
816.		*Lecane hamata*			
817.		*Lecane hornemanni*			
818.		*Lecane ludwigii*			
819.		*Lecane luna*			
820.		*Lecane lunaris*			
821.		*Lecane obtusa*			
822.		*Lecane papuana*			
823.		*Lecane quadridentata*			
824.		*Lecane signifera*			
825.		*Lecane stenroosi*			
826.		*Lecane thalera*			
827.		*Lecane unguitata*			
Lentibulariaceae					
828.	7125	*Utricularia australis*			
Lepadellidae					
829.		*Colurella sp.*			
830.		*Lepadella (H.) ehrenbergii*			
831.		*Lepadella (H.) heterostyla*			
832.		*Lepadella ovalis*			
833.		*Lepadella patella*			
834.		*Lepadella triptera*			
Leporidae					
835.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
Leptoceridae					
836.		*Leptocerus atsou*			
837.		*Leptocerus sp. AV2 (atsou?) (PSW)*			
838.		*Oecetis sp.*			
839.		*Oecetis sp. Pilbara 4 (PSW)*			
840.		*Oecetis sp. Pilbara 5 (PSW)*			
841.		*Triplectides australis*			
842.		*Triplectides ciuskus seductus*			
843.		*Triplectides parvus*			
Lesquereusidae					
844.		*Lesquereusia spiralis*			
Libellulidae					
845.		*Diplacodes bipunctata*			
846.		*Diplacodes haematodes*			
847.		*Diplacodes sp.*			
848.		*Orthetrum caledonicum*			
849.		*Zyxomma elgneri*			
Limnesiidae					
850.		*Limnesia maceripalpis*			
851.		*Limnesia parasolida*			
852.		*Limnesia sp. 4 (PSW)*			
Limnichidae					
853.		*Limnichidae sp. P1*			
Limnocytheridae					
854.		*Gomphodella 'hirsuta' (PSS)*			
855.		*Limnocythere dorsosicula*			
Lindeniidae					
856.		*Ictinogomphus dobsoni*			
Loranthaceae					
857.	13700	*Amyema bifurcata*			
858.	2385	*Amyema sanguinea*			
859.	2396	*Lysiana casuarinae*			
Lutjanidae					
860.		*Lutjanus carponotatus*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Lycosidae					
861.		*Hoggicosa castanea*			
862.		*Hogna crispipes*			
Lymnaeidae					
863.		*Austropeplea vinosa*			
Lythraceae					
864.	5276	*Ammannia auriculata*			
865.	5277	*Ammannia baccifera*			
866.	5285	*Rotala diandra*			
867.	5286	*Rotala mexicana*			
Macropodidae					
868.	25489	*Macropus robustus (Euro)*			
869.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
870.	24136	*Macropus rufus (Red Kangaroo, Marlu)*			
871.	24144	*Petrogale rothschildi (Rothschild's Rock-wallaby)*			
Maluridae					
872.	25647	*Amytornis striatus (Striated Grasswren)*			
873.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
874.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
875.	25656	*Stipiturus ruficeps (Rufous-crowned Emu-wren)*			
876.	24556	*Stipiturus ruficeps subsp. ruficeps (Rufous-crowned Emu-wren)*			
Malvaceae					
877.	4891	*Abutilon fraseri (Lantern Bush)*			
878.	16919	*Abutilon hannii*			
879.	4895	*Abutilon lepidum*			
880.	4898	*Abutilon macrum*			
881.	4901	*Abutilon otocarpum (Desert Chinese Lantern)*			
882.	4902	*Abutilon oxycarpum (Flannel Weed)*			
883.	42920	*Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)*			
884.	14113	*Abutilon sp. Pilbara (W.R. Barker 2025)*			
885.	13659	*Corchorus laniflorus*			
886.	18408	*Corchorus lasiocarpus subsp. parvus*			
887.	4862	*Corchorus parviflorus*			
888.	4864	*Corchorus sidoides (Flannel Weed)*			
889.	18415	*Corchorus sidoides subsp. sidoides*			
890.	18414	*Corchorus sidoides subsp. vermicularis*			
891.	20242	*Corchorus sp. Hamersley Range hilltops (S. van Leeuwen 3826)*			
892.	17661	*Corchorus tectus*			
893.	4865	*Corchorus tridens*			
894.	4910	*Gossypium australe (Native Cotton)*			
895.	4918	*Gossypium robinsonii (Wild Cotton)*			
896.	29317	*Hibiscus austrinus var. austrinus*			
897.	4925	*Hibiscus coatesii*			
898.	4930	*Hibiscus goldsworthii*			
899.	4933	*Hibiscus leptocladus*			
900.	4941	*Hibiscus solanifolius*			
901.	11651	*Hibiscus sturtii var. campylochlamys*			
902.	11385	*Hibiscus sturtii var. grandiflorus*			
903.	11477	*Hibiscus sturtii var. platychlamys*			
904.	5024	*Keraudrenia nephrosperma*			
905.	5051	*Melhania oblongifolia*			
906.	5053	*Melochia pyramidata*	Y		
907.	31758	*Sida arsiniata*			
908.	4971	*Sida cardiophylla*			
909.	4972	*Sida clementii*			
910.	4976	*Sida echinocarpa*			
911.	4977	*Sida fibulifera (Silver Sida)*			
912.	4988	*Sida rohlenae*			
913.	18149	*Sida rohlenae subsp. rohlenae*			
914.	15227	*Sida sp. A Kimberley Flora (P.A. Fryxell & L.A. Craven 3900)*			
915.	33698	*Sida sp. Pilbara (A.A. Mitchell PRP 1543)*			
916.	16948	*Sida sp. verrucose glands (F.H. Mollemans 2423)*			
917.	4989	*Sida spinosa (Spiny Sida)*			
918.	4875	*Triumfetta chaetocarpa (Urchins)*			
919.	14694	*Triumfetta clementii*			
920.	4878	*Triumfetta johnstonii*			
921.	14942	*Triumfetta maconochieana*			
922.	5106	*Waltheria indica*			

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Marsileaceae					
923.	74	*Marsilea drummondii (Common Nardoo)*			
924.	76	*Marsilea hirsuta (Nardoo)*			
Megadermatidae					
925.	24180	*Macroderma gigas (Ghost Bat)*		P4	
Meliphagidae					
926.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
927.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
928.	24570	*Epthianura tricolor (Crimson Chat)*			
929.	25661	*Lichmera indistincta (Brown Honeyeater)*			
930.	24582	*Lichmera indistincta subsp. indistincta (Brown Honeyeater)*			
931.	24583	*Manorina flavigula (Yellow-throated Miner)*			
932.	25665	*Melithreptus gularis (Black-chinned Honeyeater)*			
933.	42310	*Sugomel niger (Black Honeyeater)*			
Melitidae					
934.		*Melitidae sp. 1 (PSS)*			
Menispermaceae					
935.	2942	*Tinospora smilacina (Snakevine, Oondala)*			
Meropidae					
936.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
Mesoveliidae					
937.		*Mesovelia hungerfordi*			
938.		*Mesovelia vittigera*			
Microcerberidae					
939.		*Microcerberidae sp.*			
Mideopsidae					
940.		*Gretacarus bifalcisetus*			
941.		*Gretacarus nsp. P1 (PSW)*			
942.		*Gretacarus sp.*			
943.		*Guineaxonopsis sp.*			
944.		*Guineaxonopsis sp. S1 (PSS)*			
Molluginaceae					
945.	2835	*Glinus lotoides (Hairy Carpet Weed)*			
946.	2836	*Glinus oppositifolius*			
947.	29851	*Mollugo molluginea*			
Molossidae					
948.	24181	*Chaerephon jobensis (Northern Freetail-bat)*			
949.	24185	*Tadarida australis (White-striped Freetail-bat)*			
Moraceae					
950.	31578	*Ficus aculeata var. indecora (Ranji)*			
951.	19648	*Ficus brachypoda*			
Motacillidae					
952.	25670	*Anthus australis (Australian Pipit)*			
Mugilidae					
953.		*Liza subviridis*			
954.		*Mugil cephalus*			
Muridae					
955.	24217	*Leggadina lakedownensis (Short-tailed Mouse, Karekanga)*		P4	
956.	24223	*Mus musculus (House Mouse)*	Y		
957.	24224	*Notomys alexis (Spinifex Hopping-mouse)*			
958.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
959.	24234	*Pseudomys delicatulus (Delicate Mouse)*			
960.	24235	*Pseudomys desertor (Desert Mouse)*			
961.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
962.	24248	*Zyzomys argurus (Common Rock-rat)*			
Myobatrachidae					
963.	25445	*Uperoleia russelli (Northwest Toadlet)*			
964.	41428	*Uperoleia saxatilis (Pilbara Toadlet)*			
Myrtaceae					
965.	16783	*Corymbia candida*			
966.	16782	*Corymbia candida subsp. candida*			
967.	16780	*Corymbia candida subsp. dipsodes*			

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968.	17077	*Corymbia ferriticola*			
969.	17093	*Corymbia hamersleyana*			
970.	17084	*Corymbia zygophylla*			
971.	5580	*Eucalyptus camaldulensis (River Gum, Yabalinyba)*			
972.	35345	*Eucalyptus camaldulensis subsp. obtusa (Blunt-budded River Red Gum)*			
973.	35343	*Eucalyptus camaldulensis subsp. refulgens*			
974.	18088	*Eucalyptus leucophloia subsp. leucophloia*			
975.	5875	*Melaleuca argentea (Silver Cadjeput, Bandaran)*			
976.	5879	*Melaleuca bracteata (River Teatree)*			
977.	5915	*Melaleuca glomerata*			
Mytilinidae					
978.		*Mytilina ventralis macracantha*			
NO FAMILY					
979.		*No invertebrates*			
Naididae					
980.		*Allonais pectinata*			
981.		*Allonais ranauana*			
982.		*Branchiura sowerbyi*			
983.		*Bratislavia unidentata*			Y
984.		*Dero digitata*			
985.		*Dero nivea*			
986.		*Pristina aequiseta*			
987.		*Pristina longiseta*			
988.		*Tubificidae stygo morphotype 2 (PSS)*			
989.		*Tubificidae stygo type 2A*			
990.		*Tubificidae stygo type 3*			Y
Nematoda					
991.		*Nematoda sp.*			
992.		*Nematoda sp. 11 (PSS)*			Y
993.		*Nematoda sp. 2 (PSS)*			
994.		*Nematoda sp. 3 (PSS)*			Y
995.		*Nematoda sp. P2/P4 (PSW)*			
996.		*Nematoda sp. P3 (PSW)*			
997.		*Nematoda sp. P5 (PSW)*			
998.		*Nematoda sp. P8 (PSW)*			
Nemertini					
999.		*Nemertini sp.*			
Nemesiidae					
1000.		*Aname mellosa*			
Neoniphargidae					
1001.		*Wesniphargus sp.*			Y
Nepidae					
1002.		*Ranatra diminuta*			
1003.		*Ranatra sp.*			
Nereidae					
1004.		*Nereidae sp.*			
Noteridae					
1005.		*Neohydrocoptus subfasciatus*			
Notommatidae					
1006.		*Cephalodella forficula*			
1007.		*Cephalodella gibba*			
1008.		*Cephalodella tenuiseta*			
1009.		*Monommata sp.*			
1010.		*Notommata copeus*			
Notonectidae					
1011.		*Anisops hackeri*			
Nyctaginaceae					
1012.	2769	*Boerhavia burbidgeana*			
1013.	2770	*Boerhavia coccinea (Tar Vine, Wituka)*			
1014.	2772	*Boerhavia gardneri*			
1015.	2774	*Boerhavia repleta*			
1016.	2775	*Boerhavia schomburgkiana*			
Ochteridae					

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1017.		*Ochterus sp.*			
Oleaceae					
1018.	12059	*Jasminum didymum subsp. lineare (Desert Jasmine)*			
Olibrinidae					
1019.		*Adoniscus sp.*			
Oligochaeta					
1020.		*Oligochaeta sp.*			
Olpiidae					
1021.		*Linnaeolpium linnaei*			Y
Onagraceae					
1022.	6136	*Ludwigia perennis*			
Oonopidae					
1023.		*Cavisternum clavatum*			
1024.		*Opopaea ectognophus*			Y
Ostracoda					
1025.		*Ostracoda (unident.)*			
Otididae					
1026.	24610	*Ardeotis australis (Australian Bustard)*			
Oxidae					
1027.		*Frontipoda nr tasmanica*			Y
1028.		*Frontipoda sp P3 (PSW)*			
1029.		*Frontipoda spinosa*			
1030.		*Oxus orientalis*			
Pachycephalidae					
1031.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
1032.	24618	*Oreoica gutturalis (Crested Bellbird)*			
1033.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
Papaveraceae					
1034.	17797	*Argemone ochroleuca subsp. ochroleuca*	Y		
Parabathynellidae					
1035.		*Atopobathynella sp.*			
1036.		*Atopobathynella sp. A*			
1037.		*Notobathynella sp.*			
Paramelitidae					
1038.		*Paramelitidae sp.*			
1039.		*Paramelitidae sp. 2 (PSS)*			
1040.		*Pilbarus millsi*			
Parasitiformes					
1041.		*Mesostigmata sp.*			
Parastenocarididae					
1042.		*Parastenocaris jane*			
1043.		*Parastenocaris sp.*			
Pardalotidae					
1044.	24627	*Pardalotus rubricatus (Red-browed Pardalote)*			
1045.	25682	*Pardalotus striatus (Striated Pardalote)*			
1046.	24628	*Pardalotus striatus subsp. murchisoni (Striated Pardalote)*			
Pedaliaceae					
1047.	43521	*Josephinia sp. Style-topped fruit (M. Maier BES MM 1017)*			Y
Pelecanidae					
1048.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
Peritrichidae					
1049.		*Zoothamnium sp.*			
Petroicidae					
1050.	24658	*Petroica cucullata (Hooded Robin)*			
1051.	24659	*Petroica goodenovii (Red-capped Robin)*			
Pezidae					
1052.		*Peza sp.*			Y
1053.		*Pezidae sp.*			
Phalacrocoracidae					

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1054.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
1055.	24666	*Phalacrocorax melanoleucos subsp. melanoleucos (Little Pied Cormorant)*			
1056.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
1057.	25699	*Phalacrocorax varius (Pied Cormorant)*			
Phalangeridae					
1058.	24157	*Trichosurus vulpecula subsp. arnhemensis (Northern Brushtail Possum)*			
Phasianidae					
1059.	25701	*Coturnix ypsilophora (Brown Quail)*			
Philodinidae					
1060.		*Dissotrocha sp.*			
Philopotamidae					
1061.		*Chimarra sp AV17 (PSW)*			
Pholcidae					
1062.		*Trichocyclus nigropunctatus*			
Phreodrilidae					
1063.		*Insulodrilus angela*			
1064.		*Phreodrilid with dissimilar ventral chaetae*			
1065.		*Phreodrilid with similar ventral chaetae*			
1066.		*Phreodrilidae sp.*			
1067.		*Phreodrilus n. sp. WA12 (PSW)*			Y
Phrymaceae					
1068.	7060	*Glossostigma diandrum*			
1069.	12486	*Peplidium aithocheilum*			
Phyllanthaceae					
1070.	12013	*Flueggea virosa subsp. melanthesoides (Dogwood, Guwal)*			
1071.	17626	*Phyllanthus erwinii*			
1072.	4680	*Phyllanthus maderaspatensis*			
1073.	4684	*Phyllanthus reticulatus*			
1074.	11990	*Phyllanthus reticulatus var. glaber*			
Pionidae					
1075.		*Piona cumberlandensis*			
Planorbidae					
1076.		*Ameriana sp.*			
1077.		*Gyraulus hesperus*			
1078.		*Gyraulus sp.*			
1079.		*Planorbidae sp.*			
Plantaginaceae					
1080.	7098	*Stemodia grossa (Marsh Stemodia, Mindjaara)*			
Pleidae					
1081.		*Paraplea n. sp. (ANIC 6)*			
1082.		*Paraplea sp.*			
1083.		*Pleidae sp.*			
Poaceae					
1084.	172	*Acrachne racemosa*			
1085.	204	*Aristida burbidgeae*			
1086.	207	*Aristida contorta (Bunched Kerosene Grass)*			
1087.	210	*Aristida holathera*			
1088.	12063	*Aristida holathera var. holathera*			
1089.	213	*Aristida ingrata*			
1090.	215	*Aristida latifolia (Feathertop Wiregrass)*			
1091.	217	*Aristida nitidula (Flat-awned Threeawn)*			
1092.	239	*Bothriochloa bladhii (Forest Bluegrass)*			
1093.	16355	*Bothriochloa decipiens var. cloncurrensis*		P1	
1094.	241	*Brachyachne convergens (Spider Grass)*			
1095.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
1096.	259	*Cenchrus echinatus (Burrgrass)*	Y		
1097.	29721	*Cenchrus setiger (Birdwood Grass)*	Y		
1098.	266	*Chloris barbata (Purpletop Chloris)*	Y		
1099.	270	*Chloris pumilio*			
1100.	279	*Cymbopogon ambiguus (Scentgrass)*			
1101.	283	*Cynodon dactylon (Couch)*	Y		
1102.	290	*Dactyloctenium radulans (Button Grass)*			
1103.	303	*Dichanthium fecundum (Curly Bluegrass)*			
1104.	13741	*Dichanthium sericeum subsp. humilius*			

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1105.	310	*Digitaria brownii (Cotton Panic Grass)*			
1106.	313	*Digitaria ctenantha (Comb Finger Grass)*			
1107.	328	*Echinochloa colona (Awnless Barnyard Grass)*	Y		
1108.	355	*Elytrophorus spicatus (Spikegrass)*			
1109.	357	*Enneapogon caerulescens (Limestone Grass)*			
1110.	375	*Eragrostis cumingii (Cuming's Love Grass)*			
1111.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
1112.	380	*Eragrostis eriopoda (Woollybutt Grass, Wangurnu)*			
1113.	16731	*Eragrostis exigua*			
1114.	388	*Eragrostis leptocarpa (Drooping Lovegrass)*			
1115.	38505	*Eragrostis surreyana*		P3	
1116.	398	*Eragrostis tenellula (Delicate Lovegrass)*			
1117.	400	*Eriachne aristidea*			
1118.	403	*Eriachne benthamii (Swamp Wanderrie)*			
1119.	407	*Eriachne festucacea (Plains Wandarrie Grass)*			
1120.	411	*Eriachne helmsii (Buck Wanderrie Grass)*			
1121.	413	*Eriachne mucronata (Mountain Wanderrie Grass)*			
1122.	16485	*Eriachne pulchella subsp. dominii*			
1123.	16486	*Eriachne pulchella subsp. pulchella*			
1124.	421	*Eriachne tenuiculmis*			
1125.	11011	*Eulalia aurea*			
1126.	443	*Heteropogon contortus (Bunch Speargrass)*			
1127.	464	*Iseilema membranaceum (Small Flinders Grass)*			
1128.	471	*Leptochloa digitata (Whorled Cane Grass)*			
1129.	19061	*Leptochloa fusca*			
1130.	518	*Paspalidium clementii (Clements Paspalidium)*			
1131.	519	*Paspalidium constrictum (Knottybutt Grass)*			
1132.	523	*Paspalidium rarum (Rare Paspalidium)*			
1133.	525	*Paspalidium tabulatum*			
1134.	606	*Setaria dielsii (Diels' Pigeon Grass)*			
1135.	629	*Sporobolus australasicus (Fairy Grass)*			
1136.	673	*Themeda triandra*			
1137.	679	*Triodia angusta*			
1138.	43220	*Triodia sp. Peedamulla (A.A. Mitchell PRP 1636)*			
1139.	35843	*Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)*		P3	
1140.	704	*Triodia wiseana (Limestone Spinifex)*			
1141.	706	*Triraphis mollis (Needle Grass)*			
1142.	717	*Urochloa piligera*			
1143.	730	*Xerochloa imberbis (Rice Grass)*			
1144.	732	*Yakirra australiensis*			
1145.	11894	*Yakirra australiensis var. australiensis*			
Podargidae					
1146.	25703	*Podargus strigoides (Tawny Frogmouth)*			
Podicipedidae					
1147.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
1148.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
1149.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
Polycentropodidae					
1150.		*Paranyctiophylax sp AV5 (KIM-UWA)*			
Pomatostomidae					
1151.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
1152.	25706	*Pomatostomus temporalis (Grey-crowned Babbler)*			
1153.	24684	*Pomatostomus temporalis subsp. rubeculus (Grey-crowned Babbler)*			
Portulacaceae					
1154.	2864	*Calandrinia ptychosperma*			
1155.	2878	*Portulaca conspicua*			
1156.	2882	*Portulaca intraterranea*			
1157.	2884	*Portulaca oleracea (Purslane, Wakati)*			
1158.	2886	*Portulaca pilosa (Djanggara)*	Y		
Potamogetonaceae					
1159.	113	*Potamogeton tricarinatus (Floating Pondweed)*			
Prodidomidae					
1160.		*Nomindar jarrnarm*			Y
1161.		*Wydundra kennedy*			
Proteaceae					

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1162.	19570	*Grevillea pyramidalis subsp. leucadendron*			
1163.	13440	*Grevillea wickhamii subsp. aprica*			
1164.	19478	*Grevillea wickhamii subsp. hispidula*			
1165.	19074	*Grevillea wickhamii subsp. macrodonta*			
1166.	2138	*Hakea chordophylla*			
1167.	19137	*Hakea lorea subsp. lorea*			
Psittacidae					
1168.	25715	*Cacatua roseicapilla (Galah)*			
1169.	24726	*Cacatua roseicapilla subsp. roseicapilla (Galah)*			
1170.	25716	*Cacatua sanguinea (Little Corella)*			
1171.	24727	*Cacatua sanguinea subsp. westralensis (Little Corella)*			
1172.	24736	*Melopsittacus undulatus (Budgerigar)*			
1173.	24742	*Nymphicus hollandicus (Cockatiel)*			
1174.	24743	*Pezoporus occidentalis (Night Parrot)*		T	
1175.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
1176.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
Pteridaceae					
1177.	30	*Ceratopteris thalictroides*			
1178.	32	*Cheilanthes brownii*			
1179.	37	*Cheilanthes lasiophylla (Woolly Cloak Fern)*			
1180.	12818	*Cheilanthes sieberi subsp. sieberi*			
Ptilonorhynchidae					
1181.	25724	*Ptilonorhynchus maculatus (Spotted Bowerbird)*			
1182.	24757	*Ptilonorhynchus maculatus subsp. guttatus (Western Bowerbird)*			
Pygopodidae					
1183.	30906	*Delma concinna (Javelin Legless Lizard)*			
1184.	30905	*Delma concinna subsp. concinna (Javelin Legless Lizard)*			
1185.	30904	*Delma concinna subsp. major (Javelin Legless Lizard)*		P1	
1186.	24998	*Delma elegans*			
1187.	25001	*Delma nasuta*			
1188.	25002	*Delma pax*			
1189.	25004	*Delma tincta*			
1190.	25005	*Lialis burtonis*			
1191.	25009	*Pygopus nigriceps*			
Pyralidae					
1192.		*Pyralidae Pilbara sp 2 (PSW)*			
1193.		*Pyralidae sp.*			
1194.		*Pyralidae sp. 22 of JHH (PSW) (=Parapoynx stagnalis)*			Y
1195.		*Pyralidae sp. 3 of JHH (PSW) (= Margarosticha ?repetitalis)*			
Rallidae					
1196.	25727	*Fulica atra (Eurasian Coot)*			
1197.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
1198.	25730	*Gallirallus philippensis (Buff-banded Rail)*			
1199.	25732	*Porzana pusilla (Baillon's Crake)*			
Recurvirostridae					
1200.	25734	*Himantopus himantopus (Black-winged Stilt)*			
Ridgewayiidae					
1201.		*Stygoridgewayia trispinosa*			
Rubiaceae					
1202.	7338	*Oldenlandia crouchiana*			
1203.	7339	*Oldenlandia galioides*			
1204.	12964	*Pomax rupestris*			
Salticidae					
1205.		*Omoedus orbiculatus*			
1206.		*Pellenes bitaeniata*			
Sapindaceae					
1207.	4759	*Dodonaea coriacea*			
Scaridiidae					
1208.		*Scaridium sp.*			
Scatophagidae					
1209.		*Selenotoca multifasciata*			
Scincidae					
1210.	25015	*Carlia munda (Shaded-litter Rainbow Skink)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1211.	25017	*Carlia triacantha (Desert Rainbow Skink)*			
1212.	30893	*Cryptoblepharus buchananii*			
1213.	30892	*Cryptoblepharus ustulatus*			
1214.	25461	*Ctenotus brooksi*			
1215.	25032	*Ctenotus calurus*			
1216.	25036	*Ctenotus duricola*			
1217.	25462	*Ctenotus grandis*			
1218.	25041	*Ctenotus grandis subsp. grandis*			
1219.	25043	*Ctenotus grandis subsp. titan*			
1220.	25044	*Ctenotus hanloni*			
1221.	25045	*Ctenotus helenae*			
1222.	25463	*Ctenotus pantherinus (Leopard Ctenotus)*			
1223.	25064	*Ctenotus pantherinus subsp. ocellifer (Leopard Ctenotus)*			
1224.	25065	*Ctenotus pantherinus subsp. pantherinus (Leopard Ctenotus)*			
1225.	25066	*Ctenotus quattuordecimlineatus*			
1226.	25072	*Ctenotus rubicundus*			
1227.	25073	*Ctenotus saxatilis (Rock Ctenotus)*			
1228.	25077	*Ctenotus serventyi*			
1229.	25466	*Cyclodomorphus melanops (Slender Blue-tongue)*			
1230.	25090	*Cyclodomorphus melanops subsp. melanops (Slender Blue-tongue)*			
1231.	41406	*Egernia cygnitos (Western Pilbara Spiny-tailed Skink)*			
1232.	25092	*Egernia depressa (Southern Pygmy Spiny-tailed Skink)*			
1233.	25094	*Egernia formosa*			
1234.	25101	*Egernia pilbarensis (Pilbara Skink)*			
1235.	42404	*Eremiascincus isolepis*			
1236.	43381	*Eremiascincus pallidus (Western Narrow-banded Skink, Narrow-banded Sand Swimmer)*			
1237.	25125	*Lerista bipes*			
1238.	30928	*Lerista clara*			
1239.	25135	*Lerista flammicauda*			
1240.	25142	*Lerista ips*			
1241.	25155	*Lerista muelleri*			
1242.	30925	*Lerista verhmens*			
1243.	25184	*Menetia greyii*			
1244.	25187	*Menetia surda subsp. surda*			
1245.	25495	*Morethia ruficauda*			
1246.	25193	*Morethia ruficauda subsp. exquisita*			
1247.	25196	*Notoscincus butleri (Lined Soil-crevice Skink)*		P4	
1248.	25499	*Notoscincus ornatus*			
1249.	25197	*Notoscincus ornatus subsp. ornatus*			
1250.	25202	*Tiliqua multifasciata (Central Blue-tongue)*			

Sciomyzidae

1251.		*Sciomyzidae sp.*			

Scirtidae

1252.		*Scirtidae sp.*			
1253.		*Scirtidae sp. 1 (PSW)*			

Scolopacidae

1254.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
1255.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
1256.	24806	*Tringa glareola (Wood Sandpiper)*		IA	

Scolopendridae

1257.		*Arthrorhabdus paucispinus*			
1258.		*Cormocephalus turneri*			
1259.		*Ethmostigmus curtipes*			
1260.		*Scolopendra laeta*			
1261.		*Scolopendra morsitans*			

Scorpaenidae

1262.		*Scorpaena sumptuosa*			

Scrophulariaceae

1263.	15052	*Eremophila forrestii subsp. forrestii*			
1264.	16696	*Eremophila fraseri subsp. fraseri*			
1265.	7234	*Eremophila longifolia (Berrigan, Tulypurpa)*			
1266.	23997	*Eremophila tietkensii*			

Scutigeridae

1267.		*Pilbarascutigera incola*			

Sididae

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1268.		*Latonopsis australis*			
Sillaginidae					
1269.		*Sillago ingenuua*			
Simuliidae					
1270.		*Simulium ornatipes*			
Solanaceae					
1271.	6971	*Nicotiana benthamiana (Tjuntiwari)*			
1272.	11331	*Nicotiana occidentalis subsp. obliqua*			
1273.	11856	*Nicotiana occidentalis subsp. occidentalis*			
1274.	20652	*Physalis angulata*	Y		
1275.	6989	*Solanum ashbyae*			
1276.	6995	*Solanum centrale (Desert Raisin, Kampurarpa)*			
1277.	6998	*Solanum cleistogamum*			
1278.	7002	*Solanum diversiflorum*			
1279.	7009	*Solanum gabrielae*			
1280.	7014	*Solanum horridum*			
1281.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
1282.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
1283.	7029	*Solanum phlomoides*			
1284.	7036	*Solanum sturtianum (Thargomindah Nightshade)*			
Sparassidae					
1285.		*Isopedella tindalei*			
Spongillidae					
1286.		*Spongillidae sp.*			
Staphylinidae					
1287.		*Staphylinidae sp.*			
Stratiomyidae					
1288.		*Stratiomyidae sp.*			
Strigidae					
1289.	25747	*Ninox connivens (Barking Owl)*			
1290.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
1291.	24820	*Ninox novaeseelandiae subsp. boobook (Boobook Owl)*			
Stylidiaceae					
1292.	7729	*Stylidium fluminense*			
1293.	18123	*Stylidium weeliwolli*		P2	
Surianaceae					
1294.	3182	*Stylobasium spathulatum (Pebble Bush)*			
Syarinidae					
1295.		*Ideoblothrus linnaei*			Y
1296.		*Ideoblothrus pisolitus*			Y
Sylviidae					
1297.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
1298.	24833	*Cincloramphus cruralis (Brown Songlark)*			
1299.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			
1300.	24837	*Eremiornis carteri (Spinifex-bird)*			
Synchaetidae					
1301.		*Polyarthra dolichoptera*			
Tabanidae					
1302.		*Tabanidae sp.*			
Tachyglossidae					
1303.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
Terapontidae					
1304.	34042	*Leiopotherapon aheneus (Fortescue Grunter)*		P4	
1305.		*Terapon jarbua*			
Testudinellidae					
1306.		*Testudinella amphora*			
1307.		*Testudinella patina*			
1308.		*Testudinella sp.*			
Tetraodontidae					
1309.		*Chelonodon patoca*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Thermosbaenacea					
1310.		*Thermosbaenacea sp.*			Y
Thermosbaenacidae					
1311.		*Halosbaena sp.*			
1312.		*Halosbaena tulki*			
Thiaridae					
1313.		*Melanoides (Stenomelania) tuberculata*			
1314.		*Plotiopsis australis*			
Threskiornithidae					
1315.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
1316.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
Thymelaeaceae					
1317.	5230	*Pimelea ammocharis*			
Tipulidae					
1318.		*Tipulidae sp.*			
1319.		*Tipulidae type D (SAP)*			
1320.		*Tipulidae type E (SAP)*			
1321.		*Tipulidae type P1 (PSW)*			
1322.		*Tipulidae type P4 (nr SAP type I) (PSW)*			Y
Trichocercidae					
1323.		*Trichocerca braziliensis*			
1324.		*Trichocerca musculus*			Y
1325.		*Trichocerca pusilla*			
1326.		*Trichocerca similis*			
Trichotriidae					
1327.		*Macrochaetus altamirai*			
Trochanteriidae					
1328.		*Trachyspina capensis*			
Trochanteriidae?					
1329.		*Fissarena castanea*			
Turbellaria					
1330.		*Microturbellaria sp.*			
1331.		*Turbellaria sp.*			
Turnicidae					
1332.	24851	*Turnix velox (Little Button-quail)*			
Tytonidae					
1333.	25762	*Tyto alba (Barn Owl)*			
Unionicolidae					
1334.		*Koenikea nsp. (nr timmsi) (PSW)*			Y
1335.		*Koenikea sorpresa*			
1336.		*Koenikea sp. 2/3 (Pilbara) (PSW)*			
1337.		*Neumania sp.*			
1338.		*Recifella doomba*			
1339.		*Recifella sp.*			
1340.		*Recifella tinka*			
1341.		*Unionicola crassipalpis*			
1342.		*Unionicola flabelliseta*			
1343.		*Unionicola longiseta*			Y
1344.		*Unionicola neoaffinis*			
1345.		*Unionicolidae sp.*			
Urodacidae					
1346.		*Urodacus butleri*			
Varanidae					
1347.	25209	*Varanus acanthurus (Spiny-tailed Monitor)*			
1348.	25210	*Varanus brevicauda (Short-tailed Pygmy Monitor)*			
1349.	30825	*Varanus bushi (Pilbara Mulga Monitor)*			
1350.	25211	*Varanus caudolineatus*			
1351.	25212	*Varanus eremius (Pygmy Desert Monitor)*			
1352.	25216	*Varanus giganteus (Perentie)*			
1353.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
1354.	25524	*Varanus panoptes (Yellow-spotted Monitor)*			
1355.	25222	*Varanus panoptes subsp. panoptes*			
1356.	25223	*Varanus panoptes subsp. rubidus*			

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

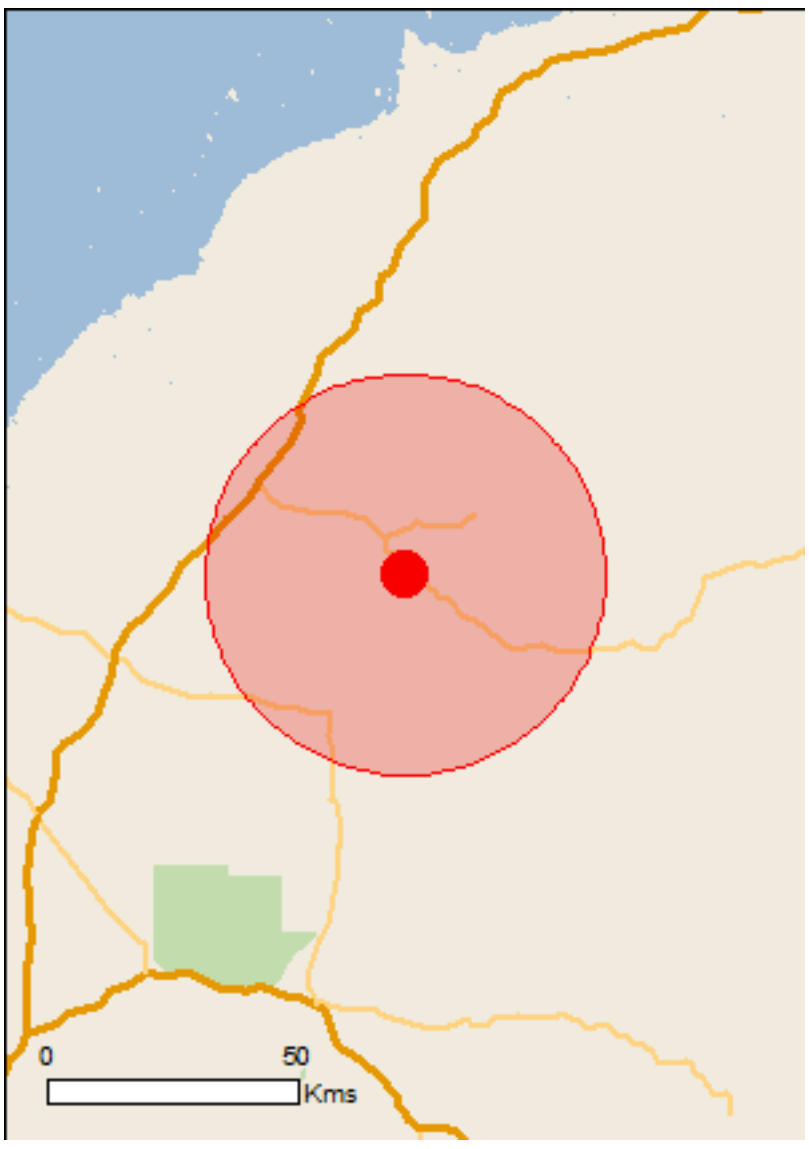
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 21/09/15 10:16:32

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

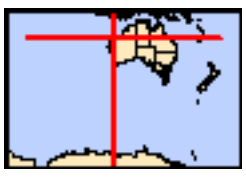
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 40.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	7
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	12
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	10
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus Kakarratul, Northern Marsupial Mole [295]	Endangered	Species or species habitat may occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.74635 116.20092

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1357.	25224	*Varanus pilbarensis (Pilbara Rock Monitor)*			
1358.	25526	*Varanus tristis (Racehorse Monitor)*			
1359.	25227	*Varanus tristis subsp. tristis (Racehorse Monitor)*			
Veliidae					
1360.		*Microvelia (Austromicrovelia) peramoena*			
Vespertilionidae					
1361.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
1362.	42365	*Nyctophilus daedalus (Northwestern Long-eared Bat)*			
1363.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
1364.	24200	*Scotorepens greyii (Little Broad-nosed Bat)*			
1365.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			
Violaceae					
1366.	5215	*Hybanthus aurantiacus*			
Zygophyllaceae					
1367.	4368	*Tribulopis angustifolia*			
1368.	4374	*Tribulus astrocarpus*			
1369.	4379	*Tribulus macrocarpus*			
1370.	4380	*Tribulus occidentalis (Perennial Caltrop)*			
1371.	4381	*Tribulus platypterus (Cork Hopbush)*			
1372.	4383	*Tribulus terrestris (Caltrop)*	Y		

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix E: Previous Flora Survey Area Locations

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410000 415000 420000 425000 430000

7600000 7595000 7590000

Legend

- Mesa H Riparian Community Survey Area
- Astron (2016a)
- Astron (2016b)
- Astron (2011)
- Biota (2012)
- Biota (2011a)
- Biota (2006a)
- Biota (2003)

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure E.1: Previous Flora Survey Area Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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Author: D. Roocke | Drawn: W. An | Date: 05-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigE1_PreSurveyArea

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Appendix F: Vegetation Classification and Condition Scales and Fauna Habitat Condition Scale

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Table F.1: Vegetation Classification System (Specht 1970) as modified by Aplin (1979).

Stratum	70-100% cover	30-70% cover	10-30% cover	2-10% cover	<2% cover
Trees > 30 m	Tall closed forest	Tall open Forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees < 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs > 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs < 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, sedges, herbs	Closed tussock grassland/ sedgeland/ herbland	Tussock grassland/ sedgeland/ herbland	Open tussock grassland/ sedgeland/ herbland	Very open tussock grassland/ sedgeland/ herbland	Scattered tussock grasses/ sedges/ herbs

Table F.2: Summary of vegetation condition scale, as adapted from Trudgen (1988).

Vegetation condition	Condition description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Very Poor	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Table F.3: Fauna habitat condition scale (Thompson and Thompson 2010).

Habitat condition	Condition description
High Quality Fauna Habitat (1.0)	These areas closely approximate the vegetation mix and quality that would have been in the area prior to any human induced disturbance. The habitat has connectivity with other habitats and is likely to support the most natural vertebrate fauna assemblage.
Very Good Fauna Habitat (0.8)	These areas show minimal signs of human induced disturbance (e.g. grazing, clearing, fragmentation, weeds) and retain almost all of the characteristics of the habitat had it not been disturbed. The habitat has connectivity with other habitats, and fauna assemblages in these areas are likely to be minimally affected by disturbance.
Good Fauna Habitat (0.6)	These areas show signs of human induced disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat had it not been disturbed. The habitat still retains some connectivity with other habitats but fauna assemblages in these areas are likely to be affected by disturbance. Fauna assemblages in these areas are likely to be similar to what might be expected in this habitat.
Disturbed Fauna Habitat (0.4)	These areas show signs of human induced significant disturbance (e.g. mining, clearing, tracks and roads). Many of the trees, shrubs and undergrowth have died or have been cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain an abundance of weeds or have been damaged by vehicles or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
Highly Degraded Fauna Habitat (<0.2)	These areas often have a significant human induced loss of vegetation, and / or a large number of vehicle tracks and / or have been completely cleared, and / or areas have been heavily grazed or farmed. There is limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to differ significantly from what existed prior to the disturbance, and are often depleted compared to what existed prior to the disturbance.

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Appendix G: Vegetation and Flora Sample Site Locations

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410000 415000 420000 425000 430000

7600000

7595000

7590000

Pannawonica

Millstream Rd

Robe River

Jimmawurrada Creek

Legend

- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Sampling Sites

- Quadrat Astron 1 phase
- Quadrat Astron 2 phases
- Relevé Astron 2 phases
- Quadrat Ecologia 1 phase, Astron 1 phase

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Mesa H Riparian Community Assessment - June 2016

Figure G.1: Current Survey and Previous Surveys Vegetation and Flora Sampling Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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Appendix H: Fauna Habitat Mapping and Significant Areas

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410000 415000 420000 425000 430000

7605000 7600000 7595000 7590000

Legend

- Fauna Habitat Assessment Sites
- Mesa H Riparian Community Survey Area

Conservation Significant Areas

- Pool

Fauna Habitat

- Riverine
- Drainage
- Disturbed

HA1 HA2 HA3 HA4 HA5 HA6 HA7 HA8 HA9 HA10

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Mesa H Riparian Community Assessment - June 2016

Figure H.1: Fauna Habitat Mapping

Coordinate System: GDA94 MGA zone 50

0 1,000 2,000 3,000 Metres

N

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Table H.1: Astron fauna habitat assessment locations.

Site ID	Previous Site ID	MGA Zone 50 K		Date	Habitat	Condition	Disturbance	Microhabitats	Photo
		Easting (mE)	Northing (mN)						
HA1	RHA1	407118	7594065	7/5/2016	Drainage Line	1.0	Nil	Sparse logs and leaf litter	
HA2	RHA2	413299	7595588	7/5/2016	Riverine	0.8	Grazing	Hollow logs and leaf litter	
HA3	HA01	414405	7596614	26/09/2015	Riverine	0.8	Weeds	Standing water	
HA4	HA15	417192	7598072	30/09/2015	Riverine	0.8	Grazing, weeds	Standing water	No photo

Site ID	Previous Site ID	MGA Zone 50 K		Date	Habitat	Condition	Disturbance	Microhabitats	Photo
		Easting (mE)	Northing (mN)						
HA5	HA04	418205	7598125	27/09/2015	Riverine	0.8	Grazing	Standing water, rushes	
HA6	HA13	419528	7598021	30/09/2015	Riverine	0.8	Grazing, weeds	Standing water	
HA7	HA02	419980	7597945	26/09/2015	Riverine	0.8	Weeds, grazing, vehicular tracks	Standing water	No photo
HA8	HA22	423930	7592643	02/05/2016	Drainage Line	0.4	Weeds	Standing water	

Site ID	Previous Site ID	MGA Zone 50 K		Date	Habitat	Condition	Disturbance	Microhabitats	Photo
		Easting (mE)	Northing (mN)						
HA9	HA23	424018	7592961	02/05/2016	Drainage Line	0.4	Weeds		
HA10	HA15	427030	7599901	21/06/2015	Riverine	0.6	Grazing	Ephemeral pools	

Table H.2: Location of significant areas recorded during the Astron field surveys.

Site ID	Survey	MGA Zone 50 K		Reason	Photograph
		Easting (mE)	Northing (mN)		
Water Sources					
Pool 1	Level 1 survey (Astron 2014)	414390	7597485	Permanent pool of the Robe River, likely to support MNES bat species, migratory bird species and other conservation significant fauna species.	
Pool 2	Level 1 survey (Astron 2014)	414415	7596570	Permanent pool of the Robe River, likely to support MNES bat species, migratory bird species and other conservation significant fauna species.	
Pool 3	Phase 1 Level 2 survey (Astron 2016)	414405	7596615	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds.	

Site ID	Survey	MGA Zone 50 K		Reason	Photograph
		Easting (mE)	Northing (mN)		
Pool 4	Phase 1 Level 2 survey (Astron 2016)	417192	7598072	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds.	
Pool 5	Phase 1 Level 2 survey (Astron 2016)	418060	7598016	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds.	
Pool 6	Riparian Community Assessment	411435	7594952	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds.	

Site ID	Survey	MGA Zone 50 K		Reason	Photograph
		Easting (mE)	Northing (mN)		
Pool 7	Riparian Community Assessment	420290	7597902	Small but deep permanent pool of the Robe River.	
Pool 8	Riparian Community Assessment	414438	7596216	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds.	
Pool 9	Riparian Community Assessment	412021	7595303	Small but deep permanent pool of the Robe River.	

Site ID	Survey	MGA Zone 50 K		Reason	Photograph
		Easting (mE)	Northing (mN)		
Pool 10	Middle Robe and East Deepdale Level 2 Fauna Assessment (Astron 2015)	423718	7596616	Permanent pool of the Robe River with abundant Typha. Important habitat for migratory listed birds. Northern Quoll and Pilbara Olive Python scats recorded nearby, Pilbara Leaf-nosed Bat calls recorded nearby.	
Pool 11	Middle Robe and East Deepdale Level 2 Fauna Assessment (Astron 2015)	429712	7601411	Permanent pool of the Robe River with abundant Typha. Northern Quoll recorded nearby.	
Pool 12	Riparian Community Assessment	419813	7598056	Small but deep permanent pool of the Robe River.	No photo
Pool 13	Riparian Community Assessment	420948	7597275	Small but deep permanent pool of the Robe River.	No photo

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Appendix I: Priority Ecological Communities of the Riparian Community Survey Area

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400000 410000 420000 430000 440000 450000

7610000 7600000 7590000 7580000

Wona Land System

Pannawonica - Millstream Rd

PANNAWONICA

Pannawonica Rd

Robe River

Jimmawurrada Creek

Millstream - Yarraloola Rd

Triodia sp. Robe River Assemblages

Legend

- Towns
- Main Road
- Railway
- River/Creek
- Mesa H Riparian Community Survey Area

Priority Ecological Community (Department of Parks and Wildlife 2015b)

- Wona Land System (P1): Four plant assemblages of the Wona Land System (previously 'Cracking clays of the Chichester and Mungaroona Range')
- *Triodia* sp. Robe River Assemblages (P3): *Triodia* sp. Robe River assemblages of mesas of the West Pilbara

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure I.1: Priority Ecological Communities of the Mesa H Riparian Community Survey Area

Datum: GDA 1994 - Projection: MGA Zone 50

0 2 4 6 8 10 km

N

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Appendix J: Threatened and Priority Flora Species Likelihood of Occurrence within the Survey Area

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Table J.1: Likelihood of occurrence of Threatened and Priority flora recorded within 20 km of the Mesa H survey area (Astron 2016b, NatureMap (Department of Parks and Wildlife 2016a), TPFL (Department of Parks and Wildlife 2015c), TP List (Department of Parks and Wildlife 2015d), WAHerb (Department of Parks and Wildlife 2015e)). The TP List database is searched using place names. As a result, many of the records obtained from this database may occur beyond 50 km of the Mesa H survey area.

Species	Habit and flowering information	Life Form	Habitat	Likelihood of occurrence	
				Pre-survey	Post-survey
Threatened					
Thyrptomene wittwerii	Spreading or rounded shrub, 0.5 m to 1.5 (-2.1) m high. White-cream flowers in April, July or August.	Perennial	Skeletal red stony soils. Breakaways, stony creek beds.	Unlikely	Unlikely
Priority 1					
Bothriochloa decipiens var. *cloncurrensis*	Herbaceous grass, to 1.4 m high.	Perennial	Seasonally damp depression. Stony clay plain.	Potential	Unlikely
Triodia sp. Pannawonica (B.M. Anderson & M.D. Barrett BMA 89)	Hummock grass.	Perennial	Shale	Unlikely	Unlikely
Priority 2					
Dicladanthera glabra	Spreading herb or shrub, to 0.6 (-1) m high.	Perennial	Alluvium. Along watercourses, near rock pools.	Potential	Unlikely
Euphorbia australis var. *glabra*	Herb	Annual	Creek banks. Red brown loam, some pebbles.	Potential	Potential
Pentalepis trichodesmoides subsp. *hispida*	Multi-stemmed shrub to 0.8 m high. Flowers July to October.	Perennial	Summits of ridges, cobbled slopes, outcrops, banks of creeks and edges of basalt screes.	Unlikely	Unlikely
Stylidium weeliwolli	Herb, 0.1 m to 0.25 m high, throat appendages 4, rod-shaped. Pink and red flowers from August to September.	Annual	Gritty sand soil, sandy clay. Edge of watercourses.	Likely	Potential

Species	Habit and flowering information	Life Form	Habitat	Likelihood of occurrence	
				Pre-survey	Post-survey
Priority 3					
Eragrostis surreyana	Grass. Culms erect or decumbent, 5-8 (-13) cm tall. Panicle linear, 9 cm to 13 cm long; 0.5 cm to 1.3 cm wide.	Annual	Soak area. Red-brown sandy clay.	Potential	Potential
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Shrub or herb 0.2 m to 2 m high. May to July.	Perennial	Drainage lines, creeks in hills or plains. Brown silty loam.	Potential	Potential
Pleurocarpaea gracilis	Rounded shrub to 0.5 m. June to October.	Perennial	Summit of rounded hill, slopes, skeletal red gritty soil over massive Brockman Iron Formation rock.	Unlikely	Unlikely
Solanum albostellatum	Low herb or shrub to 0.2 m high. March.	Perennial	Floodplains, slight bedrock outcrops. Red brown silty clay loam. Cracking clay.	Unlikely	Unlikely
Terminalia supranitifolia	Spreading tangled tree or shrub to 3 m high.	Perennial	Sandy soils or among basalt rocks.	Unlikely	Unlikely
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	Hummock grass. June, July, September.	Perennial	Mesa tops and edges; breakaways; hillsides and hilltops.	Unlikely	Recorded
Priority 4					
Goodenia nuda	Erect to ascending herb to 0.5 m high. Yellow flowers, April to August.	Short-lived perennial	Alluvial soils over ironstone, floodplains, valleys, watercourses, orange-brown alluvial sand over ironstone.	Potential	Unlikely
Rhynchosia bungarensis	Compact, prostrate shrub, to 0.5 m high. May to November.	Short-lived perennial	Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.	Likely	Recorded

Appendix K: Fauna Species Lists

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Table K.1: Amphibian species list – results of database searches, literature reviews and Astron survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
HYLIDAE										
Cyclorana maini	Sheep Frog					x			x	
Litoria rubella	Little Red Tree Frog					x			x	
MYOBATRACHIDAE										
Pseudophryne douglasi	Gorge Toadlet								x	
Uperoleia russelli	Northwest Toadlet					x			x	
Uperoleia saxatilis	Pilbara Toadlet					x			x	
BUFONIDAE										
Platyplectrum spenceri	Centralian Burrowing Frog					x				

Table K.2: Reptile species list – results of database searches, literature reviews and Astron survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
AGAMIDAE										
Amphibolurus longirostris	Long-Nosed Dragon					x			x	x
Ctenophorus caudicinctus	Ring-tailed Rock Dragon					x			x	
Ctenophorus femoralis	Dune Dragon					x				
Ctenophorus isolepis isolepis	Military Sand Dragon					x			x	
Ctenophorus nuchalis	Central Netted Dragon					x			x	
Ctenophorus reticulatus	Western Netted Dragon					x				
Pogona minor minor	Bearded Dragon					x			x	
DIPLODACTYLIDAE										
Crenadactylus ocellatus	Clawless Gecko					x			x	
Diplodactylus bilybara	Western Fat-tailed Gecko					x			x	
Diplodactylus galaxias						x			x	
Diplodactylus mitchelli						x				
Diplodactylus savagei						x			x	
Lucasium stenodactylum	Pale-snouted Ground Gecko					x			x	
Lucasium wombeyi						x			x	
Oedura marmorata	Marbled Velvet Gecko					x			x	
Rhynchoedura ornata	Beaked Gecko					x			x	
Strophurus ciliaris						x				
Strophurus elderi	Jewelled Gecko					x			x	
Strophurus wellingtonae						x				
CARPHODACTYLIDAE										
Nephrurus levis pilbarensis									x	
Nephrurus wheeleri cinctus	Banded Knob-tailed Gecko					x			x	
Nephrurus wheeleri wheeleri	Banded Knob-tailed Gecko					x			x	
GEKKONIDAE										
Gehyra pilbara						x			x	
Gehyra punctata	Spotted Rock Dtella					x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Gehyra variegata	Variegated Tree Dtella					x			x	
Hemidactylus frenatus	Asian House Gecko	*				x			x	
Heteronotia binoei	Bynoe's Gecko					x			x	x
Heteronotia spelea	Pilbara Cave Gecko					x			x	
PYGOPODIDAE										
Delma butleri									x	
Delma elegans						x			x	
Delma nasuta						x			x	
Delma pax						x			x	
Delma tincta						x			x	
Lialis burtonis	Burrton's Legless Lizard					x			x	
Pygopus nigiceps						x			x	
EUGONGYLIDAE										
Carlia munda						x			x	
Carlia triacantha						x				
Cryptoblepharus plagiocephalus									x	
Cryptoblepharus buchananii						x				
Cryptoblepharus ustulatus						x			x	
Menetia greyii						x			x	
Menetia surda surda						x			x	
Morethia ruficauda exquisita	Fire-tailed Skink					x			x	
AGAMIDAE										
Ctenotus brooksi						x				
Ctenotus calurus						x				
Ctenotus duricola						x			x	
Ctenotus grandis titan						x			x	
Ctenotus hanloni						x			x	
Ctenotus helenae						x			x	
Ctenotus pantherinus	Leopard Ctenotus					x			x	
Ctenotus rubicundus						x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Ctenotus quattuordecimlineatus						x				
Ctenotus saxatilis	Rock Ctenotus					x			x	
Ctenotus schomburgkii						x			x	
Ctenotus serventyi						x			x	
Eremiascincus isolepis						x			x	
Eremiascincus faciolatus									x	
Lerista bipes						x			x	
Lerista flammicauda						x			x	
Lerista ips						x				
Lerista muelleri						x			x	
Lerista verhmens						x				
Notoscincus butleri	Lined Soil-crevice Skink				P4	x			x	
Notoscincus ornatus						x			x	
EGERNIIDAE										
Cyclodomorphus melanops	Slender Blue-tongue					x			x	
Egernia cygnitos						x				
Ergenia depressa						x				
Ergenia formosa						x			x	
Ergenia pilbarensis	Pilbara Skink					x			x	
Tiliqua multifasciata	Central Blue-tongue					x			x	
VARANIDAE										
Varanus acanthurus	Spiny-tailed Monitor					x			x	
Varanus brevicauda	Short-tailed Pygmy Monitor					x			x	
Varanus bushi	Pilbara Mulga Monitor					x			x	
Varanus caudolineatus						x				
Varanus eremius	Pygmy Desert Monitor					x			x	
Varanus giganteus	Perentie					x			x	
Varanus gouldii	Bungarra					x			x	
Varanus hamersleyensis	Southern Pilbara Rock Monitor					x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Varanus panoptes panoptes						x			x	
Varanus pilbarensis									x	
Varanus tristis tristis	Racehorse Monitor					x			x	
TYPHLOPIDAE										
Anilios ammodytes						x			x	
Anilios ganei					P1	x			x	
Anilios grypus	Beaked Blind snake					x			x	
Anilios hamatus									x	
Anilios pilbarensis						x			x	
BOIDAE										
Antaresia perthensis	Pygmy Python					x			x	
Antaresia stimsoni stimsoni	Stimson's Python					x			x	
Aspidites melanocephalus	Black-headed python					x			x	
Liasis olivaceus barroni	Pilbara Olive Python		VU	S3		x	x		x	
ELAPIDAE										
Acanthopis wellsi	Pilbara Death Adder					x			x	
Brachyurophis approximans						x			x	
Demansia psammophis cupreiceps	Yellow-faced Whipsnake					x			x	
Demansia rufescens	Rufous Whipsnake					x			x	
Furina ornata	Moon Snake					x			x	
Parasuta monachus						x			x	
Pseudechis australis	Mulga Snake					x			x	
Pseudonaja mengdeni	Western Brown Snake					x			x	
Pseudonaja modesta	Ringed Brown Snake					x			x	
Pseudonaja nuchalis	Gwardar; Northern Brown Snake					x				
Simoselaps anomalus	Desert Banded Snake					x				
Suta fasciata	Rosen's Snake					x			x	
Suta punctata	Spotted Snake					x				

Table K.3: Bird species list – results of database searches, literature reviews and Astron survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
DROMAIIDAE										
Dromaius novaehollandiae	Emu					x		x	x	
PHASIANIDAE										
Coturnix ypsilophora	Brown Quail					x			x	
ANATIDAE										
Anas gracilis	Grey Teal					x		x	x	
Anas superciliosa	Pacific Black Duck					x		x	x	x
Aytha australis	Hardhead					x		x		x
Cygnus atratus	Black Swan					x		x	x	
Chenonetta jubata	Australian Wood Duck					x			x	
Dendrocygna eytoni	Plumed Whistling Duck					x				
Dendrocygna arcuata	Wandering Whistling Duck								x	
Nettapus pulchellus	Green Pygmy Goose								x	
PODICIPEDIDAE										
Tachybaptus novaehollandiae	Australasian Grebe					x		x	x	x
Poliocephalus poliocephalus	Hoary-headed Grebe					x		x	x	
COLUMBIDAE										
Columba livia	Domestic Pigeon	*				x	x			
Geopelia cuneata	Diamond Dove					x		x	x	
Geopelia striata placida	Peaceful Dove					x		x	x	
Geophaps plumifera	Spinifex Pigeon					x		x	x	
Ocyphaps lophotes	Crested Pigeon					x		x	x	
Phaps chalcoptera	Common Bronzewing					x		x	x	x
Phaps histrionica	Flock Bronzewing					x				
PODARGIDAE										
Podargus strigoides	Tawny Frogmouth					x		x	x	
CAPRIMULGIDAE										
Eurostopodus argus	Spotted Nightjar					x			x	x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
AEGOTHELIDAE										
Aegotheles cristatus	Australian Owlet-nightjar					x			x	
APOPDIDAE										
Apus pacificus	Fork-tailed Swift		Mi	S5			x		x	
ANHINGIDAE										
Anhinga novaehollandiae	Darter					x		x	x	
PHALACROCORACIDAE										
Phalacrocorax melanoleucos	Little Pied Cormorant							x	x	
Phalacrocorax varius	Pied Cormorant							x	x	x
Phalacrocorax sulcirostris	Little Black Cormorant								x	
PELECANIDAE										
Pelecanus conspicillatus	Australian Pelican					x		x	x	x
CICONIIDAE										
Ephippiorhynchus asiaticus	Black-necked stork								x	
ARDEIDAE										
Ardea ibis	Cattle Egret		Mi	S5			x		x	
Ardea intermedia	Intermediate Egret					x	x		x	
Ardea modesta	Eastern Great Egret		Mi	S5		x	x	x	x	
Ardea garzetta	Little Egret					x			x	
Ardea novaehollandiae	White-faced Heron					x		x	x	x
Ardea pacifica	White-necked Heron					x		x	x	x
Butorides striata	Striated Heron							x		
Nycticorax caledonicus	Nankeen Night-heron					x		x	x	
THRESKIORNITHIDAE										
Platalea flavipes	Yellow-billed Spoonbill								x	
Threskiornis spinicollis	Straw-necked Ibis					x		x	x	
ACCIPITRIDAE										
Accipiter cirrocephalus	Collared Sparrowhawk					x			x	
Accipiter fasciatus fasciatus	Brown Goshawk					x		x	x	
Aquila audax	Wedge-tailed Eagle					x		x	x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Circus approximans	Swamp Harrier					x				
Circus assimilis	Spotted Harrier					x		x	x	
Elanus scriptus	Letter-winged Kite				P4	x				
Elanus caeruleus	Black-shouldered Kite					x			x	
Lophoictinia isura	Square-tailed Kite					x		x		
Haliaeetus leucogaster	White-bellied Sea Eagle						x	x	x	
Haliastur sphenurus	Whistling Kite					x		x	x	x
Haliastur indus	Brahminy Kite							x		
Hieraaetus morphnoides	Little Eagle					x		x	x	
Milvus migrans	Black Kite					x		x	x	
Panidon haliaetus	Eastern Osprey		Mi	S5			x			
FALCONIDAE										
Falco cenchroides cenchroides	Australian Kestrel					x		x	x	
Falco berigora berigora	Brown Falcon					x		x	x	
Falco longipennis	Australian Hobby					x		x	x	
RALLIDAE										
Gallirallus philippensis	Buff-banded Rail					x				
Fulica atra	Eurasian Coot					x		x	x	x
Porzana tabuensis	Spotless Crake					x			x	
Tribonyx ventralis	Black-tailed Native-hen								x	
OTIDIDAE										
Ardeotis australis	Australian Bustard					x		x	x	
BURHINIDAE										
Burhinus grallarius	Bush Stone-curlew					x			x	
RECURVIROSTRIDAE										
Himantopus himantopus	Black-winged Stilt					x			x	
CHARADRIIDAE										
Charadrius veredus	Oriental Plover		Mi	S5			x			
Charadrius ruficapillus	Red-capped Plover							x		
Charadrius leschenaultii	Greater Sand Plover		Mi	S5				x		

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Elseyornis melanops	Black-fronted Dotterel					x		x	x	
Erythrogonys cinctus	Red-kneed Dotterel								x	
Vanellus tricolor	Banded Lapwing					x		x		
CINCLOSOMATIDAE										
Psophodes occidentalis	Chiming Wedgebill					x				
ROSTRATULIDAE										
Rostratula benghalensis australis	Australian Painted Snipe		EN	S2			x			
SCOLOPACIDAE										
Actitis hypoleucos	Common Sandpiper					x		x		
Calidris acuminata	Sharp-tailed Sandpiper			S5		x				
Numenius phaeopus	Whimbrel			S5				x		
Tringa glareola	Wood Sandpiper			S5		x		x	x	
Tringa nebularia	Common Greenshank			S5				x		
TURNICIDAE										
Turnix velox	Little Button-quail					x		x	x	
GLAREOLIDAE										
Glareola maldivarum	Oriental Pratincole		Mi	S5			x			
PSITTACIDAE										
Platycercus zonarius zonarius	Australian Ringneck					x		x	x	x
Melopsittacus undulatus	Budgerigar					x		x	x	
Nymphicus hollandicus	Cockatiel					x		x	x	
Pezoporus occidentalis	Night Parrot		EN	S2		x	x			
CACATUIDAE										
Cacatua sanguinea	Little Corella					x		x	x	x
Cacatua roseicapilla	Galah					x		x	x	
CUCULIDAE										
Cacomantis pallidus	Pallid Cuckoo					x		x	x	
Chrysococcyxs basalis	Horsfield's Bronze Cuckoo					x		x	x	x
Chrysococcyxs osculans	Black-eared Cuckoo								x	
Centropus phasianinus	Pheasant Coucal							x	x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
STRIGIDAE										
Ninox connivens	Barking Owl					x			x	
Ninox boobook boobook	Southern Boobook Owl					x		x	x	
TYTONIDAE										
Tyto javanica	Eastern Barn Owl					x				
ACLEDINIDAE										
Dacelo leachii leachii	Blue-winged Kookaburra					x		x	x	
Todiramphus pyrrhopygia	Red-backed Kingfisher					x		x	x	
Todiramphus sanctus	Sacred Kingfisher					x		x	x	
MEROPIDAE										
Merops ornatus	Rainbow Bee-eater		Mi	S5		x	x	x	x	x
PTILONORHYNCHIDAE										
Ptilonorhynchus maculatus guttatus	Western Bowerbird					x			x	
MALURIDAE										
Amytornis striatus	Striated Grasswren					x		x	x	
Malurus lamberti assimilis	Variegated Fairy-wren					x		x	x	x
Malurus leucopterus	White-winged Fairy-wren					x		x	x	
Stipiturus ruficeps	Rufous Crowned Emu-wren								x	
ACANTHIZIDAE										
Acanthiza apicalis	Inland Thornbill					x			x	
Acanthiza uropygialis	Chestnut-rumped Thornbill					x			x	
Gerygone fusca	Western Gerygone					x			x	x
Gerygone tenebrosa	Dusky Gerygone							x		
Smicrornis brevirostris	Weebill					x		x	x	x
PARDALOTIDAE										
Pardalotus punctatus	Spotted Pardalote					x				
Pardalotus rubricatus	Red-browed Pardalote					x		x	x	
Pardalotus striatus	Striated Pardalote					x			x	
MELIPHAGIDAE										

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x		x	x	
Certhionyx variegatus	Pied Honeyeater					x			x	
Epthianura tricolor	Crimson Chat					x			x	
Ptilotula keartlandi	Grey-headed Honeyeater							x	x	
Ptilotula penicillatus	White-plumed Honeyeater							x	x	x
Gavicalis virescens	Singing Honeyeater							x	x	
Lichmera indistincta	Brown Honeyeater					x		x	x	x
Manorina flavigula	Yellow-throated Miner					x		x	x	
Melithreptus gularis	Black-chinned Honeyeater					x			x	
Sugomel niger	Black Honeyeater					x			x	
POMATOSTOMIDAE										
Pomatostomus supercilious	White-browed Babbler					x				
Pomatostomus temporalis	Grey-crowned Babbler					x		x	x	x
CAMPEPHAGIDAE										
Coracina maxima	Ground Cuckoo-shrike					x				
Coracina novaehollandiae	Black-faced Cuckoo-shrike					x		x	x	
Lalage tricolor	White-winged Triller					x		x	x	
PACHYCEPHALIDAE										
Colluricincla harmonica	Grey Shrike-thrush					x		x	x	x
Oreoica gutturalis	Crested Bellbird					x		x	x	
Pachycephala melanura	Mangrove Golden Whistler							x		
Pachycephala lanioides	White-breasted Whistler							x		
Pachycephala rufiventris	Rufous Whistler					x		x	x	x
Cincloramphus cruralis	Brown Songlark					x		x	x	
Cincloramphus mathewsi	Rufous Songlark					x		x	x	
ARTAMIDAE										
Artamus cinereus melanops	Black-faced Woodswallow					x		x	x	
Artamus leucorynchus	White-breasted Woodswallow							x	x	
Artamus minor	Little Woodswallow					x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Artamus personatus	Masked Woodswallow					x			x	
CRACTICIDAE										
Cracticus torquatus	Grey Butcherbird								x	
Cracticus nigrogularis	Pied Butcherbird					x		x	x	
Cracticus tibicen	Australian Magpie					x		x	x	
DICRURIDAE										
Rhipidura albiscapa	Grey Fantail					x			x	x
Rhipidura phasiana	Mangrove Grey Fantail							x		
Rhipidura leucophrys leucophrys	Willie Wagtail					x		x	x	x
Grallina cyanoleuca	Magpie-lark					x		x	x	x
CORVIDAE										
Corvus bennetti	Little Crow					x		x	x	
Corvus orru	Torresian Crow					x		x	x	x
PETROICIDAE										
Melanodryas cucullata	Hooded Robin					x			x	
Petroicas goodenovii	Red-capped Robin					x			x	
ALAUDIDAE										
Mirafra javanica	Horsfield's Bushlark					x		x	x	
Mirafra cantillans	Singing Bushlark								x	
ACROCEPHALIDAE										
Acrocephalus australis	Australian Reed Warbler								x	x
LOCUSTELLIDAE										
Eremiornis carteri	Spinifex-bird					x		x	x	
TIMALIIDAE										
Zosterops luteus	Yellow White-eye							x		
HIRUNDINIDAE										
Cheramoeca leucosternus	White-backed swallow					x				
Hirundo neoxena	Welcome Swallow							x	x	
Hirundo rustica	Barn Swallow		Mi	S5			x			
Petrochelidon ariel	Fairy Martin					x		x	x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Petrochelidon nigricans	Tree Martin					x		x	x	
DICAEIDAE										
Dicaeum hirundinaceum	Mistletoebird					x		x	x	
ESTRILDIDAE										
Emblema pictum	Painted Finch					x		x	x	
Neochmia ruficauda subclarescens	Star Finch (Western)					x		x	x	x
Taeniopygia guttata	Zebra Finch					x		x	x	
MOTACILLIDAE										
Anthus australis	Australian Pipit					x		x	x	

Table K.4: Mammal species list – results of database searches, literature reviews and Astron survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
TACHYGLOSSIDAE										
Tachyglossus aculeatus	Short-beaked Echidna					x			x	
DASYURIDAE										
Dasycercus blythi	Brush-tailed Mulgara				P4	x				
Dasykaluta rosamondae	Little Red Kaluta					x			x	
Dasyurus hallucatus	Northern Quoll		EN	S2		x	x		x	
Ningaui ridei	Wongai Ningaui					x				
Ningaui timealeyi	Pilbara Ningaui					x			x	
Planigale ingrami	Long-tailed Planigale					x			x	
Planigale maculata	Common Planigale					x				
Planigale 'species 1'	Pilbara Planigale								x	
Pseudantechinus roryi	Rory's Pseudantechinus								x	
Pseudantechinus woolleyae	Woolley's Pseudantechinus					x			x	
Pseudantechinus sp.									x	
Sminthopsis longicaudata	Long-tailed Dunnart				P4	x				
Sminthopsis macroura	Stripe-faced Dunnart					x			x	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart					x			x	
THYLACOMYIDAE										
Macrotis lagotis	Greater Bilby, Dalgyte		VU	S3		x	x			
NOTORYCTIDAE										
Notoryctes caurinus	Northern Marsupial Mole		EN				x			
MACROPODIDAE										
Osphranter robustus erubescens	Euro, Biggada					x			x	
Osphranter rufus	Red Kangaroo, Marlu					x			x	
Petrogale rothschildi	Rothschild's Rock-wallaby					x			x	
PHALANGERIDAE										
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum					x				
MEGADERMATIDAE										

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Macroderma gigas	Ghost Bat		VU	S3		x	x		x	
HIPPOSIDERIDAE										
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat		VU	S3		x	x		x	
EMBALLONURIDAE										
Sacclaimus flaviventris	Yellow-bellied Sheathtail-bat					x			x	
Taphozous georgaianus	Common Sheathtail-bat					x			x	
VESPERTILIONIDAE										
Chalinolobus gouldii	Gould's Wattled Bat					x			x	
Nyctophilus daedalus	Northwestern Long-eared Bat								x	
Nyctophilus geoffroyi	Lesser Long-eared Bat					x			x	
Scotorepens greyii	Little Broad-nosed Bat					x			x	
Vespadelus finlaysoni	Finlayson's Cave Bat					x			x	
MOLOSSIDAE										
Chaerephon jobensis colonicus	Greater Northern Free-tailed Bat					x			x	
Ozimops lumsdenae	Northern Free-tailed Bat					x			x	
Tadarida australis	White-striped Freetail-bat					x			x	
MURIDAE										
Leggadina lakedownensis	Short-tailed Mouse				P4	x	x			
Mus musculus	House Mouse	*				x	x		x	
Notomys alexis	Spinifex Hopping-mouse					x			x	
Pseudomys chapmani	Western Pebble-mound Mouse				P4	x	x		x	
Pseudomys delicatus	Delicate Mouse					x			x	
Pseudomys desertor	Desert Mouse					x			x	
Pseudomys hermannsburgensis	Sandy Inland Mouse					x			x	
Zyzomys argurus	Common Rock-rat					x			x	
LEPORIDAE										
Oryctolagus cuniculus	Rabbit	*				x	x			
CANIDAE										
Canis dingo	Dingo	*				x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Canis familiaris	Dog	*							x	
Vulpes vulpes	Red Fox	*				x	x			
FELIDAE										
Felis catus	Cat	*				x	x		x	
CAMELIDAE										
Camelus dromedarius	Dromedary, Camel	*				x				
EQUIDAE										
Equus asinus	Donkey	*				x	x			
BOVIDAE										
Bos taurus	European Cattle	*				x			x	
Capra hircus	Goat	*					x			

Previous surveys

Astron 2011, Mesa J Tail Track Extension Vegetation, Flora and Fauna Survey
Astron 2014, Mesa H Level 1 Flora, Vegetation and Fauna Assessment
Astron 2016d, Mesa H Level 2 Fauna Survey
Astron 2016e, Bungaroo Iron Ore Mine and Infrastructure Project, Level 2 Fauna Survey
Astron 2016f, Middle Robe and East Deepdale Level 2 Fauna Assessment
Biologic 2014, Yarraloola Targeted Fauna Survey
Biota 2005, Fauna Habitats and Fauna Assemblage of Mesa A and Mesa G
Biota 2006b, Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo
Biota 2007, Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonnica
Biota 2009, Mesa G Baseline Fauna Survey
Biota 2010a, Greater Bungaroo Seasonal Fauna Survey
Biota 2011, Robe Valley Mesas Fauna Survey
Ecologia Environment 2013, Middle Robe and East Deepdale Flora, Vegetation, Vertebrate and Invertebrate Fauna Survey

Appendix L: Threatened and Priority Fauna Species Records and Likelihood of Occurrence within the Survey Area

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405000 410000 415000 420000 425000 430000

7605000

7600000

7595000

7590000

Legend

Mesa H Riparian Community Survey Area

Conservation Significant Fauna Records (Current Survey)

Birds

Merops ornatus (Rainbow Bee-eater)

Conservation Significant Fauna Records (Previous Surveys)

Reptiles

Liasis olivaceus barroni (Pilbara Olive Python)

Notoscincus butleri (Lined Soil-crevice Skink)

Birds

Merops ornatus (Rainbow Bee-eater)

Ardea modesta (Eastern Great Egret)

Mammals

Rhinonicteris aurantia (Pilbara Leaf-nosed Bat)

Macroderma gigas (Ghost Bat)

Dasyurus hallucatus (Northern Quoll)

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure L.1: Threatened and Priority Fauna Species Records

Coordinate System: GDA94 MGA zone 50

0 1,000 2,000 3,000 4,000 Metres

N

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Author: J. Trainer | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigL1_PFauna

Table L.1: Likelihood of occurrence of conservation listed vertebrate fauna species listed as potentially occurring in the vicinity of the survey area.

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Reptiles						
Notoscincus butleri (Lined Soil-crevice Skink)			P4	Arid, rocky, near coastal Pilbara regions. Associated with spinifex-dominated areas near creeks and river margins.	Low	Low
Anilios ganei (Blindsnake)			P1	Little information is available on this species but it is believed to be associated with moist gorges and gullies.	Low	Low
Liasis olivaceus barroni (Pilbara Olive Python)	VU	S3		Generally rocky habitats in close association to permanent and semi-permanent water sources.	High – previously recorded	High
Birds						
Apus pacificus (Fork-tailed Swift)	Mi	S5		Largely aerial species independent of the terrestrial environment.	Moderate	Moderate
Ardea ibis (Cattle Egret)	Mi	S5		Largely wetland species however can exploit drier open habitats more than other heron species.	Moderate	Moderate
Ardea modesta (Eastern Great Egret)	Mi	S5		Wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral).	High – previously recorded	High
Elanus scriptus (Letter-winged Kite)			P4	The Letter-winged Kite is a bird of open country and grasslands in arid and semi-arid Australia, where there are tree-lined streams or water courses.	Moderate	Moderate
Panidon haliaetus (Eastern Osprey)	Mi	S5		Favours coastal areas, especially the mouths of large rivers, lagoons and lakes.	Low	Low

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Charadrius veredus (Oriental Plover)	Mi	S5		Breeding habitat includes arid grasslands, saltpans; non-breeding habitat includes grasslands, salt-fields, and coastal regions.	Low	Low
Charadrius leschenaultii (Greater Sand Plover)	Mi	S5		This species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons.	Low	Low
Rostratula benghalensis (sensu lato) (Australian Painted Snipe)	EN	S2		Shallow terrestrial freshwater wetlands, temporary/permanent lakes, swamps and claypans with emergent grass, sedges, rushes and samphire.	Moderate	Moderate
Actitis hypoleucos (Common Sandpiper)	Mi	S5		Non-breeding migrant to a wide variety of habitats, such as riverbanks, estuaries, freshwater seeps on coastal shores, tidal creeks, mangrove swamps and saltmarshes.	Moderate	Moderate
Calidris acuminata (Sharp-tailed Sandpiper)	Mi	S5		Muddy edges of shallow fresh/brackish wetlands with emergent sedges, saltmarsh, grass and low vegetation.	Moderate	Moderate
Numenius phaeopus (Whimbrel)	Mi	S5		Primarily found in coastal habitats such as beaches, dunes, mudflats and mangroves however there are also scattered inland records.	Low	Low
Tringa glareola (Wood Sandpiper)	Mi	S5		Occurs mainly on freshwater wetlands of the inland interior and arid regions.	Moderate	Moderate
Tringa nebularia (Common Greenshank)	Mi	S5		Inland wetlands and coastal habitats of varying salinity. Typically large mudflats, saltmarsh, mangroves and seagrass	Moderate	Moderate
Glareola maldivarum (Oriental Pratincole)	Mi	S5		Feeds in the air and roosts on bare ground besides water	Moderate	Moderate

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Merops ornatus (Rainbow Bee-eater)	Mi	S5		Lightly wooded, preferably sandy soil, near drainage channels and creek lines.	High – previously recorded	Recorded
Hirundo rustica (Barn Swallow)	Mi	S5		Coastal open country generally, especially near surface water and man-made structures such as bridges and power wires.	Low	Low
Mammals						
Dasycercus blythi (Brush-tailed Mulgara)			P4	Triodia hummock and Acacia shrublands of sand or sandy-loam.	Low	Low
Dasyurus hallucatus (Northern Quoll)	EN	S2		Dissected rocky escarpments and rocky eucalypt woodland.	High – previously recorded	High
Sminthopis longicaudata (Long-tailed Dunnart)			P4	Common in rocky screes with hummock grassland and Acacia shrubs, tall open shrubland and woodlands.	Low	Low
Macrotis lagotis (Greater Bilby, Dalgyte)	VU	S3		Sand or sandy-loam in hummock grassland (Triodia species) and or Acacia shrublands.	Low	Low
Notoryctes caurinus (Northern Marsupial Mole)	EN			Lives primarily underground of sand dunes and sandy soils along river flats.	Low	Low
Macroderma gigas (Ghost Bat)	VU	S3		A wide range from rainforest, monsoon and vine scrub in the tropics to open woodlands and arid areas.	High – previously recorded	High
Rhinonicteris aurantia (Pilbara form) (Pilbara Leaf-nosed Bat)	VU	S3		Deep warm, humid caves or rock cracks.	High – previously recorded	High

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Leggadina lakedownensis (Short-tailed Mouse, Karekanga)			P4	Open tussock and hummock grassland, Acacia shrubland and savannah woodland on alluvial clay/sandy soils.	Low	Low
Pseudomys chapmani (Western Pebble-mound Mouse)			P4	Gentle rocky slopes, hills and spurs with small pebble surface cover and sparse vegetation.	Low	Low

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Appendix M: Vegetation Association Mapping

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410000 415000 420000 425000 430000

7600000 7595000 7590000

Legend

- Survey Site
- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Vegetation Association Mapping

- AtrPl
- EcEvAtrApyPlTw
- Es
- EvAtrTwCspp
- MaEcCv
- Disturbed

Pannawonica

Pannawonica

Robe River

Robe River

MH203 MH363 MH204 MH337r MH397 MH398 MH354 MH379 MH332 MH321 MH385 MH44 MH43 MH394 MH303 MH381 MH384 MH388 MH387 MH389 Millstream Rd

E20 E07 E09 AM215 MH393 MH401 MH392 MH373

Jimmawurrada Creek

Jungroo Creek

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure M.1: Vegetation Association Mapping

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

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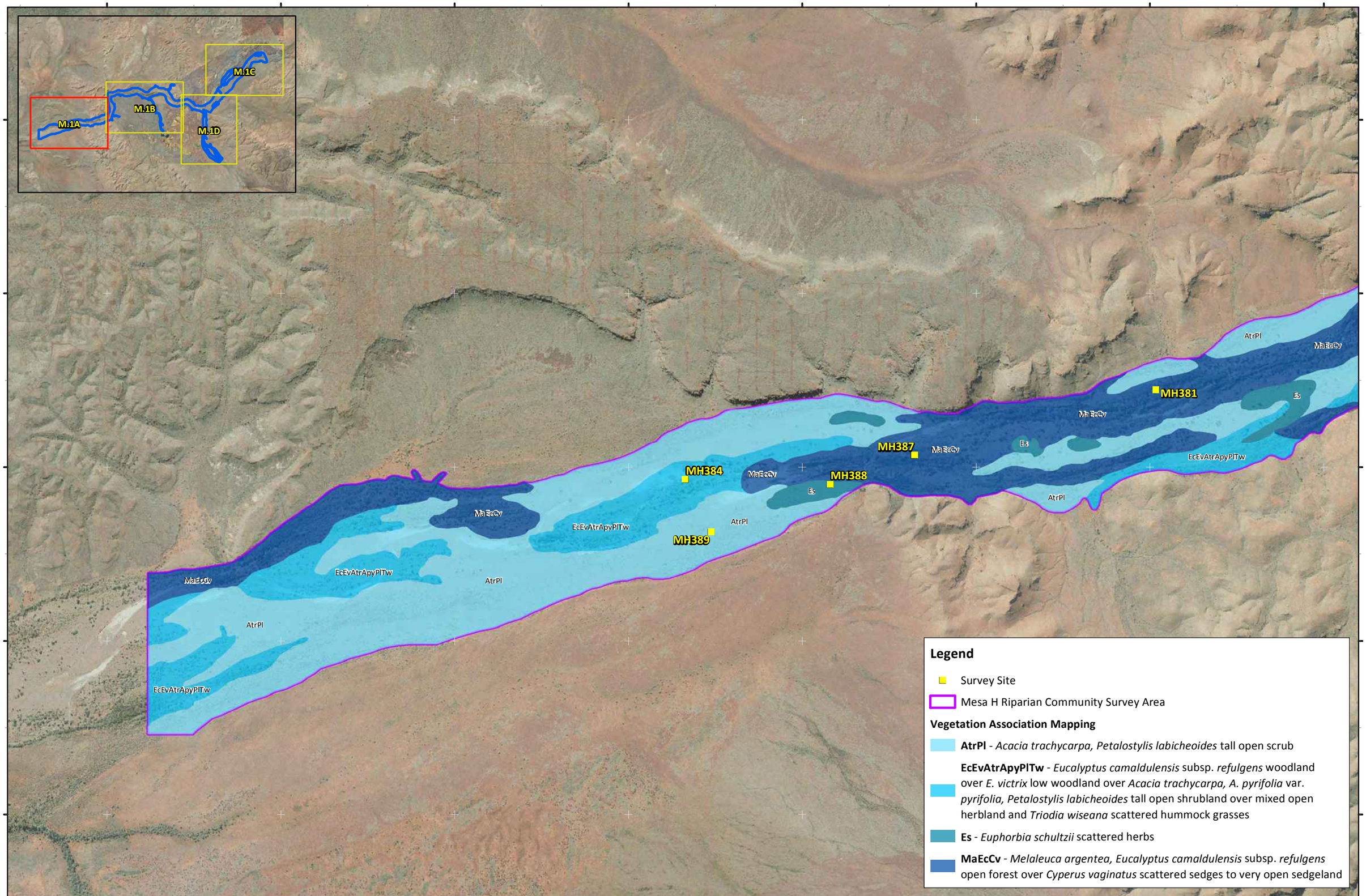
Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigM1_VegAsso



Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure M.1A: Vegetation Association Mapping

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

astron delivering environmental intelligence™

Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigM1_VegAsso_Subset

415000 416000 417000 418000 419000 420000 421000

7599000 7598000 7597000 7596000 7595000

MH363 MH204 MH203 MH397 MH398 MH337r MH354 MH379 MH332 MH321 MH44 MH43 MH385 MH394 MH303

Millstream Rd

AtrPl Disturbed MaEcCv EcEvAtrApyPlTw Es

M.1A M.1B M.1C M.1D

Legend

- Survey Site
- Railway
- Main Road
- Main Road
- Mesa H Riparian Community Survey Area

Vegetation Association Mapping

- **AtrPl** - *Acacia trachycarpa, Petalostylis labicheoides* tall open scrub
- **EcEvAtrApyPlTw** - *Eucalyptus camaldulensis* subsp. *refulgens* woodland over *E. victrix* low woodland over *Acacia trachycarpa, A. pyrifolia* var. *pyrifolia, Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* scattered hummock grasses
- **Es** - *Euphorbia schultzii* scattered herbs
- **MaEcCv** - *Melaleuca argentea, Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Cyperus vaginatus* scattered sedges to very open sedgeland
- **Disturbed**

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure M.1B: Vegetation Association Mapping

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigM1_VegAsso_Subset

425000 426000 427000 428000 429000 430000 431000

7602000 7601000 7600000 7599000 7598000

M.1A M.1B M.1C M.1D

E20 E07 E09

Disturbed
AtrPl
EcEvAtrApyPlTw
MaEcCv

Legend

- Survey Site
- Railway
- Main Road
- Mesa H Riparian Community Survey Area

Vegetation Association Mapping

- **AtrPl** - *Acacia trachycarpa, Petalostylis labicheoides* tall open scrub
- **EcEvAtrApyPlTw** - *Eucalyptus camaldulensis* subsp. *refulgens* woodland over *E. victrix* low woodland over *Acacia trachycarpa, A. pyrifolia* var. *pyrifolia, Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* scattered hummock grasses
- **MaEcCv** - *Melaleuca argentea, Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Cyperus vaginatus* scattered sedges to very open sedgeland
- **Disturbed**

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure M.1C: Vegetation Association Mapping

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

astron delivering environmental intelligence™

Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigM1_VegAsso_Subset

422000 423000 424000 425000 426000 427000

7597000 7596000 7595000 7594000 7593000 7592000 7591000

AtrPl
EvAtrTwCspp
Es
EcEvAtrApyPlTw
MaEcCv
Disturbed
AtrPl
EcEvAtrApyPlTw
MaEcCv
Disturbed
EcEvAtrApyPlTw
AtrPl
MaEcCv
AtrPl
EcEvAtrApyPlTw
AM215
AtrPl
Es
MH393
MH401
MH392
MH373
EvAtrTwCspp
EcEvAtrApyPlTw
M.1C
M.1B
M.1A
M.1D

Legend

- Survey Site
- Railway
- Main Road
- Mesa H Riparian Community Survey Area

Vegetation Association Mapping

- **AtrPl** - *Acacia trachycarpa, Petalostylis labicheoides* tall open scrub
- **EcEvAtrApyPlTw** - *Eucalyptus camaldulensis* subsp. *refulgens* woodland over *E. victrix* low woodland over *Acacia trachycarpa, A. pyrifolia* var. *pyrifolia, Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* scattered hummock grasses
- **Es** - *Euphorbia schultzii* scattered herbs
- **EvAtrTwCspp** - *Eucalyptus victrix* low open woodland over *Acacia trachycarpa* tall open shrubland over *Triodia wiseana* open hummock grassland and **Cenchrus* spp. very open tussock grassland
- **MaEcCv** - *Melaleuca argentea, Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Cyperus vaginatus* scattered sedges to very open sedgeland
- **Disturbed**

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure M.1D: Vegetation Association Mapping

astron
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Author: D. Roocke	Date: 06-04-2017	Coordinate System: GDA94 MGA zone 50
Drawn: W. An	Figure Ref: 14269-16-BIDR-1RevB_170406_FigM1_VegAsso_Subset_4	0 200 400 600 800 1,000 Metres

N

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Appendix N: Vegetation and Flora Sample Site Data

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Site: MH43
Location: Map 4 **Type:** 20x125m Quadrat
Date: 2016-05-04 **Described by:** JA/LV
MGA Zone: 50 **Easting:** 419042 **Northing:** 7596362
Habitat: Major creek
Soil: Brown sandy loam
Rock type: Ironstone
Vegetation: *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* woodland over *Acacia trachycarpa* scattered tall shrubs over **Cenchrus ciliaris* and **C. setiger* very open tussock grassland with *Cyperus vaginatus* scattered sedges.
Veg Condition: Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	0.1
Acacia bivenosa	0.5	1.5
Acacia colei var. *ileocarpa*	0.5	2.2
Acacia elachantha	0.5	2.0
Acacia pyrifolia var. *pyrifolia*	0.5	1.2
Acacia trachycarpa	1	2.5
Capparis spinosa var. *nummularia*	0.5	0.15
**Cenchrus ciliaris*	1	0.15
**Cenchrus setiger*	1	0.2
**Citrullus colocynthis*	0.5	0.1
Cleome viscosa	0.5	0.1
Corchorus lasiocarpus subsp. *parvus*	0.5	0.1
Cucumis variabilis	0.5	0.15
Cyperus vaginatus	1	0.5
Eucalyptus camaldulensis subsp. *refulgens*	14	10.0
Eucalyptus victrix	14	10.0
Euphorbia schultzii	0.5	0.1
Evolvulus alsinoides var. *villosicalyx*	0.5	0.02
Gossypium robinsonii	0.5	0.05
Hybanthus aurantiacus	0.5	0.2
Melaleuca glomerata	0.5	3.5
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)	0.5	0.15
Petalostylis labicheoides	0.5	1.7
Phyllanthus maderaspatensis	0.5	0.1

Name	Cover (%)	Height (m)
Pterocaulon sp.	0.5	0.1
Ptilotus astrolasius	0.5	0.3
Ptilotus axillaris	0.5	0.1
Ptilotus nobilis subsp. *nobilis*	0.5	0.15
Solanum diversiflorum	0.5	0.15
Solanum horridum	0.5	0.12
Stylobasium spathulatum	0.5	1.7
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.25
Triodia epactia	0.5	0.5
Triumfetta appendiculata	0.5	0.4
Waltheria indica	0.5	0.01

* denotes weed species
? denotes unconfirmed ID

Site: MH44
Location: NA **Type:** 20x125m Quadrat
Date: 2016-05-04 **Described by:** JA
MGA Zone: 50 **Easting:** 418862 **Northing:** 7596737
Habitat: Major creek
Soil: Orange brown sandy clay loam
Rock type: NA
Vegetation: *Eucalyptus camaldulensis* subsp. *refulgens, E. victrix* low woodland over *Acacia trachycarpa* and *A. bivenosa* scattered tall shrubs to tall open shrubland over **Cenchrus ciliaris* and **C. setiger* very open tussock grassland.
Veg Condition: Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon lepidum	0.5	0.2
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	0.7
Acacia bivenosa	1	2.2
Acacia pyrifolia var. *pyrifolia*	0.5	2.3
Acacia trachycarpa	2	3.8
**Cenchrus ciliaris*	2	0.15
**Cenchrus setiger*	1	0.15
Cleome viscosa	0.5	0.1
Corchorus lasiocarpus subsp. *parvus*	0.5	0.5
Cyperus vaginatus	0.5	0.7
Eriachne mucronata	0.5	0.4
Eucalyptus camaldulensis subsp. *refulgens*	20	11.0
Eucalyptus victrix	7	9.0
Flueggea virosa subsp. *melanthesoides*	0.5	1.4
Gossypium robinsonii	0.5	0.3
Hybanthus aurantiacus	0.5	0.1
**Malvastrum americanum*	0.5	0.15
Melaleuca glomerata	0.5	2.4
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)	0.5	0.1
Petalostylis labicheoides	0.5	2.3
Phyllanthus maderaspatensis	0.5	0.25
Pterocaulon sphaeranthoides	0.5	0.1
Ptilotus nobilis subsp. *nobilis*	0.5	0.05
Rhynchosia minima	0.5	0.1

Name	Cover (%)	Height (m)
Solanum cleistogamum	0.5	0.15
Solanum diversiflorum	0.5	0.3
Solanum horridum	0.5	0.15
Stylobasium spathulatum	0.5	1.1
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.15
Themeda triandra	0.5	0.9
Triodia epactia	0.5	0.5
Triumfetta appendiculata	0.5	0.15
**Vachellia farnesiana*	0.5	1.8
Waltheria indica	0.5	0.1

* denotes weed species
? denotes unconfirmed ID

Site: MH203
Location: Map 4 **Type:** 50x50m Quadrat
Date: 2016-05-02 **Described by: DR/LV**
MGA Zone: 50 **Easting:** 418754 **Northing:** 7598544
Habitat: Major creek
Soil: Red brown sand
Rock type: Ironstone
Vegetation: *Acacia trachycarpa* and *A. bivenosa* tall open scrub.
Veg Condition: Excellent
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	1	2.1
Acacia pyrifolia var. *pyrifolia*	0.5	2.2
Acacia trachycarpa	35	4.5
Adriana tomentosa	0.5	1.3
**Cenchrus setiger*	0.5	0.4
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	0.3
Euphorbia schultzii	0.5	0.15
Hybanthus aurantiacus	0.5	0.2
Ptilotus auriculifolius	0.5	0.3
Rhynchosia bungarensis P4	0.5	0.4

* denotes weed species
? denotes unconfirmed ID

Site: MH204
Location: NA **Type:** 50x50m Quadrat
Date: 2016-05-03 **Described by:** DR/KMc
MGA Zone: 50 **Easting:** 417491 **Northing:** 7598178
Habitat: Major creek
Soil: Red brown sandy loam
Rock type: NA
Vegetation: *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Acacia trachycarpa* tall open shrubland over *Cyperus vaginatus* scattered sedges.
Veg Condition: Very Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	0.5	1.5
Acacia synchronicia	0.5	0.3
Acacia trachycarpa	3	2.5
**Cenchrus ciliaris*	0.5	0.2
Cleome viscosa	0.5	0.5
Cyperus vaginatus	1	0.9
Eucalyptus camaldulensis subsp. *refulgens*	10	17
Euphorbia australis	0.5	
Euphorbia biconvexa	0.5	0.1
**Euphorbia hirta*	0.5	0.1
Euphorbia schultzii	0.5	0.2
Ipomoea muelleri	0.5	0.3
Lobelia sp.	0.5	0.2
Melaleuca argentea	40	18
**Passiflora foetida* var. *hispida*	0.5	0.9
Petalostylis labicheoides	0.5	1.8
Phyllanthus maderaspatensis	0.5	0.2
Pluchea rubelliflora	0.5	0.2
Rhynchosia bungarensis P4	0.5	0.3
Sesbania formosa	0.5	6.7
Stemodia grossa	0.5	0.2
Streptoglossa liatroides	0.5	0.3
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.0
Tephrosia sp. Fortescue (A.A. Mitchell 606)	0.5	
Vigna lanceolata var. *lanceolata*	0.5	0.3

Name	Cover (%)	Height (m)
Waltheria indica	0.5	0.6

* denotes weed species
? denotes unconfirmed ID

Site: MH303
Location: NA **Type:** 25x100m Quadrat
Date: 2016-04-29 **Described by:** JA/KMc
MGA Zone: 50 **Easting:** 419534 **Northing:** 7595539
Habitat: Minor creek
Soil: Red brown silty loam
Rock type: Ironstone
Vegetation: *Eucalyptus camaldulensis* subsp. *refulgens* low open forest over *Acacia trachycarpa* and *Petalostylis labicheoides* tall open shrubland over Melaleuca glomerata and *A. bivenosa* open shrubland over *Triumfetta clementii* scattered low shrubs over **Cenchrus setiger* tussock grassland with *Cyperus vaginatus* scattered sedges.
Veg Condition: Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon lepidum	0.5	0.3
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	2.0
Acacia bivenosa	1	1.2
Acacia colei var. *ileocarpa*	0.5	2.2
Acacia pyrifolia var. *pyrifolia*	0.5	1.5
Acacia trachycarpa	1	2.1
Boerhavia coccinea	0.5	0.1
Cleome viscosa	0.5	0.6
**Cenchrus ciliaris*	0.5	0.1
**Cenchrus setiger*	32	0.4
Corchorus lasiocarpus subsp. *parvus*	0.5	0.2
Cucumis variabilis	0.5	
Cymbopogon ambiguus	0.5	0.7
Cyperus vaginatus	1	0.6
Dactyloctenium radulans	0.5	0.2
**Echinochloa colona*	0.5	0.1
Eriachne mucronata	0.5	0.4
Eucalyptus camaldulensis subsp. *refulgens*	40	7.0
Eulalia aurea	0.5	0.6
**Euphorbia hirta*	0.5	0.05
Euphorbia schultzii	0.5	0.15
Ficus aculeata var. *indecora*	0.5	1.0
Flueggea virosa subsp. *melanthesoides*	0.5	0.4

Name	Cover (%)	Height (m)
Gomphrena cunninghamii	0.5	0.05
Gossypium robinsonii	0.5	0.1
Hybanthus aurantiacus	0.5	0.3
Ipomoea muelleri	0.5	0.2
Lepidium pholidogynum	0.5	0.1
Lobelia arnhemiaca	0.5	0.05
**Malvastrum americanum*	0.5	0.3
Melaleuca glomerata	1	1.2
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)	0.5	0.05
Paraneurachne muelleri	0.5	0.5
Paspalidium clementii	0.5	0.2
Petalostylis labicheoides	1	2.3
Phyllanthus maderaspatensis	0.5	0.25
Ptilotus appendiculatus	0.5	0.1
Ptilotus sp.	0.5	0.1
**Setaria verticillata*	0.5	0.4
Sida sp. Articulation below (A.A. Mitchell PRP 1605)	0.5	0.3
Solanum diversiflorum	0.5	0.45
Solanum horridum	0.5	0.15
**Sonchus oleraceus*	0.5	0.15
Stylobasium spathulatum	0.5	2.0
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.5
Themeda triandra	0.5	0.9
Trachymene oleracea subsp. *oleracea*	0.5	0.65
Triodia wiseana	0.5	0.6
Triumfetta appendiculata	0.5	0.8
Triumfetta clementii	1	0.1
Triumfetta sp.	0.5	0.2
**Vachellia farnesiana*	0.5	0.5
Waltheria indica	0.5	0.15

* denotes weed species
? denotes unconfirmed ID

Site: MH321
Location: NA **Type:** 40x60m Quadrat
Date: 2016-05-11 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 414835 **Northing:** 7596664
Habitat: Major creek
Soil: Brown loamy sand
Rock type: NA
Vegetation: *Petalostylis labicheoides* and *Acacia trachycarpa* tall shrubland.
Veg Condition: Very Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	0.5	1.6
Acacia synchronicia	0.5	3.4
Acacia trachycarpa	6	2.5
Acacia trachycarpa x *tumida* var. *pilbarensis*	0.5	1.0
**Cenchrus ciliaris*	0.5	0.4
**Cenchrus setiger*	0.5	0.5
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	0.5
**Cynodon dactylon*	0.5	0.1
Euphorbia schultzii	0.5	0.1
Gomphrena cunninghamii	0.5	0.15
Petalostylis labicheoides	8	2.2
Ptilotus astrolasius	0.5	0.5
Ptilotus nobilis subsp. *nobilis*	0.5	0.5
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.7
Triodia epactia	0.5	0.3
Triodia wiseana	0.5	0.4
Triumfetta ?*chaetocarpa*	0.5	0.5

* denotes weed species
? denotes unconfirmed ID

Site: MH332
Location: NA **Type:** 50x50m Quadrat
Date: 2016-05-11 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 414398 **Northing:** 7597069
Habitat: Major creek
Soil: Red brown silty clay loam
Rock type: NA
Vegetation: *Melaleuca argentea* open forest over *Acacia trachycarpa* and *Petalostylis labicheoides* tall open shrubland over *Cyperus vaginatus* scattered sedges.
Veg Condition: Excellent
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	2.5
Acacia bivenosa	0.5	2.8
Acacia pyrifolia var. *pyrifolia*	0.5	1.5
Acacia trachycarpa	2	2.8
Capparis spinosa var. *nummularia*	0.5	0.5
**Cenchrus ciliaris*	0.5	0.45
Cleome viscosa	0.5	0.2
Corchorus crozophorifolius	0.5	1.1
**Cynodon dactylon*	0.5	0.1
Cyperus vaginatus	1	1.0
Eleocharis geniculata	0.5	0.08
Eucalyptus sp.	0.5	5.5
Eucalyptus victrix	0.5	5.5
Euphorbia schultzii	0.5	0.3
Gossypium robinsonii	0.5	2.5
Helichrysum luteoalbum	0.5	0.15
Ipomoea muelleri	0.5	
Jasminum didymum subsp. *lineare*	0.5	1.2
**Lactuca serriola*	0.5	0.2
Lobelia arnhemiaca	0.5	
Melaleuca argentea	32	15.0
**Passiflora foetida* var. *hispida*	0.5	
Petalostylis labicheoides	1	2.5
Phyllanthus maderaspatensis	0.5	0.2
Pluchea rubelliflora	0.5	0.2

Name	Cover (%)	Height (m)
Rhynchosia bungarensis P4	0.5	
Schoenoplectus subulatus	0.5	1.4
Sesbania formosa	0.5	4.5
Stemodia grossa	0.5	0.1
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.1
Trachymene oleracea subsp. *oleracea*	0.5	1.0
Triumfetta appendiculata	0.5	1.3
Triumfetta johnstonii	0.5	1.3
Typha domingensis	0.5	1.5
**Vachellia farnesiana*	0.5	0.7
Vigna lanceolata var. *lanceolata*	0.5	

* denotes weed species
? denotes unconfirmed ID

Site: MH337r
Location: NA **Type:** 50x50m Relevé
Date: 2016-05-05 **Described by:** DR/KMc
MGA Zone: 50 **Easting:** 419227 **Northing:** 7597959
Habitat: Major creek
Soil: Red brown silty clay loam
Rock type: NA
Vegetation: *Melaleuca argentea* open forest over *Cyperus vaginatus* scattered sedges.
Veg Condition: Very Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	0.5	1.5
**Argemone ochroleuca* subsp. *ochroleuca*	0.5	0.8
**Cenchrus setiger*	0.5	0.6
***Cucumis** variabilis*	0.5	0.1
Cymbopogon ambiguus	0.5	0.5
Cyperus vaginatus	1	1.0
Ipomoea muelleri	0.5	
Lobelia arnhemiaca	0.5	
Melaleuca argentea	50	25
**Passiflora foetida* var. *hispida*	0.5	
Petalostylis labicheoides	0.5	1.5
Phyllanthus maderaspatensis	0.5	0.5
Rhynchosia bungarensis P4	0.5	0.3
Stemodia grossa	0.5	0.5
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.2
Trachymene oleracea subsp. *oleracea*	0.5	1.1
Vigna lanceolata var. *lanceolata*	0.5	

* denotes weed species
? denotes unconfirmed ID

Site: MH354
Location: Map 4 in river north of Mesa h **Type:** 50x50m Quadrat
Date: 2016-05-05 **Described by:** DR/KMc
MGA Zone: 50 **Easting:** 418262 **Northing:** 7597672
Habitat: Major creek
Soil: Red brown sandy loam
Rock type: Ironstone
Vegetation: *Acacia trachycarpa* and *Petalostylis labicheoides* tall open scrub.
Veg Condition: Very Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	0.5	1.3
Acacia trachycarpa	32	3.0
**Cenchrus ciliaris*	0.5	0.3
**Cenchrus setiger*	0.5	0.2
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	1.1
Cymbopogon ambiguus	0.5	0.8
Enneapogon caerulescens	0.5	0.3
Eucalyptus camaldulensis subsp. *refulgens*	0.5	5.0
Euphorbia schultzii	0.5	0.3
Indigofera monophylla	0.5	0.4
Petalostylis labicheoides	1	2.8
Phyllanthus maderaspatensis	0.5	0.3
Ptilotus nobilis subsp. *nobilis*	0.5	0.1
Rhynchosia bungarensis P4	0.5	0.5
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.6
Triodia epactia	0.5	0.4

* denotes weed species
? denotes unconfirmed ID

Site: MH363
Location: Map 3 **Type:** 50x50m Quadrat
Date: 2016-05-03 **Described by:** DR/KMc
MGA Zone: 50 **Easting:** 415908 **Northing:** 7598273
Habitat: Major creek
Soil: Red brown sandy loam
Rock type: NA
Vegetation: *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Acacia trachycarpa* scattered tall shrubs shrubland over *Cyperus vaginatus* scattered sedges.
Veg Condition: Very Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	1	2.3
**Argemone ochroleuca* subsp. *ochroleuca*	0.5	0.1
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	1.9
**Cynodon dactylon*	0.5	0.1
Cyperus vaginatus	1	0.9
Eucalyptus camaldulensis subsp. *refulgens*	2	11.0
**Euphorbia hirta*	0.5	0.1
Gossypium robinsonii	0.5	2.3
Heliotropium pachyphyllum	0.5	0.2
Melaleuca argentea	62	14.0
**Passiflora foetida* var. *hispida*	0.5	1.0
Petalostylis labicheoides	0.5	2.5
Phyllanthus maderaspatensis	0.5	0.2
Pluchea rubelliflora	0.5	0.2
Ptilotus sp.	0.5	0.1
Sesbania formosa	0.5	4.5
Sporobolus australasicus	0.5	0.1
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.5
Trachymene oleracea subsp. *oleracea*	0.5	0.3
Vigna lanceolata var. *lanceolata*	0.5	0.5
Wahlenbergia tumidifructa	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH373
Location: Map 11 in Bungaroo creek **Type:** 50x50m Quadrat
Date: 2016-05-10 **Described by:** KMc/LV
MGA Zone: 50 **Easting:** 424165 **Northing:** 7592224
Habitat: Major creek
Soil: Brown silty clay
Rock type: NA
Vegetation: *Eucalyptus victrix* and *E. camaldulensis* subsp. *refulgens* woodland over **Cenchrus* sp. open tussock grassland.
Veg Condition: Poor
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Abutilon sp.	0.5	0.1
Acacia colei var. *ileocarpa*	0.5	0.5
Acacia pyrifolia var. *pyrifolia*	0.5	0.8
Acacia trachycarpa	0.5	2.5
Cenchrus sp.	25	0.1
Cyperus vaginatus	0.5	0.5
**Echinochloa colona*	0.5	0.05
Eucalyptus camaldulensis subsp. *refulgens*	6	13.0
Eucalyptus victrix	6	13.0
**Euphorbia hirta*	0.5	0.2
Gossypium robinsonii	0.5	0.7
Hakea chordophylla	0.5	9.0
Hybanthus aurantiacus	0.5	0.4
Indigofera boviperda	0.5	0.5
Ipomoea polymorpha	0.5	0.05
**Malvastrum americanum*	0.5	0.1
Marsilea sp.	0.5	0.02
Mollugo molluginea	0.5	0.05
Phyllanthus maderaspatensis	0.5	0.1
Phyllanthus sp.	0.5	0.01
Pterocaulon sp.	0.5	0.1
Sida fibulifera	0.5	0.05
Solanum cleistogamum	0.5	0.2
**Vachellia farnesiana*	0.5	0.1
Vigna lanceolata var. *lanceolata*	0.5	0.05

* denotes weed species
? denotes unconfirmed ID

Site: MH379
Location: Map 4 in river north east of mesa h **Type:** 60x40m Quadrat
Date: 2016-05-05 **Described by:** DR/KMc
MGA Zone: 50 **Easting:** 418345 **Northing:** 7597456
Habitat: Major creek
Soil: Red brown sandy loam
Rock type: Ironstone
Vegetation: *Eucalyptus camaldulensis* subsp. *refulgens* low woodland over *Petalostylis labicheoides* and *Acacia trachycarpa* tall open shrubland over **Cenchrus ciliaris* and *C. *setiger* very open tussock grassland with *Cyperus vaginatus* very open sedgeland.
Veg Condition: Very Good
Fire Age: No fire evident

Notes: NA
Species List

Name	Cover (%)	Height (m)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	1.0
Acacia bivenosa	0.5	3.0
Acacia pyrifolia var. *pyrifolia*	0.5	3.0
Acacia trachycarpa	1	4.0
**Argemone ochroleuca* subsp. *ochroleuca*	0.5	0.1
Capparis spinosa var. *nummularia*	0.5	0.05
**Cenchrus ciliaris*	1	0.4
**Cenchrus setiger*	1	0.1
**Citrullus colocynthis*	0.5	0.1
Cleome viscosa	0.5	0.2
Corchorus sp.	0.5	0.6
Cucumis variabilis	0.5	0.05
Cyperus vaginatus	2	0.8
Eucalyptus camaldulensis subsp. *refulgens*	15	8.0
Euphorbia biconvexa	0.5	0.3
Gossypium robinsonii	0.5	2.5
Hybanthus aurantiacus	0.5	0.2
Lysiana casuarinae	0.5	
**Malvastrum americanum*	0.5	0.2
**Passiflora foetida* var. *hispida*	0.5	0.3
Petalostylis labicheoides	2	3.0
Phyllanthus maderaspatensis	0.5	0.8
Ptilotus astrolasius	0.5	0.1

Name	Cover (%)	Height (m)
Ptilotus nobilis subsp. *nobilis*	0.5	0.05
Senna notabilis	0.5	1.5
Solanum diversiflorum	0.5	0.5
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.5
Triodia wiseana	0.5	0.6

* denotes weed species
? denotes unconfirmed ID

Site: MH381
Location: Map 2 **Type:** 50x50m Quadrat
Date: 2016-05-13 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 413034 **Northing:** 7595447
Habitat: Channel
Soil: Reddish brown sandy clay loam
Rock type: NA
Vegetation: *Melaleuca argentea* woodland over *Cyperus vaginatus* open sedgeland.
Veg Condition: Very Good
Fire Age: No fire evident

Notes: NA
Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	0.5	2.0
Capparis spinosa var. *nummularia*	0.5	0.3
Cenchrus sp.	0.5	0.2
Cleome viscosa	0.5	0.05
Corchorus sp.	0.5	0.1
Crotalaria novae-hollandiae	0.5	0.3
Cucumis variabilis	0.5	0.1
**Cynodon dactylon*	0.5	0.05
Cyperus vaginatus	3	1.0
Eucalyptus camaldulensis subsp. *refulgens*	0.5	9.0
Euphorbia biconvexa	0.5	0.05
Hybanthus aurantiacus	0.5	0.2
Lobelia arnhemiaca	0.5	0.01
Melaleuca argentea	28	19
**Passiflora foetida* var. *hispida*	0.5	6.0
Petalostylis labicheoides	0.5	2.0
Phyllanthus maderaspatensis	0.5	0.3
Pluchea rubelliflora	0.5	0.3
Pterocaulon sp.	0.5	0.01
Ptilotus sp.	0.5	0.01
Rhynchosia bungarensis P4	0.5	0.2
Sesbania formosa	0.5	10
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.1
Typha domingensis	0.5	0.2

Name	Cover (%)	Height (m)
**Vachellia farnesiana*	0.5	0.1
Waltheria indica	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH384
Location: NA **Type:** 40x62.5m Quadrat
Date: 2016-06-06 **Described by:** JA
MGA Zone: 50 **Easting:** 410331 **Northing:** 7594931
Habitat: Major creek
Soil: Red brown loamy sand
Rock type: River stones
Vegetation: *Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus* ?*victrix* woodland over *Petalostylis labicheoides* and *Acacia trachycarpa* tall shrubland over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) scattered low shrubs.
Veg Condition: Very Good
Fire Age: >10 years

Notes: NA
Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	0.5	1.6
Acacia trachycarpa	7	4.0
Boerhavia coccinea	0.5	0.1
Bonamia pilbarensis	0.5	0.05
**Cenchrus ciliaris*	0.5	0.4
**Cenchrus setiger*	0.5	0.4
Cleome viscosa	0.5	0.3
Corchorus crozophorifolius	0.5	1.0
Corchorus lasiocarpus subsp. *parvus*	0.5	1.2
Cucumis variabilis	0.5	0.5
**Cynodon dactylon*	0.5	0.15
Cyperus vaginatus	0.5	0.7
Eriachne pulchella subsp. *dominii*	0.5	0.15
Eucalyptus ?victrix	11	11.0
Eucalyptus camaldulensis subsp. *refulgens*	12	13.0
Euphorbia biconvexa	0.5	0.2
Euphorbia schultzii	0.5	0.15
Hybanthus aurantiacus	0.5	0.2
Melaleuca argentea	0.5	
Paspalidium sp.	0.5	0.2
Petalostylis labicheoides	8	4.0
Phyllanthus maderaspatensis	0.5	0.3

Name	Cover (%)	Height (m)
Rhynchosia bungarensis P4	0.5	0.4
Sida rohlenae subsp. *rohlenae*	0.5	0.3
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	1	0.5
Triodia wiseana	0.5	0.6

* denotes weed species
? denotes unconfirmed ID

Site: MH385
Location: NA **Type:** 50x50m Quadrat
Date: 2016-05-05 **Described by:** JA/LV
MGA Zone: 50 **Easting:** 421571 **Northing:** 7597120
Habitat: Channel
Soil: Brown loamy sand
Rock type: NA
Vegetation: *Melaleuca argentea* open forest over *Petalostylis labicheoides* and *Acacia trachycarpa* tall open shrubland.
Veg Condition: Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Acacia pyrifolia var. *pyrifolia*	0.5	4.3
Acacia trachycarpa	1	3.2
Amaranthus undulatus	0.5	0.2
Capparis spinosa var. *nummularia*	0.5	0.4
**Cenchrus ciliaris*	0.5	0.4
Cleome viscosa	0.5	0.2
Cucumis variabilis	0.5	
Cyperus vaginatus	0.5	0.9
Eucalyptus sp.	0.5	1.5
Euphorbia biconvexa	0.5	0.4
Euphorbia schultzii	0.5	0.1
Hybanthus aurantiacus	0.5	0.3
Ipomoea muelleri	0.5	
Jasminum didymum subsp. *lineare*	0.5	0.7
Melaleuca argentea	60	20.0
Paspalidium clementii	0.5	0.15
**Passiflora foetida* var. *hispida*	6	
Petalostylis labicheoides	1	3.0
Phyllanthus maderaspatensis	0.5	0.3
Ptilotus sp.	0.5	0.05
Rhynchosia bungarensis P4	0.5	0.4
**Setaria verticillata*	0.5	0.4
Trachymene oleracea subsp. *oleracea*	0.5	0.1

* denotes weed species

Site: MH387
Location: NA **Type:** 50x50m Quadrat
Date: 2016-05-13 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 411646 **Northing:** 7595070
Habitat: Channel
Soil: Brown loamy sand
Rock type: NA
Vegetation: *Melaleuca argentea* and *Eucalyptus camaldulensis* subsp. *refulgens* open forest over *Acacia trachycarpa* and *Petalostylis labicheoides* tall open shrubland over *Cyperus vaginatus* scattered sedges.
Veg Condition: Very Good
Fire Age: >10 years

Notes: NA
Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	4	4.0
Acacia trachycarpa x tumida var. *pilbarensis*	0.5	1.9
Alternanthera nana	0.5	0.15
Capparis spinosa var. nummularia	0.5	0.5
Cenchrus sp.	0.5	0.4
Cucumis variabilis	0.5	1.0
**Cynodon dactylon*	0.5	0.4
Cyperus vaginatus	1	1.2
Eucalyptus camaldulensis subsp. *refulgens*	10	12.0
Euphorbia schultzii	0.5	0.2
Melaleuca argentea	25	15.0
**Passiflora foetida* var. *hispida*	0.5	4.5
Petalostylis labicheoides	1	4.0
Phyllanthus maderaspatensis	0.5	0.3
Pluchea rubelliflora	0.5	0.2
Sesbania formosa	0.5	9.0
Stemodia grossa	0.5	0.6
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	1.9
**Vachellia farnesiana*	0.5	1.6
Vigna lanceolata var. lanceolata	0.5	0.4

* denotes weed species
? denotes unconfirmed ID

Site: MH388
Location: Map 2 **Type:** 50x50m Quadrat
Date: 2016-06-06 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 411162 **Northing:** 7594904
Habitat: Major creek
Soil: Brown sandy loam
Rock type: River stones
Vegetation: *Euphorbia schultzii*, *Cleome viscosa* and *Hybanthus aurantiacus* very scattered herbs.
Veg Condition: Very Good
Fire Age: No fire evident

Notes: NA

Species List

Name	Cover (%)	Height (m)
**Argemone ochroleuca subsp. ochroleuca*	0.5	0.01
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. parvus	0.5	1.0
Euphorbia schultzii	0.5	0.2
Hybanthus aurantiacus	0.5	0.1
Petalostylis labicheoides	0.5	1.5
Ptilotus obovatus	0.5	0.3

* denotes weed species
? denotes unconfirmed ID

Site: MH389
Location: Mesa G Robe River **Type:** 50x50m Quadrat
Date: 2016-06-06 **Described by:** DR
MGA Zone: 50 **Easting:** 410478 **Northing:** 7594630
Habitat: Major creek
Soil: Brown sandy loam
Rock type: River stones
Vegetation: *Acacia trachycarpa* and *Petalostylis labicheoides* tall shrubland.
Veg Condition: Very Good
Fire Age: No fire evident

Notes: NA

Species List

Name	Cover (%)	Height (m)
Acacia bivenosa	0.5	2.0
Acacia trachycarpa	22	4.5
**Cenchrus ciliaris*	0.5	0.3
**Cenchrus setiger*	0.5	0.4
Cleome viscosa	0.5	0.3
Corchorus crozophorifolius	0.5	1.3
Corchorus lasiocarpus subsp. *parvus*	0.5	0.9
Cucumis variabilis	0.5	0.3
Dysphania sp.	0.5	0.02
Euphorbia schultzii	0.5	0.2
Hybanthus aurantiacus	0.5	0.1
Indigofera monophylla	0.5	0.2
Ipomoea muelleri	0.5	0.4
Paspalidium sp.	0.5	0.1
Petalostylis labicheoides	7	3.0
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.9
Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)	0.5	0.4
Triodia epactia	0.5	0.6
Triodia wiseana	0.5	0.8

* denotes weed species
? denotes unconfirmed ID

Site: MH392
Location: NA **Type:** 50x50m Quadrat
Date: 2016-05-10 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 424829 **Northing:** 7592502
Habitat: Major creek
Soil: Red brown sandy clay loam
Rock type: NA
Vegetation: *Eucalyptus victrix* open woodland over *Acacia trachycarpa* tall open shrubland over *Triodia wiseana* very open hummock grassland and **Cenchrus ciliaris* very open tussock grassland.
Veg Condition: Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	0.5
Acacia bivenosa	0.5	1.1
Acacia pyrifolia var. *pyrifolia*	0.5	1.6
Acacia trachycarpa	7	2.1
Boerhavia coccinea	0.5	0.1
Capparis spinosa var. *nummularia*	0.5	0.4
**Cenchrus ciliaris*	3	0.25
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	0.5
Cymbopogon ambiguus	0.5	0.8
Cyperus vaginatus	0.5	0.6
Eucalyptus victrix	6	14.0
Euphorbia biconvexa	0.5	0.15
Euphorbia schultzii	0.5	0.05
Evolvulus alsinoides var. *villosicalyx*	0.5	0.1
Flueggea virosa subsp. *melanthesoides*	0.5	3.8
Gomphrena cunninghamii	0.5	0.05
Gossypium australe	0.5	0.4
Gossypium robinsonii	0.5	1.0
Grevillea wickhamii	0.5	0.7
Hybanthus aurantiacus	0.5	0.1
Indigofera monophylla	0.5	0.15
**Malvastrum americanum*	0.5	0.1
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)	0.5	0.1
**Passiflora foetida* var. *hispida*	0.5	0.1

Name	Cover (%)	Height (m)
Phyllanthus maderaspatensis	0.5	0.3
Pterocaulon sphaeranthoides	0.5	0.1
Ptilotus appendiculatus	0.5	0.05
Ptilotus calostachyus	0.5	0.4
Ptilotus incanus	0.5	0.2
Ptilotus nobilis subsp. *nobilis*	0.5	0.1
Rhynchosia minima	0.5	0.05
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.5	0.6
Solanum diversiflorum	0.5	0.1
Solanum horridum	0.5	0.15
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.6
Trianthema triquetrum	0.5	0.05
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367) P3	0.5	0.5
Triodia wiseana	3	0.6
Triumfetta appendiculata	0.5	0.3
Triumfetta clementii	0.5	0.1
Waltheria indica	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH393
Location: Map 11 **Type:** 25x100m Quadrat
Date: 2016-05-10 **Described by:** JA/DR
MGA Zone: 50 **Easting:** 424501 **Northing:** 7592735
Habitat: Major creek
Soil: Red brown sandy clay loam
Rock type: NA
Vegetation: *Eucalyptus victrix* low open woodland over *Acacia trachycarpa* tall open shrubland over *Triodia wiseana* very open hummock grassland and **Cenchrus ciliaris* very open tussock grassland.
Veg Condition: Good
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.5	0.2
Acacia bivenosa	0.5	2.1
Acacia colei var. *ileocarpa*	0.5	0.6
Acacia pyrifolia var. *pyrifolia*	0.5	2.1
Acacia synchronicia	0.5	2.2
Acacia trachycarpa	9	2.7
Acacia tumida var. *pilbarensis*	0.5	1.3
Boerhavia coccinea	0.5	0.1
**Cenchrus ciliaris*	3	0.2
Cleome viscosa	0.5	0.2
Corchorus lasiocarpus subsp. *parvus*	0.5	0.2
Cucumis variabilis	0.5	0.2
Cymbopogon ambiguus	0.5	0.3
Eriachne mucronata	0.5	0.4
Eriachne tenuiculmis	0.5	0.3
Eucalyptus victrix	2	8.0
Euphorbia australis	0.5	0.05
Euphorbia biconvexa	0.5	0.1
Euphorbia schultzii	0.5	0.02
Gossypium australe	0.5	0.3
Gossypium robinsonii	0.5	0.6
Hybanthus aurantiacus	0.5	0.1
**Malvastrum americanum*	0.5	0.3
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)	0.5	0.1
Phyllanthus maderaspatensis	0.5	0.2

Name	Cover (%)	Height (m)
Pterocaulon sp.	0.5	0.2
Ptilotus appendiculatus	0.5	0.1
Ptilotus auriculifolius	0.5	0.1
Rhynchosia minima	0.5	0.1
Senna ferraria	0.5	1.1
Senna notabilis	0.5	0.2
Solanum diversiflorum	0.5	0.2
Solanum horridum	0.5	0.2
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.2
Triodia wiseana	7	0.6
Waltheria indica	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH394
Location: SW corner Map 6 **Type:** 50x50m Quadrat
Date: 2016-05-11 **Described by:** KMc/LV
MGA Zone: 50 **Easting:** 414348 **Northing:** 7595672
Habitat: Major creek
Soil: Brown sand
Rock type: Ironstone
Vegetation: *Acacia trachycarpa* very scattered shrub over *Euphorbia schultzii* very scattered low shrubs.
Veg Condition: Excellent
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
**Argemone ochroleuca* subsp. *ochroleuca*	0.5	0.3
Acacia trachycarpa	0.5	2.5
Cleome viscosa	0.5	0.01
Corchorus ?crozophorifolius	0.5	0.4
Euphorbia schultzii	0.5	0.15
Hybanthus aurantiacus	0.5	0.15
Ptilotus incanus	0.5	0.3
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)	0.5	0.35

* denotes weed species
? denotes unconfirmed ID

Site: MH397
Location: Map 3 **Type:** 50x50m Quadrat
Date: 2016-05-12 **Described by:** DR
MGA Zone: 50 **Easting:** 416275 **Northing:** 7597984
Habitat: Major creek
Soil: Brown sandy clay loam
Rock type: NA
Vegetation: *Acacia trachycarpa* and *Petalostylis labicheoides* very scattered tall shrubs over *Euphorbia schultzii* very scattered herbs.
Veg Condition: Very Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	0.5	2.8
Euphorbia schultzii	0.5	0.2
Ipomoea muelleri	0.5	0.1
Petalostylis labicheoides	0.5	2.5
Phyllanthus maderaspatensis	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH398
Location: NA **Type:** 60x42m Quadrat
Date: 2016-05-12 **Described by:** JA
MGA Zone: 50 **Easting:** 417606 **Northing:** 7597831
Habitat: Channel
Soil: Brown loamy sand
Rock type: NA
Vegetation: *Acacia trachycarpa* scattered tall shrubs to tall open shrubland (over *Euphorbia schultzii* very scattered herbs).
Veg Condition: Excellent
Fire Age: >10 years

Species List

Name	Cover (%)	Height (m)
Acacia trachycarpa	2	3.7
Euphorbia schultzii	0.5	0.15
Hybanthus aurantiacus	0.5	0.2
Ipomoea muelleri	0.5	0.05
Ptilotus incanus	0.5	0.2

* denotes weed species
? denotes unconfirmed ID

Site: MH401
Location: Map 11 just NE of creek **Type:** 50x50m Quadrat
Date: 2016-05-10 **Described by:** KMc
MGA Zone: 50 **Easting:** 424035 **Northing:** 7592626
Habitat: Floodplain
Soil: Light reddish brown silty clay
Rock type: NA
Vegetation: *Eucalyptus victrix* low open woodland over *Acacia trachycarpa* and *Melaleuca glomerata* tall open shrubland over *Triodia wiseana* open hummock grassland with **Cenchrus ciliaris* open tussock grassland.
Veg Condition: Good
Fire Age: No fire evident

Species List

Name	Cover (%)	Height (m)
Abutilon sp.	0.5	0.2
Acacia bivenosa	0.5	1.2
Acacia colei var. *ileocarpa*	0.5	0.6
Acacia pyrifolia var. *pyrifolia*	0.5	3.0
Acacia sclerosperma subsp. *sclerosperma*	0.5	1.3
Acacia trachycarpa	7	2.5
**Cenchrus ciliaris*	12	0.1
Eucalyptus victrix	7	8.0
Euphorbia biconvexa	0.5	0.1
Gossypium robinsonii	0.5	0.25
Indigofera boviperda	0.5	0.1
**Malvastrum americanum*	0.5	0.2
Melaleuca glomerata	2	2.2
**Passiflora foetida* var. *hispida*	0.5	0.1
Pterocaulon sp.	0.5	0.05
Rhynchosia minima	0.5	0.1
Sida fibulifera	0.5	0.05
Triodia wiseana	14	0.6
**Vachellia farnesiana*	0.5	0.6

* denotes weed species
? denotes unconfirmed ID

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Appendix O: Vegetation Condition Mapping

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410000 415000 420000 425000 430000

7600000 7595000 7590000

Legend

- Survey Site
- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Vegetation Condition Mapping

- Excellent
- Very Good
- Good
- Poor
- Disturbed

Pannawonica

Pannawonica

E20

E07

E09

MH203

MH363

Robe River

MH204

MH397

MH398

MH337r

MH354

MH379

MH385

AM215

MH332

MH321

MH44

MH43

MH394

MH303

MH381

MH387

MH388

MH384

MH389

Millstream Rd

MH393

MH401

MH392

MH373

Jimmawurrudo Creek

Bungaroo Creek

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure O.1: Vegetation Condition Mapping

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigO1_VegCond

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Appendix P: Flora Species Lists

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Table P.1: Vascular flora species list for the survey area.

Family	Species name	Conservation status	Weed
Aizoaceae	*Trianthema triquetrum*		
Amaranthaceae	*Alternanthera nana*		
	Amaranthus cuspidifolius		
	Amaranthus undulatus		
	Aerva javanica		*
	Gomphrena cunninghamii		
	Ptilotus appendiculatus		
	Ptilotus astrolasius		
	Ptilotus auriculifolius		
	Ptilotus axillaris		
	Ptilotus calostachyus		
	Ptilotus incanus		
	Ptilotus nobilis subsp. *nobilis*		
	Ptilotus obovatus		
Araliaceae	*Trachymene oleracea* subsp. *oleracea*		
Arecaceae	*Livistona alfredii*	P4	
Asteraceae	*Bidens bipinnata*		*
	Flaveria trinervia		*
	Helichrysum luteoalbum		
	Lactuca serriola		*
	Pluchea rubelliflora		
	Pterocaulon sphaeranthoides		
	Sonchus oleraceus		*
	Streptoglossa liatroides		
Boraginaceae	*Heliotropium pachyphyllum*		
Brassicaceae	*Lepidium pholidogynum*		
Campanulaceae	*Lobelia arnhemiaca*		
	Wahlenbergia tumidifructa		
Capparaceae	*Capparis spinosa* var. *nummularia*		
Chenopodiaceae	*Dysphania* sp.		
Cleomaceae	*Cleome viscosa*		
Convolvulaceae	*Bonamia pilbarensis*		
	Evolvulus alsinoides var. *villosicalyx*		
	Ipomoea muelleri		
	Ipomoea polymorpha		
Cucurbitaceae	*Citrullus colocynthis*		*

Family	Species name	Conservation status	Weed
Cucurbitaceae	*Cucumis variabilis*		
Cyperaceae	*Cyperus vaginatus*		
	Eleocharis geniculata		
	Schoenoplectus subulatus		
Euphorbiaceae	*Adriana tomentosa*		
	Euphorbia australis		
	Euphorbia biconvexa		
	Euphorbia boophthona		
	Euphorbia hirta		*
	Euphorbia schultzii		
Fabaceae	*Acacia bivenosa*		
	Acacia colei var. *ileocarpa*		
	Acacia elachantha		
	Acacia pyrifolia var. *pyrifolia*		
	Acacia sclerosperma subsp. *sclerosperma*		
	Acacia synchronicia		
	Acacia trachycarpa		
	Acacia trachycarpa x tumida var. *pilbarensis*		
	Acacia tumida var. *pilbarensis*		
	Crotalaria novae-hollandiae		
	Indigofera boviperda		
	Indigofera monophylla		
	Petalostylis labicheoides		
	Rhynchosia bungarensis	P4	
	Rhynchosia minima		
	Senna ferraria		
	Senna notabilis		
	Sesbania formosa		
	Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)		
	Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)		
	Tephrosia sp. Fortescue (A.A. Mitchell 606)		
	Vachellia farnesiana		*
	Vigna lanceolata var. *lanceolata*		
Goodeniaceae	*Goodenia lamprosperma*		
Lamiaceae	*Ocimum basilicum*		*
Loranthaceae	*Lysiana casuarinae*		
Marsileaceae	*Marsilea* sp.		
Malvaceae	*Abutilon lepidum*		
	Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)		

Family	Species name	Conservation status	Weed
Malvaceae	*Corchorus crozophorifolius*		
	Corchorus lasiocarpus subsp. *parvus*		
	Gossypium australe		
	Gossypium robinsonii		
	Malvastrum americanum		*
	Melochia pyramidata		*
	Sida fibulifera		
	Sida rohlenae subsp. *rohlenae*		
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)		
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)		
	Triumfetta appendiculata		
	Triumfetta ?chaetocarpa		
	Triumfetta clementii		
	Triumfetta johnstonii		
	Waltheria indica		
Molluginaceae	*Mollugo molluginea*		
Moraceae	*Ficus aculeata* var. *indecora*		
Myrtaceae	*Eucalyptus camaldulensis* subsp. *refulgens*		
	Eucalyptus victrix		
	Melaleuca argentea		
	Melaleuca glomerata		
Nyctaginaceae	*Boerhavia coccinea*		
Oleaceae	*Jasminum didymum* subsp. *lineare*		
Papaveraceae	*Argemone ochroleuca* subsp. *ochroleuca*		*
Passifloraceae	*Passiflora foetida* var. *hispida*		*
Phyllanthaceae	*Flueggea virosa* subsp. *melanthesoides*		
	Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)		
	Phyllanthus maderaspatensis		
Plantaginaceae	*Stemodia grossa*		
Poaceae	*Cenchrus ciliaris*		*
	Cenchrus setiger		*
	Chloris barbata		*
	Cynodon dactylon		*
	Cymbopogon ambiguus		
	Dactyloctenium radulans		
	Echinochloa colona		*
	Enneapogon caerulescens		
	Eriachne mucronata		
	Eriachne pulchella subsp. *dominii*		

Family	Species name	Conservation status	Weed
Poaceae	*Eriachne tenuiculmis*		
	Eulalia aurea		
	Paraneurachne muelleri		
	Paspalidium clementii		
	Setaria verticillata		*
	Sporobolus australasicus		
	Themeda triandra		
	Triodia epactia		
	Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	P3	
	Triodia wiseana		
Polygonaceae	*Rumex vesicarius*		*
Proteaceae	*Grevillea wickhamii*		
	Hakea chordophylla		
Solanaceae	*Datura leichhardtii*		*
	Solanum cleistogamum		
	Solanum diversiflorum		
	Solanum horridum		
	Solanum nigrum		*
Surianaceae	*Stylobasium spathulatum*		
Typhaceae	*Typha domingensis*		
Violaceae	*Hybanthus aurantiacus*		

Table P.2: Site by species matrix for the survey area.

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
Abutilon lepidum			0.5																					0.5
Abutilon sp.									0.5													0.5		
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)			0.5		0.5					0.5							0.5	0.5					0.5	0.5
Acacia bivenosa	1	0.5	1	0.5	0.5		0.5			0.5		0.5				0.5	0.5	0.5				0.5	0.5	1
Acacia colei var. *ileocarpa*			0.5						0.5									0.5				0.5	0.5	
Acacia elachantha																							0.5	
Acacia pyrifolia var. *pyrifolia*	0.5		0.5		0.5				0.5	0.5			0.5				0.5	0.5				0.5	0.5	0.5
Acacia sclerosperma subsp. *sclerosperma*																						0.5		
Acacia synchronicia		0.5		0.5														0.5						
Acacia trachycarpa	35	3	1	6	2	0.5	32	1	0.5	1	0.5	7	1	4		22	7	9	0.5	0.5	2	7	1	2
Acacia trachycarpa x tumida var. *pilbarensis*				0.5										0.5										
Acacia tumida var. *pilbarensis*																		0.5						
Adriana tomentosa	0.5																							
Alternanthera nana														0.5										
Amaranthus undulatus													0.5											
**Argemone ochroleuca* subsp. *ochroleuca*						0.5		0.5		0.5					0.5				0.5					
Boerhavia coccinea			0.5									0.5					0.5	0.5						
Bonamia pilbarensis												0.5												
Capparis spinosa var. *nummularia*					0.5					0.5	0.5		0.5	0.5			0.5						0.5	
**Cenchrus ciliaris*		0.5	0.5	0.5	0.5		0.5			1		0.5	0.5			0.5	3	3				12	1	2
**Cenchrus setiger*	0.5		32	0.5		0.5	0.5			1		0.5				0.5							1	1
Cenchrus sp.									25		0.5			0.5										
**Citrullus colocynthis*										0.5													0.5	
Cleome viscosa	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5				0.5	0.5

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
Corchorus ?crozophorifolius																			0.5					
Corchorus crozophorifolius					0.5							0.5				0.5								
Corchorus lasiocarpus subsp. *parvus*	0.5		0.5	0.5			0.5	0.5				0.5			0.5	0.5	0.5	0.5					0.5	0.5
Corchorus sp.										0.5	0.5													
Crotalaria novae-hollandiae											0.5													
Cucumis variabilis			0.5			0.5				0.5	0.5	0.5	0.5	0.5		0.5		0.5					0.5	
Cymbopogon ambiguus			0.5			0.5	0.5										0.5	0.5						
**Cynodon dactylon*				0.5	0.5			0.5			0.5	0.5		0.5										
Cyperus vaginatus		1	1		1	1		1	0.5	2	3	0.5	0.5	1			0.5						1	0.5
Dactyloctenium radulans			0.5																					
Dysphania sp.																0.5								
**Echinochloa colona*			0.5						0.5															
Eleocharis geniculata					0.5																			
Enneapogon caerulescens							0.5																	
Eriachne mucronata			0.5															0.5						0.5
Eriachne pulchella subsp. *dominii*												0.5												
Eriachne tenuiculmis																		0.5						
Eucalyptus ?victrix												11												
Eucalyptus camaldulensis subsp. *refulgens*		10	40				0.5	2	6	15	0.5	12		10									14	20
Eucalyptus sp.					0.5								0.5											
Eucalyptus victrix					0.5				6								6	2				7	14	7
Eulalia aurea			0.5																					
Euphorbia australis		0.5																0.5						
Euphorbia biconvexa		0.5								0.5	0.5	0.5	0.5				0.5	0.5				0.5		
Euphorbia boophthona																								

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
**Euphorbia hirta*		0.5	0.5					0.5	0.5															
Euphorbia schultzii	0.5	0.5	0.5	0.5	0.5		0.5					0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		0.5	
Evolvulus alsinoides var. *villosicalyx*																	0.5						0.5	
Ficus aculeata var. *indecora*			0.5																					
Flueggea virosa subsp. *melanthesoides*			0.5														0.5							0.5
Gomphrena cunninghamii			0.5	0.5													0.5							
Goodenia lamprosperma																								
Gossypium australe																	0.5	0.5						
Gossypium robinsonii			0.5		0.5			0.5	0.5	0.5							0.5	0.5				0.5	0.5	0.5
Grevillea wickhamii																	0.5							
Hakea chordophylla									0.5															
Helichrysum luteoalbum					0.5																			
Heliotropium pachyphyllum								0.5																
Hybanthus aurantiacus	0.5		0.5						0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5		0.5		0.5	0.5
Indigofera boviperda									0.5													0.5		
Indigofera monophylla							0.5									0.5	0.5							
Ipomoea muelleri		0.5	0.5		0.5	0.5							0.5			0.5				0.5	0.5			
Ipomoea polymorpha									0.5															
Jasminum didymum subsp. *lineare*					0.5								0.5											
**Lactuca serriola*					0.5																			
Lepidium pholidogynum			0.5																					
Lobelia arnhemiaca			0.5		0.5	0.5					0.5													
Lobelia sp.		0.5																						
Lysiana casuarinae										0.5														
**Malvastrum americanum*			0.5						0.5	0.5							0.5	0.5				0.5		0.5

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
Marsilea sp.									0.5															
Melaleuca argentea		40			32	50		62			28	0.5	60	25										
Melaleuca glomerata			1																			2	0.5	0.5
Mollugo molluginea									0.5															
Notoleptopus decaisnei var. Orbicularis (A.B. Craig 428)			0.5														0.5	0.5					0.5	0.5
Paraneurachne muelleri			0.5																					
Paspalidium clementii			0.5										0.5											
Paspalidium sp.												0.5				0.5								
**Passiflora foetida* var. *hispida*		0.5			0.5	0.5		0.5		0.5	0.5		6	0.5			0.5					0.5		
Petalostylis labicheoides		0.5	1	8	1	0.5	1	0.5		2	0.5	8	1	1	0.5	7				0.5			0.5	0.5
Phyllanthus maderaspatensis		0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5			0.5	0.5		0.5			0.5	0.5
Phyllanthus sp.									0.5															
Pluchea rubelliflora		0.5			0.5			0.5			0.5			0.5										
Pterocaulon sp.									0.5		0.5							0.5				0.5	0.5	
Pterocaulon sphaeranthoides																	0.5							0.5
Ptilotus appendiculatus			0.5														0.5	0.5						
Ptilotus astrolasius				0.5						0.5													0.5	
Ptilotus auriculifolius	0.5																	0.5						
Ptilotus axillaris																							0.5	
Ptilotus calostachyus																	0.5							
Ptilotus incanus																	0.5		0.5		0.5			
Ptilotus nobilis subsp. *nobilis*				0.5			0.5			0.5							0.5						0.5	0.5
Ptilotus obovatus															0.5									
Ptilotus sp.			0.5					0.5			0.5		0.5											
Rhynchosia bungarensis P4	0.5	0.5			0.5	0.5	0.5				0.5	0.5	0.5											

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
Rhynchosia minima																	0.5	0.5				0.5		0.5
Schoenoplectus subulatus					0.5																			
Senna ferraria																		0.5						
Senna notabilis										0.5								0.5						
Sesbania formosa		0.5			0.5			0.5			0.5			0.5										
**Setaria verticillata*			0.5										0.5											
Sida fibulifera									0.5													0.5		
Sida rohlenae subsp. *rohlenae*												0.5												
Sida sp. Articulation below (A.A. Mitchell PRP 1605)			0.5																					
Sida sp. Pilbara (A.A. Mitchell PRP 1543)																	0.5							
Solanum cleistogamum									0.5															0.5
Solanum diversiflorum			0.5							0.5							0.5	0.5					0.5	0.5
Solanum horridum			0.5														0.5	0.5					0.5	0.5
**Sonchus oleraceus*			0.5																					
Sporobolus australasicus								0.5																
Stemodia grossa		0.5			0.5	0.5								0.5										
Streptoglossa liatroides		0.5																						
Stylobasium spathulatum			0.5																				0.5	0.5
Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186)		0.5	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	1		0.5		0.5	0.5	0.5	0.5				0.5	0.5
Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)																0.5								
Tephrosia sp. Fortescue (A.A. Mitchell 606)		0.5																						
Themeda triandra			0.5																					0.5
Trachymene oleracea subsp. *oleracea*			0.5		0.5	0.5		0.5					0.5											
Trianthema triquetrum																	0.5							
Triodia epactia				0.5			0.5									0.5							0.5	0.5

Species	MH203	MH204	MH303	MH321	MH332	MH337r	MH354	MH363	MH373	MH379	MH381	MH384	MH385	MH387	MH388	MH389	MH392	MH393	MH394	MH397	MH398	MH401	MH43	MH44
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367) P3																	0.5							
Triodia wiseana			0.5	0.5						0.5		0.5				0.5	3	7				14		
Triumfetta ?chaetocarpa				0.5																				
Triumfetta appendiculata			0.5		0.5												0.5						0.5	0.5
Triumfetta clementii			1														0.5							
Triumfetta johnstonii					0.5																			
Triumfetta sp.			0.5																					
Typha domingensis					0.5						0.5													
**Vachellia farnesiana*			0.5		0.5				0.5		0.5			0.5								0.5		0.5
Vigna lanceolata var. *lanceolata*		0.5			0.5	0.5		0.5	0.5					0.5										
Wahlenbergia tumidifructa								0.5																
Waltheria indica		0.5	0.5								0.5						0.5	0.5					0.5	0.5

Appendix Q: Conservation Significant Flora and Introduced Flora Species Locations and Descriptions

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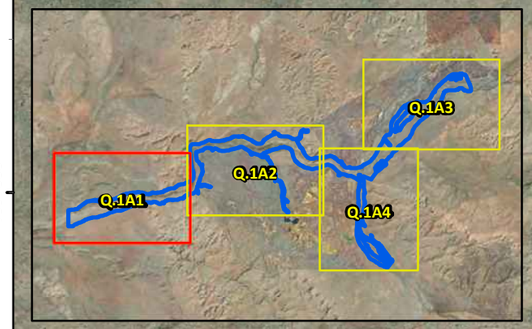
407000 408000 409000 410000 411000 412000 413000 414000

7597000 7596000 7595000 7594000 7593000



Robe River

Legend

- River/Creek
- Mesa H Riparian Community Survey Area

Priority Flora (Astron 2016c)

- *Rhynchosia bungarensis* P4

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1A1: Priority Flora Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

astron delivering environmental intelligence™

Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1A_Pflora

415000 416000 417000 418000 419000 420000 421000

7599000 7598000 7597000 7596000 7595000

Milistream Rd

Robe River

Q.1A1 Q.1A2 Q.1A3 Q.1A4

Legend

- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Priority Flora (Astron 2016b, Astron 2016c)

- *Rhynchosia bungarensis* P4

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1A2: Priority Flora Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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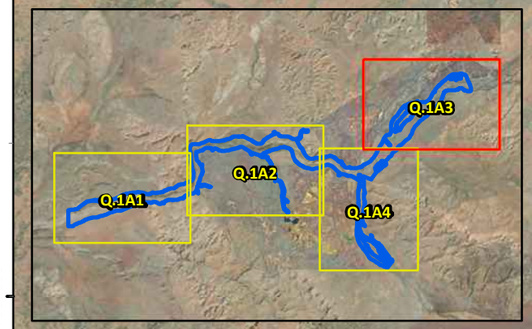
Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1A_Pflora

425000 426000 427000 428000 429000 430000 431000

7602000 7601000 7600000 7599000 7598000



Robe River

Legend

- Railway
- River/Creek
- Mesa H Riparian Community Survey Area

Priority Flora (Astron 2016a)

- *Livistona alfredii* P4
- *Rhynchosia bungarensis* P4

Priority Flora (ecologia 2013)

- *Rhynchosia bungarensis* P4
- *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1A3: Priority Flora Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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Author: D. Roocke | Drawn: W. An | Date: 06-04-2017 | Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1A_Pflora

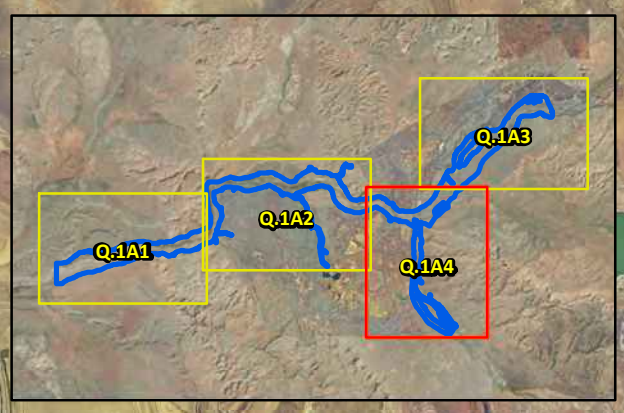
422000 423000 424000 425000 426000 427000

7597000 7596000 7595000 7594000 7593000 7592000 7591000

Robe River

Jimmawurrada Creek

Millstream Rd



Legend

- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Priority Flora (Astron 2016a)

- *Rhynchosia bungarensis* P4
- *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3

Priority Flora (Astron 2016b)

- *Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3

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Mesa H Riparian Community Assessment - June 2016

Figure Q.1A4: Priority Flora Locations

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Author: D. Roocke	Date: 06-04-2017	Coordinate System: GDA94 MGA zone 50
Drawn: W. An	Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1A_Pflora_4	0 200 400 600 800 1,000 Metres

N

Table Q.1: Locations of conservation significant flora recorded in the survey area (MGA Zone 50, GDA 94).

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
Livistona alfredii P4	1	5	427068	7599750	*Rhynchosia bungarensis* P4	20	1	416270	7598414
Rhynchosia bungarensis P4	2	0.5	410332	7594925		4	0.5	416272	7598043
	8	1	412722	7595283		3	0.5	416273	7598141
	20	10	414365	7596627		8	0.5	416282	7598050
	30	10	414378	7596612		2	0.5	416298	7598017
	1	0.5	414379	7596678		5	0.5	416301	7598136
	10	5	414391	7596598		3	0.5	416321	7598122
	20	10	414392	7596536		5	0.5	416454	7598142
	5	10	414397	7596506		4	0.5	416466	7598138
	30	10	414401	7596557		6	0.5	416488	7598127
	30	10	414401	7596578		2	0.5	416496	7598065
	1	0.5	414445	7597046		1	0.5	416848	7598067
	2	0.5	414449	7597007		4	0.5	417356	7598199
	2	0.5	414451	7597792		1	0.5	417371	7598516
	5	0.5	414493	7597788		20	1	417465	7598189
	1	0.5	414563	7598015		2	0.5	417491	7598142
	4	1	414747	7597960		10	1	417512	7598340
	2	0.5	414805	7598078		6	0.5	417536	7598076
	4	0.5	415373	7598344		4	0.5	417573	7598108
	1	0.5	415398	7598328		10	0.5	417611	7598095
	4	0.5	415628	7598299		5	0.5	417611	7598153
	3	0.5	415642	7598296		10	0.5	417635	7598162
	20	0.5	415660	7598289		30	1	417654	7598145
	5	0.5	415703	7598297		10	0.5	417671	7598127
	20	1	415726	7598294		5	0.5	417704	7598101
	10	0.5	415751	7598296		2	0.5	417716	7598329
	1	0.5	415933	7598303		8	0.5	417799	7598066
	3	0.5	415974	7598022		6	0.5	417816	7598095
	4	0.5	416021	7598062		6	0.5	417842	7598132
	5	0.5	416059	7598100		3	0.5	417853	7598147
	2	0.5	416077	7598100		3	0.5	417865	7598113
	2	0.5	416081	7598367		8	0.5	417903	7598110
	8	0.5	416085	7598109		5	0.5	417922	7598103
	4	0.5	416093	7598125		9	0.5	417941	7598095
	1	0.5	416123	7598081		1	0.5	417986	7597984
	1	0.5	416135	7598132		2	0.5	418158	7598016
	30	2	416135	7598369		1	0.5	418301	7597624
	2	0.5	416141	7598064		2	0.5	418344	7598236
	4	0.5	416158	7598103		7	0.5	418351	7597980
	7	0.5	416181	7598133		2	0.5	418365	7598255
	20	2	416194	7598381		3	0.5	418420	7598164
	2	0.5	416225	7598067		10	0.5	418435	7598154
	30	3	416226	7598405		2	0.5	418445	7598171
	2	0.5	416251	7598141		1	0.5	418446	7598353
	6	0.5	416254	7598073		6	0.5	418469	7598137

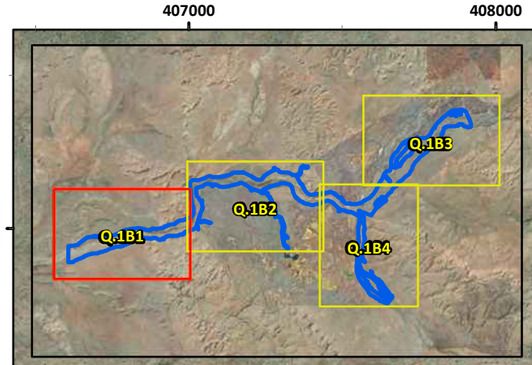
Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
Rhynchosia bungarensis P4	4	0.5	416466	7598138	*Rhynchosia bungarensis* P4	5	0.5	418663	7598161
	6	0.5	416488	7598127		6	0.5	418693	7598166
	2	0.5	416496	7598065		2	2	418695	7598048
	1	0.5	416848	7598067		6	0.5	418727	7598286
	4	0.5	417356	7598199		2	0.5	418736	7598075
	1	0.5	417371	7598516		1	0.5	418737	7597974
	20	1	417465	7598189		4	0.5	418740	7598167
	2	0.5	417491	7598142		2	0.5	418759	7597794
	10	1	417512	7598340		4	0.5	418762	7598089
	6	0.5	417536	7598076		5	0.5	418773	7598077
	4	0.5	417573	7598108		4	0.5	418775	7598529
	10	0.5	417611	7598095		3	0.5	418790	7597802
	5	0.5	417611	7598153		5	0.5	418795	7598185
	10	0.5	417635	7598162		2	0.5	418806	7598187
	30	1	417654	7598145		9	0.5	418817	7598192
	10	0.5	417671	7598127		7	0.5	418849	7598163
	5	0.5	417704	7598101		5	0.5	418859	7597858
	2	0.5	417716	7598329		2	0.5	418877	7597945
	8	0.5	417799	7598066		3	0.5	418877	7598323
	6	0.5	417816	7598095		7	0.5	418899	7597853
	6	0.5	417842	7598132		3	0.5	418906	7597946
	3	0.5	417853	7598147		2	0.5	418907	7598476
	3	0.5	417865	7598113		10	0.5	418908	7597862
	8	0.5	417903	7598110		1	0.5	418909	7598126
	5	0.5	417922	7598103		3	0.5	418916	7598293
	9	0.5	417941	7598095		1	0.5	418930	7598069
	1	0.5	417986	7597984		6	0.5	418947	7597952
	2	0.5	418158	7598016		3	0.5	418948	7598180
	1	0.5	418301	7597624		2	0.5	418954	7598163
	2	0.5	418344	7598236		3	0.5	418955	7598495
	7	0.5	418351	7597980		9	0.5	418966	7597872
	2	0.5	418365	7598255		3	0.5	418979	7597957
	3	0.5	418420	7598164		1	0.5	418980	7597906
	10	0.5	418435	7598154		6	0.5	418981	7598515
	2	0.5	418445	7598171		2	0.5	418992	7598426
	1	0.5	418446	7598353		5	0.5	418998	7597953
	6	0.5	418469	7598137		4	0.5	419000	7597887
	4	0.5	418491	7598124		3	0.5	419002	7598341
	2	0.5	418499	7597981		4	1	419035	7598644
	3	0.5	418502	7598138		4	0.5	419056	7597950
	1	0.5	418504	7598399		20	2	419057	7597885
	1	0.5	418557	7598433		1	0.5	419093	7597968
	1	1	418578	7597972		50	2	419116	7597893
	10	0.5	418606	7598044		3	0.5	419129	7598357
	10	0.5	418613	7598142		20	1	419141	7597891
	20	1	418627	7598270		5	0.5	419159	7597898
	8	0.5	418629	7598148		1	0.5	419161	7597974
	2	1	418644	7597970		10	0.5	419168	7597899
	5	0.5	418645	7598481		4	0.5	419188	7597913

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
Rhynchosia bungarensis P4	1	0.5	419208	7598490	*Rhynchosia bungarensis* P4	50	0.5	420041	7597662
	3	0.5	419221	7597963		30	0.5	420052	7597604
	1	0.5	419227	7597968		5	0.5	420103	7598415
	4	0.5	419232	7597934		20	0.5	420133	7597620
	1	0.5	419388	7598588		5	0.5	420205	7598435
	1	0.5	419440	7598052		10	0.5	420301	7597920
	1	0.5	419441	7598295		6	0.5	420418	7597801
	1	0.5	419457	7598286		6	0.5	420440	7597773
	20	0.5	419475	7597992		15	0.5	420503	7597712
	3	0.5	419482	7598268		20	0.5	420571	7597607
	2	0.5	419490	7598605		1	0.5	420942	7596814
	4	0.5	419494	7598267		70	10	422132	7597001
	20	0.5	419495	7597999		30	1	422282	7596921
	40	0.5	419511	7597997		10	1	422363	7596860
	10	0.5	419527	7598002		20	5	422460	7596783
	2	0.5	419530	7598041		2	0.5	422562	7597259
	1	0.5	419535	7598266		20	0.5	423095	7596405
	30	0.5	419547	7598006		40	0.5	423110	7596398
	1	0.5	419556	7598008		2	0.5	423123	7596816
	20	0.5	419572	7598002		50	1	423143	7596387
	1	0.5	419573	7598594		50	2	423176	7596375
	4	0.5	419576	7598028		50	1	423186	7596355
	30	0.5	419586	7598001		7	0.5	423197	7596822
	1	0.5	419591	7598024		10	0.5	423205	7596823
	40	0.5	419609	7597991		30	1	423236	7596355
	5	0.5	419631	7598591		40	0.5	423279	7596812
	10	0.5	419657	7597960		30	0.5	423295	7596351
	2	0.5	419691	7598566		100	7	423416	7596786
	3	0.5	419796	7598175		100	3	423474	7596781
	20	0.5	419803	7597932		70	1	423527	7596785
	3	0.5	419814	7598168		60	1	423573	7596787
	20	0.5	419830	7597928		50	0.5	423619	7596790
	50	0.5	419854	7597915		20	0.5	423658	7596795
	10	0.5	419869	7597911		2	0.5	427656	7600448
	20	0.5	419883	7597904		10	0.5	427812	7600656
	50	0.5	419894	7597899		5	0.5	427990	7600923
	1	0.5	419905	7597973		5	1	428352	7600867
	50	0.5	419914	7597886		50	8	428392	7600904
	1	0.5	419917	7598059		100	1	428495	7600907
	3	0.5	419928	7598050		20	0.5	428617	7600938
	50	0.5	419942	7597858		50	0.5	428620	7600891
	2	0.5	419952	7598090		5	0.5	428642	7600994
	50	0.5	419962	7597829		400	NA	428670	7601055
	50	0.5	419968	7597818		15	NA	428937	7601233
	40	0.5	419974	7597807		50	NA	429005	7601246
	40	0.5	419989	7597784		3	NA	429093	7601254
	50	0.5	420016	7597737		2	NA	429165	7601266
	3	0.5	420023	7597990		3	NA	429215	7601269
	30	0.5	420032	7597697		2	NA	429278	7601257

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
Rhynchosia bungarensis P4	3	0.5	429577	7601363	*Triodia* sp. Robe River (M.E. Trudgen et al. MET 12367) P3	10	0.5	423200	7596821
	10	0.5	429754	7601346		1	0.5	424876	7592488
	10	0.5	429757	7601347		1000	NA	429087	7601416
	40	0.5	429781	7601319					
	70	0.5	429801	7601303					

Table Q.2: Descriptions of Priority flora recorded in the survey area.

Species	Description	Habitat
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367) P3	Hummock grass (WAHerb 1998-2016).	Rocky outcrops, breakaways, hillslopes and crests, and drainage lines (WAHerb 1998-2016).
Livistona alfredii P4	Perennial tree-like monocot (palm), to 10 m high (WAHerb 1998-2016).	Occurs on edges of permanent pools (WAHerb 1998-2016).
Rhynchosia bungarensis P4	Compact, prostrate shrub to 0.5 m high. Flowers yellow (WAHerb 1998-2016).	Pebbly, shingle coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall (WAHerb 1998-2016).



407000 408000 409000 410000 411000 412000 413000 414000

7597000 7596000 7595000 7594000 7593000

Robe River

Legend

- River/Creek
- Mesa H Riparian Community Survey Area

Introduced Flora (Astron 2016c)

- **Aerva javanica* (Kapok Bush)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Citrullus colocynthis* (Colocynth)
- **Cynodon dactylon* (Couch Grass)
- **Euphorbia hirta* (Asthma Plant)
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Vachellia farnesiana* (Mimosa Bush)

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1B1: Introduced Plant Species (Weed) Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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415000 416000 417000 418000 419000 420000 421000

7599000 7598000 7597000 7596000 7595000

Millstream Rd

Robe River

Q.1B1 Q.1B2 Q.1B3 Q.1B4

Legend

- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Introduced Flora (Astron 2016b, Astron 2016c)

- **Aerva javanica* (Kapok Bush)
- **Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)
- **Bidens bipinnata* (Bipinnate Beggartick)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Citrullus colocynthis* (Colocynth)
- **Cynodon dactylon* (Couch Grass)
- **Echinochloa colona* (Awnless Barnyard Grass)
- **Euphorbia hirta* (Asthma Plant)
- **Flaveria trinervia* (Speedy Weed)
- **Lactuca serriola* (Prickly Lettuce)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Ocimum basilicum* (Basil)
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Phoenix dactylifera* (Date Palm)
- **Rumex vesicarius* (Ruby Dock)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Sonchus oleraceus* (Common Sowthistle)
- **Vachellia farnesiana* (Mimosa Bush)

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1B2: Introduced Plant Species (Weed) Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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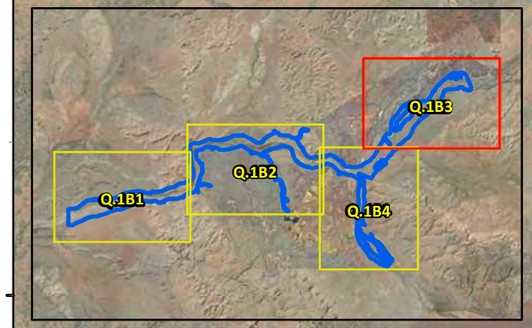
Author: D. Roocke Drawn: W. An Date: 06-04-2017 Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1B_Weed

425000 426000 427000 428000 429000 430000 431000

7602000 7601000 7600000 7599000 7598000



Robe River

Legend

- Railway
- River/Creek
- Mesa H Riparian Community Survey Area

Introduced Flora (Astron 2016a)

- **Aerva javanica* (Kapok Bush)
- **Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Citrullus colocynthis* (Colocynth)
- **Cynodon dactylon* (Couch Grass)
- **Euphorbia hirta* (Asthma Plant)
- **Lactuca serriola* (Prickly Lettuce)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Rumex vesicarius* (Ruby Dock)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Solanum nigrum* (Black Berry Nightshade)
- **Sonchus oleraceus* (Common Sowthistle)
- **Vachellia farnesiana* (Mimosa Bush)

Introduced Flora (Astron 2016c)

- **Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Cynodon dactylon* (Couch Grass)
- **Echinochloa colona* (Awnless Barnyard Grass)
- **Euphorbia hirta* (Asthma Plant)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Melochia pyramidata*
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Sonchus oleraceus* (Common Sowthistle)
- **Vachellia farnesiana* (Mimosa Bush)

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1B3: Introduced Plant Species (Weed) Locations

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 metres

N

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422000 423000 424000 425000 426000 427000

7597000 7596000 7595000 7594000 7593000 7592000 7591000

Robe River

Jimmawurrada Creek

Millstream Rd

Legend

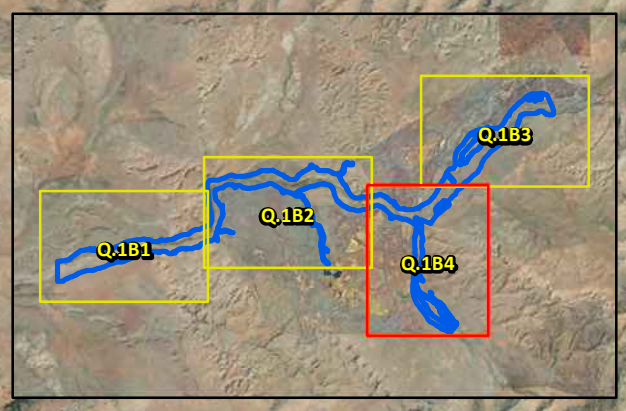
- Railway
- Main Road
- River/Creek
- Mesa H Riparian Community Survey Area

Introduced Flora (Astron 2016a)

- **Aerva javanica* (Kapok Bush)
- **Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy)
- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Chloris barbata* (Purpletop Chloris)
- **Citrullus colocynthis* (Colocynth)
- **Cynodon dactylon* (Couch Grass)
- **Datura leichhardtii* (Native Thornapple)
- **Echinochloa colona* (Awnless Barnyard Grass)
- **Flaveria trinervia* (Speedy Weed)
- **Lactuca serriola* (Prickly Lettuce)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Rumex vesicarius* (Ruby Dock)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Solanum nigrum* (Black Berry Nightshade)
- **Sonchus oleraceus* (Common Sowthistle)
- **Vachellia farnesiana* (Mimosa Bush)

Introduced Flora (Astron 2016b, Astron 2016c)

- **Cenchrus ciliaris* (Buffel Grass)
- **Cenchrus setiger* (Birdwood Grass)
- **Chloris barbata* (Purpletop Chloris)
- **Citrullus colocynthis* (Colocynth)
- **Echinochloa colona* (Awnless Barnyard Grass)
- **Euphorbia hirta* (Asthma Plant)
- **Flaveria trinervia* (Speedy Weed)
- **Malvastrum americanum* (Spiked Malvastrum)
- **Passiflora foetida* var. *hispida* (Stinking Passion Flower)
- **Rumex vesicarius* (Ruby Dock)
- **Setaria verticillata* (Whorled Pigeon Grass)
- **Vachellia farnesiana* (Mimosa Bush)



Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure Q.1B4: Introduced Plant Species (Weed) Locations

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Author: D. Roocke	Date: 06-04-2017	Coordinate System: GDA94 MGA zone 50
Drawn: W. An	Figure Ref: 14269-16-BIDR-1RevB_170406_FigQ1B_Weed_4	0 200 400 600 800 1,000 Metres; N

Table Q.3: Locations of introduced flora recorded in the survey area (MGA Zone 50, GDA 94).

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Aerva javanica*	1	0.5	408971	7594632	**Argemone ochroleuca* subsp. *ochroleuca*	100	1	418525	7598278
	1	0.5	414512	7597629		25	1	418814	7598215
	1	0.5	417776	7598306		20	0.5	418823	7598115
	4	0.5	417818	7598277		50	0.5	418824	7598082
	5	0.5	417845	7598268		100	10	418826	7598453
	10	5	418310	7598211		50	0.5	418876	7598081
	500	20	419016	7598782		25	0.5	418878	7598452
	1	0.5	419734	7598561		50	0.5	418932	7598480
	10	0.5	419854	7597914		20	0.5	418991	7598074
	3	0.5	419872	7597913		15	0.5	418993	7598520
	8	0.5	420083	7598409		50	0.5	419009	7598339
	50	10	420487	7598715		250	10	419044	7598151
	2	0.5	423846	7596818		20	0.5	419076	7598442
	1	0.5	425713	7598973		25	1	419081	7597897
	50	5	426057	7598867		25	0.5	419097	7598522
	20	0.5	426074	7599563		20	0.5	419119	7598478
	1	0.5	426203	7600051		10	0.5	419133	7597936
	5	2	427137	7599894		50	5	419141	7598195
	4	0.5	429957	7601526		100	0.5	419187	7598362
**Argemone ochroleuca* subsp. *ochroleuca*	50	0.5	414400	7595938		7	0.5	419190	7597935
	50	1	414411	7595777		15	0.5	419243	7597954
	250	40	414440	7596026		50	0.5	419295	7597951
	50	2	414446	7596068		50	0.5	419329	7597968
	500	30	414454	7595887		25	0.5	419333	7598320
	10	0.5	414529	7595497		100	0.5	419371	7598007
	100	2	414550	7595627		20	0.5	419374	7597986
	250	20	414664	7596122		10	0.5	419458	7598045
	10	1	414695	7596117		20	0.5	419483	7595796
	20	0.5	415500	7598159		5	0.5	419488	7597998
	20	0.5	415576	7598226		20	0.5	419522	7595075
	10	0.5	415916	7598222		5	0.5	419534	7598006
	1	0.5	415945	7598237		75	0.5	419587	7598051
	25	0.5	416415	7598321		75	0.5	419692	7597959
	25	0.5	416663	7598135		50	0.5	419822	7598415
	25	0.5	416751	7598139		20	0.5	419870	7597911
	100	10	416870	7598064		25	0.5	419924	7598395
	75	2	417228	7598024		25	0.5	420019	7598419
	10	0.5	417547	7597929		3	0.5	420374	7597827
	10	0.5	418210	7598162		50	0.5	420517	7597654
	50	10	418250	7598181		100	2	422276	7597391
	50	1	418362	7598193		50	2	422553	7596707

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Argemone ochroleuca* subsp. *ochroleuca*	500	0.5	422638	7597167	**Cenchrus ciliaris*	100	1	414897	7596613
	75	0.5	423139	7596809		500	10	415971	7597885
	1	0.5	418373	7597453		7	1	416050	7597874
	10	0.5	418426	7598187		500	2	416080	7597876
	50	0.5	423228	7596434		2	0.5	416423	7598116
	50	0.5	423462	7596519		1	0.5	416435	7598043
	2500	10	423968	7596855		100	20	416983	7598570
	50	0.5	423968	7596194		250	20	417029	7598583
	2500	40	424062	7596859		100	10	417234	7598543
	50	0.5	424114	7596936		500	10	417522	7598452
	250	0.5	424649	7597182		500	10	417610	7598412
	0	0.5	424653	7597185		250	1	417629	7598380
	250	0.5	425090	7597510		25	1	417738	7598321
	50	0.5	425998	7598607		1	0.5	417769	7597687
	250	0.5	426416	7598922		1	0.5	417769	7597667
	250	5	427700	7600417		1	0.5	417769	7597708
	100	2	427754	7600593		1	0.5	417787	7597889
	250	5	427956	7600835		6	0.5	417828	7598128
	0	0.5	428366	7601264		4	0.5	417937	7598118
	100	0.5	428368	7601235		2	0.5	417940	7598092
	2	0.5	428445	7601006		3	0.5	417967	7597966
	100	0.5	429158	7601303		250	30	418280	7597464
	5	0.5	429163	7601361		50	0.5	418381	7597453
	200	0.5	429169	7601400		500	2	418397	7597458
	500	0.5	429177	7601437		400	3	418417	7597454
	100	0.5	429344	7601395		20	1	418434	7597978
	100	0.5	429354	7601456		50	0.5	418436	7597450
	10	0.5	430008	7601565		99	3	418442	7597418
**Bidens bipinnata*	100	1	418229	7598181		850	16	418462	7597415
	500	50	414440	7595989		600	4	418482	7597412
**Cenchrus ciliaris*	200	2	408945	7594759		10	0.5	418645	7598042
	500	2	408946	7594749		10	1	418820	7597894
	200	0.5	408951	7594720		10	5	418841	7597975
	1	0.5	408960	7594667		400	2	418866	7596762
	11	0.5	410208	7594869		5	0.5	418952	7598082
	2	0.5	412676	7595360		10	0.5	418965	7597968
	6	0.5	412691	7595294		2	0.5	419101	7597972
	11	0.5	412704	7595288		1000	20	419168	7597898
	17	0.5	413880	7595587		10	2	414376	7597615
	20	0.5	413880	7595625		250	5	414547	7595466
	2	0.5	413881	7595577		100	2	414655	7595430
	5	0.5	413895	7595561		75	1	419463	7595062

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Cenchrus ciliaris*	250	4	414843	7596468	**Cenchrus ciliaris*	250	1	419494	7595530
	250	5	414858	7596503		1000	30	419503	7595060
	300	8	419516	7595527		50	0.5	424028	7595766
	2500	20	419520	7595076		1000	10	424029	7596796
	350	10	419529	7595518		1000	10	424042	7592639
	5000	20	419530	7595649		100	1	424057	7592259
	5000	20	419532	7594945		2500	20	424062	7592356
	100	5	419534	7598005		2500	20	424156	7592276
	250	4	419553	7595510		2500	20	424166	7592224
	75	5	419565	7598002		400	8	424267	7592020
	1000	35	419574	7595497		600	20	424277	7592036
	100	5	419620	7597986		2500	20	424278	7596268
	5	0.5	419631	7594408		500	12	424293	7592050
	75	0.5	419685	7597962		150	2	424311	7592071
	20	0.5	419871	7597911		500	4	424324	7592085
	10	0.5	419969	7597816		500	10	424337	7592100
	2500	10	420053	7598410		2500	20	424476	7596659
	8	0.5	420117	7597420		100	5	424505	7592739
	5	0.5	420166	7597963		500	40	424542	7591624
	100	5	420357	7598195		10	0.5	424649	7597184
	1000	10	420359	7598474		0	0.5	424653	7597185
	2	0.5	420723	7597303		100	30	424866	7597679
	20	1	420734	7598904		250	5	424870	7592464
	100	10	422732	7596490		100	10	424915	7592330
	25	0.5	423192	7596362		1250	12	425262	7591196
	75	0.5	423573	7596445		800	1	425274	7591211
	1000	10	423795	7593086		700	10	425288	7591226
	500	5	423800	7593009		700	6	425304	7591248
	500	5	423822	7592926		2500	80	425313	7591848
	350	10	423829	7595090		350	6	425317	7591263
	900	16	423841	7595017		700	3	425332	7591275
	3000	20	423848	7595095		100	5	425481	7598498
	1000	10	423853	7592795		250	5	425522	7598120
	1000	1	423864	7595023		0	15	425684	7599079
	500	1	414692	7595778		1000	10	425702	7599268
	5	0.5	419294	7598014		1000	30	425706	7591423
	50	0.5	419418	7598327		1000	10	425715	7598982
	2	0.5	419453	7598049		1000	10	425731	7599042
	1000	15	423869	7595099		50	5	423930	7592607
	1500	18	423885	7595036		1000	10	423950	7596049
	1000	10	423888	7592708		200	1	423967	7595850
	1000	10	423925	7592625		250	5	423970	7596197

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Cenchrus ciliaris*	150	0.5	423983	7595775	**Cenchrus setiger*	100	5	419510	7595523
	15	0.5	423997	7595850		5000	40	419521	7595076
	12	0.5	424002	7595773		200	10	419526	7595524
	300	1	424017	7595839		5000	40	419530	7595649
	250	20	426967	7599913		50	5	422731	7596521
	450	14	427114	7600166		500	10	422758	7597149
	1000	4	427127	7600151		250	3	423660	7596795
	3	0.5	427139	7600135		1000	10	423795	7593087
	40	0.5	427172	7600100		500	5	423801	7593009
	100	20	427187	7599901		500	5	423822	7592926
	100	10	428013	7600984		350	10	423823	7595097
	10	0.5	428444	7601003		900	16	423837	7595024
	100	3	428591	7601574		1000	8	423842	7595099
	2500	10	428602	7601679		1000	10	423854	7592794
	5	0.5	429185	7601478		500	1	423856	7595029
	2500	30	429206	7602125		100	5	423862	7595102
	1000	5	429529	7601476		1500	18	423875	7595035
	2500	30	429605	7602138		1000	10	423887	7592709
	0	15	425853	7599612		1000	10	423924	7592626
	500	7	426002	7599722		2500	20	423928	7592576
	2500	20	426057	7598867		2500	20	423947	7592519
	2500	20	426073	7599459		1000	10	423951	7596047
	500	7	426219	7600052		2500	0.5	423972	7592427
	250	20	426353	7599815		2500	20	423975	7596669
	500	10	426555	7600114		12	0.5	424012	7595773
	250	30	426934	7600181		10	0.5	424017	7595849
**Cenchrus setiger*	50	0.5	408953	7594770		400	8	424258	7592020
	20	0.5	408956	7594751		100	5	424272	7592035
	100	0.5	408959	7594731		500	12	424299	7592051
	250	3	414868	7596529		150	2	424303	7592070
	250	5	414892	7596572		100	1	424323	7592093
	2	0.5	417764	7597683		500	10	424336	7592107
	1	0.5	417962	7597984		1000	60	424394	7592003
	1	0.5	417965	7597959		1000	10	424478	7596663
	25	0.5	418365	7597428		2500	80	424503	7591796
	500	2	418401	7597452		2500	80	424632	7591691
	400	3	418421	7597448		2500	20	424663	7597368
	70	1	418432	7597455		2500	30	424759	7596788
	99	1	418446	7597411		5000	20	419540	7594931
	850	16	418456	7597410		250	4	419558	7595513
	100	0.5	418486	7597405		10	0.5	419577	7595506
	100	1	419488	7595537		99	10	419617	7594394

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Cenchrus setiger*	25	0.5	419676	7598570	**Citrullus colocynthis*	3	0.5	408948	7594739
	100	1	419801	7598537		10	2	414449	7595898
	100	1	419852	7598520		4	1	414510	7597987
	100	1	419938	7598471		15	30	416018	7597876
	250	2	419982	7598441		1	1	417090	7598588
	100	10	420511	7598785		4	1	417314	7598554
	2500	80	425320	7591866		3	5	417374	7598480
	1000	50	425328	7591935		2	0.5	417944	7598041
	300	1	425338	7591279		1	0.5	418086	7598077
	1000	30	425576	7598616		1	1	418159	7598107
	0	4	425684	7599079		1	0.5	418398	7597429
	1000	10	425700	7599260		3	0.5	418476	7597984
	1000	10	425716	7598982		1	0.5	418815	7597862
	1000	10	425731	7599042		1	0.5	419050	7596320
	0	10	425853	7599612		1	0.5	419060	7597915
	500	10	425943	7599486		1	0.5	420258	7597177
	1000	10	426056	7598867		1	0.5	424715	7592542
	2500	20	426073	7599460		3	0.5	425116	7597362
	100	2	426275	7600088		1	0.5	426503	7600124
	100	2	426555	7600115		1	0.5	428374	7601470
	450	14	427113	7600160	**Cynodon dactylon*	15	0.5	408949	7594729
	500	5	428591	7601574		5	0.5	408958	7594676
	2500	10	428602	7601679		25	0.5	412666	7595356
	2500	30	429204	7602124		3	0.5	412687	7595304
	1000	5	429531	7601476		3	0.5	412694	7595285
	2500	30	429606	7602138		1	0.5	412710	7595270
	1000	10	424760	7596791		5	0.5	413871	7595622
	2500	70	425087	7591333		2	0.5	413885	7595557
	2500	80	425125	7592076		1	0.5	413886	7595600
	250	10	425125	7597192		75	1	414396	7596748
	2500	80	425164	7591825		1	0.5	414397	7597027
	1250	12	425254	7591197		1	0.5	414402	7597069
	800	1	425266	7591213		1	0.5	414405	7597083
	700	10	425279	7591228		3	0.5	414837	7596656
	600	5	425296	7591250		3	0.5	415952	7598235
	350	6	425310	7591264		50	2	418702	7598300
**Chloris barbata*	3	0.5	423645	7596794		10	0.5	418903	7597956
	1	0.5	423967	7592443		1	0.5	418928	7598067
	5	0.5	425365	7591157		10	2	418991	7598191

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Cynodon dactylon*	100	0.5	419295	7597953	**Euphorbia hirta*	1	0.5	412698	7595275
	1	1	419482	7598571		2	0.5	413876	7595645
	1	0.5	419394	7598589		7	0.5	413889	7595548
	1	0.5	419409	7598604		2	0.5	415953	7598268
	1	1	419435	7598585		10	0.5	424189	7592093
	1	0.5	419547	7598580		7	0.5	424265	7592028
	1	0.5	420736	7597337		25	5	425147	7591399
	1	0.5	421871	7597055		1	0.5	425285	7591236
	100	60	422591	7596682		2	0.5	425310	7591251
	1000	50	423322	7596406		20	0.5	425886	7599393
	10	0.5	423871	7595103		10	0.5	427526	7600339
	2	0.5	424755	7597476		15	0.5	428488	7600934
	7	0.5	427183	7600085		3	0.5	429182	7601459
	20	1	427765	7600615	**Flaveria trinervia*	6	0.5	418787	7597881
**Datura leichhradtii*	3	0.5	424178	7596839		2	0.5	422744	7596453
						10	0.5	425111	7591962
**Echinochloa colona*	1	0.5	419534	7595539	**Lactuca serriola*	1	0.5	414411	7597087
	15	0.5	423361	7596400		4	0.5	417739	7598059
	3	0.5	423936	7592562		15	0.5	417757	7598064
	1	0.5	424165	7592224		10	0.5	417911	7598016
	1	0.5	429173	7601444		10	0.5	422676	7596598
**Euphorbia hirta*	4	0.5	416413	7598144		2	0.5	427577	7600393
	1	0.5	416419	7598111		6	0.5	427876	7600719
	5	0.5	417532	7598132		3	0.5	427918	7600783
	5	0.5	419500	7595491	**Malvastrum americanum*	2	0.5	419446	7598575
	2	0.5	420367	7597873		1	5	419527	7598002
	100	0.5	423795	7593086		100	0.5	419530	7595650
	100	0.5	423799	7593010		1	0.5	419555	7595503
	100	0.5	423822	7592927		10	0.5	419572	7595501
	2	0.5	423833	7595099		4	0.5	419617	7594401
	1	0.5	423847	7595026		2	0.5	419911	7598491
	100	0.5	423851	7592796		3	0.5	420530	7598776
	100	0.5	423889	7592707		15	0.5	422702	7596380
	20	0.5	423899	7592664		5	0.5	423817	7592882
	50	0.5	423924	7592626		10	0.5	423822	7592927
	50	20	423928	7592576		6	0.5	423834	7595089
	50	20	423946	7592520		5	0.5	423849	7595016
	50	0.5	423970	7592432		30	0.5	423852	7595101
	20	0.5	423977	7595850		50	0.5	423853	7592796
	2	0.5	423993	7595775		1	0.5	423873	7595094
	25	0.5	424167	7592221		50	20	423947	7592520

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Malvastrum americanum*	50	0.5	423889	7592707	**Melochia pyramidata*	1	0.5	427171	7600093
	50	0.5	423922	7592626					
	50	20	423924	7592572	**Ocimum basilicum*	15	5	417910	7598016
	1	0.5	416347	7598053					
	1	0.5	418366	7597442	**Passiflora foetida* var. *hispida*	3	0.5	411094	7594963
	1	0.5	418397	7597454		3	0.5	412704	7595257
	15	1	425398	7591887		2	0.5	413873	7595638
	20	1	425449	7591709		4	0.5	418347	7597418
	0	0.5	425684	7599079		5	1	418371	7597974
	10	1	425718	7591486		3	0.5	418440	7597973
	15	0.5	425730	7599042		20	2	418510	7597972
	4	0.5	426202	7600052		3	0.5	418613	7597961
	2	0.5	427798	7600634		3	1	418698	7598058
	5	0.5	428603	7601680		1	0.5	418705	7597957
	2	0.5	429171	7601434		5	5	418748	7598081
	15	0.5	429208	7602131		2	0.5	418778	7598079
	50	0.5	429606	7602138		1	0.5	418869	7598396
	1000	5	423952	7596047		4	0.5	418879	7598063
	15	0.5	423971	7592432		1	0.5	418929	7598073
	1	0.5	423993	7595765		6	10	418938	7598153
	10	0.5	424043	7592639		1	0.5	418984	7598424
	3	0.5	424062	7592356		1	0.5	419004	7598340
	3	0.5	424153	7592277		4	0.5	419023	7597958
	25	0.5	424168	7592222		2	0.5	413874	7595612
	3	0.5	424272	7592022		2	1	414355	7597175
	1	0.5	424286	7592036		1	0.5	414377	7595951
	50	0.5	424310	7592757		8	2	414405	7596632
	10	1	424459	7591764		1	0.5	414415	7597050
	1	0.5	424528	7592651		3	0.5	414437	7597080
	10	1	424553	7591676		4	0.5	414509	7596776
	15	0.5	424643	7597353		1	0.5	414753	7597974
	3	0.5	424867	7592496		1	0.5	414964	7595806
	50	0.5	425060	7591269		5	5	416329	7598047
	15	0.5	425142	7592200		3	0.5	416414	7598114
	2	0.5	425260	7591205		1	0.5	416423	7598091
	5	0.5	425273	7591220		3	0.5	416432	7598038
	30	0.5	425293	7591229		5	2	416479	7598061
	8	0.5	425302	7591251		6	0.5	416629	7598140
	1	0.5	425324	7591265		1	1	416723	7598125
	15	0.5	425375	7591164		5	2	416758	7598069

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Passiflora foetida* var. *hispida*	10	0.5	416794	7598164	**Passiflora foetida* var. *hispida*	75	0.5	419329	7597968
	2	0.5	417004	7598208		20	0.5	419357	7598043
	2	0.5	417194	7598153		1	0.5	419358	7598331
	3	0.5	417260	7598136		75	0.5	419370	7598008
	1	0.5	417931	7598105		20	0.5	419390	7598007
	20	4	417933	7598119		20	0.5	419402	7598047
	3	0.5	417964	7598084		1	0.5	419413	7598324
	4	0.5	417968	7597991		1	0.5	419415	7598327
	5	0.5	418111	7597998		20	0.5	419440	7598052
	3	0.5	418218	7597978		10	0.5	419446	7597991
	20	0.5	419490	7597999		1	0.5	423823	7592926
	20	0.5	419505	7598050		25	3	423825	7595096
	10	0.5	419511	7598119		1	0.5	423828	7592847
	20	0.5	419534	7598006		30	2	423842	7595021
	10	0.5	419542	7598104		2	0.5	423850	7592796
	10	0.5	419552	7598031		3	0.5	423865	7595098
	10	0.5	419561	7598139		15	1	423866	7595031
	20	0.5	419564	7598002		1	0.5	423887	7595027
	5	0.5	419586	7598095		1	0.5	423888	7592759
	1	0.5	419616	7598277		2	0.5	423890	7592706
	10	0.5	419625	7598131		1	0.5	423923	7592625
	10	0.5	419647	7598115		2	0.5	423929	7592593
	10	0.5	419684	7597962		50	2	423935	7596392
	1	0.5	419055	7598271		5	0.5	419701	7598112
	10	2	419084	7598204		1	0.5	419821	7598126
	2	0.5	419101	7597976		1	0.5	419855	7598276
	4	3	419102	7598317		2	0.5	419875	7597993
	10	0.5	419134	7598206		20	0.5	419895	7597898
	1	0.5	419146	7597961		3	0.5	419920	7597951
	10	2	419149	7598234		20	0.5	419942	7597859
	1	0.5	419162	7598298		10	0.5	419944	7597933
	1	0.5	419169	7598362		10	0.5	419970	7597814
	1	0.5	419188	7597970		20	0.5	419982	7597906
	20	0.5	419190	7597935		1	0.5	419985	7598058
	20	0.5	419212	7597949		2	0.5	419986	7597809
	7	0.5	419213	7597986		20	0.5	419989	7597932
	10	0.5	419248	7598000		2	0.5	420018	7597732
	20	0.5	419265	7597974		2	0.5	420586	7597598
	20	0.5	419292	7598014		2	0.5	420695	7597393
	10	0.5	419323	7598029		4	1	420718	7597298

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Passiflora foetida* var. *hispida*	4	1	420724	7597328	**Rumex vesicarius*	5	0.5	419241	7598357
	6	2	420735	7597351		15	0.5	419274	7598332
	6	6	421875	7597096		1	0.5	419577	7598287
	5	3	421875	7597071		6	0.5	419728	7598444
	7	3	421877	7597050		1	0.5	419912	7598280
	4	0.5	421886	7596993		100	1	422196	7597231
	5	1	422196	7597111		10	0.5	422460	7597344
	50	10	422479	7596768		2	0.5	422760	7597095
	10	5	422737	7596420		1	0.5	424643	7596978
	25	1	423087	7596423		1	0.5	414474	7595610
	10	0.5	423132	7596810		10	0.5	414504	7597491
	10	0.5	423219	7596825		4	0.5	418550	7598288
	5	0.5	423389	7596788		1	0.5	419097	7598274
	20	0.5	423773	7596419		5	0.5	419194	7598359
	1	0.5	423938	7592560		10	0.5	419220	7598312
	5	0.5	423953	7596047		1	1	425435	7591151
	3	0.5	423957	7592480		2	0.5	427726	7600478
	15	0.5	423977	7596671	**Setaria verticillata*	1	0.5	413877	7595619
	4	0.5	423977	7595840		2	0.5	418392	7597457
	1	0.5	423997	7595840		50	0.5	418437	7597413
	1	0.5	424007	7595849		500	2	419521	7595076
	1	0.5	424012	7595763		99	0.5	420726	7597338
	20	0.5	424031	7596800		5	0.5	423353	7596395
	1	0.5	424040	7592637		50	0.5	423830	7595096
	20	0.5	424061	7596863		5	0.5	423837	7592784
	8	0.5	424135	7596902		40	0.5	423845	7595020
	6	0.5	424211	7596904		100	0.5	423853	7595091
	6	0.5	424308	7597028		30	1	423868	7595021
	1	0.5	424514	7597025		10	0.5	423869	7595095
	1	0.5	424839	7592491		1000	10	423954	7596048
	3	2	427651	7600448		20	0.5	423970	7595846
	4	2	427699	7600581		10	0.5	423986	7595772
	20	20	427783	7600631		40	0.5	423987	7595850
	3	5	427985	7600549		1000	10	424032	7596799
	1	0.5	429162	7601305		4	0.5	424298	7592069
	3	0.5	429182	7601442		1000	10	424641	7597350
	1	0.5	430042	7601579		10	0.5	425286	7591228
**Phoenix dactylifera*	3	10	415371	7598339		12	0.5	425302	7591257
	5	10	415568	7598295		1	0.5	425316	7591271

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Setaria verticillata*	10	0.5	425454	7591200	**Vachellia farnesiana*	1	0.5	419549	7595438
	0	0.5	425684	7599079		10	0.5	419563	7595502
	5	0.5	425701	7599267		1	0.5	419568	7595510
	15	0.5	425730	7599042		1	0.5	419881	7598512
	0	0.5	425853	7599612		1	0.5	419602	7598562
	3	0.5	426206	7600024		4	0.5	408955	7594726
	20	1	428043	7601028		8	10	414586	7595503
	10	0.5	428591	7601574		15	2	414627	7595452
	100	0.5	428636	7601704		2	0.5	414636	7595813
	1	0.5	429795	7601309		1	0.5	414912	7595795
**Solanum nigrum*	2	0.5	422629	7596629		1	5	416002	7597896
	50	0.5	423826	7595093		1	0.5	416293	7598059
	1	0.5	423860	7595027		2	1	417065	7598586
	1	0.5	423877	7596758		1	0.5	417482	7598129
	5	0.5	424178	7596831		2	2	418204	7597525
	4	0.5	427556	7600390		2	0.5	418868	7596739
	2	0.5	427680	7600450		1	0.5	418999	7598649
	3	0.5	427735	7600593		2	2	419037	7597967
	6	0.5	427836	7600664		1	0.5	419522	7595466
	2	0.5	428005	7600965		6	1	424557	7591640
**Sonchus oleraceus*	4	0.5	417926	7598079		3	0.5	424760	7596790
	10	0.5	417954	7598071		1	0.5	424797	7592472
	5	0.5	419527	7595459		4	0.5	424891	7597740
	1	0.5	419540	7595516		1	0.5	419936	7598465
	250	0.5	423088	7596425		10	10	420536	7598797
	25	0.5	423237	7596442		7	3	420645	7598965
	5	0.5	423388	7596458		2	0.5	420694	7598934
	15	0.5	423906	7596659		1	0.5	423641	7596793
	100	0.5	423974	7595843		9	0.5	423822	7592925
	2	0.5	423988	7595768		1	0.5	423831	7595093
	1	0.5	423999	7596656		2	0.5	423879	7592697
	20	0.5	424029	7596796		10	0.5	423891	7592706
	10	0.5	424433	7597069		10	0.5	423921	7592626
	15	0.5	427520	7600359		10	0.5	423931	7592579
	20	0.5	427722	7600581		5	0.5	423953	7596047
	10	0.5	427758	7600492		3	0.5	423966	7592449
	10	0.5	427814	7600648		1	0.5	424006	7595769
	5	0.5	429165	7601407		6	0.5	424042	7592639
	70	0.5	429173	7601438		1	0.5	424062	7592356

Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)	Species	Estimated abundance	Density (%)	Easting (mE)	Northing (mN)
**Vachellia farnesiana*	4	0.5	424168	7592222	**Vachellia farnesiana*	20	3	425780	7598818
	3	0.5	424263	7592020		0	0.5	425853	7599612
	1	0.5	424278	7592043		9	6	425943	7599340
	99	0.5	424285	7592050		25	5	425957	7598911
	2	0.5	424333	7592766		3	0.5	425979	7599216
	5	2	424439	7591781		10	1	426050	7598909
	1	0.5	424987	7592353		15	10	426386	7599825
	20	5	425207	7591403		1	0.5	426504	7600127
	1	0.5	425268	7591198		2	0.5	427064	7600086
	2	0.5	425280	7591214		1	0.5	427182	7600078
	1	0.5	425324	7591278		3	1	427198	7599923
	10	2	425454	7591685		3	2	427484	7600534
	0	0.5	425684	7599079		10	2	428421	7601506
	15	0.5	425729	7599042		50	10	429609	7602138

Table Q.4: Description of introduced flora recorded in the survey area.

Species	Description	Habitat
**Aerva javanica* (Kapok Bush) 	An erect, much-branched perennial, herb between 0.4 m and 1.6 m high. It has white woolly flowers arranged in spikes between January and October (WAHerb 1998-2016).	Often on sandy soils, along drainage lines (WAHerb 1998-2016).
**Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy) 	An erect, prickly, glaucous annual herb between 0.2 m and 1 m in height with white, cream and yellow flowers between February/March and July/November (WAHerb 1998-2016).	Generally along creek edges, riverbanks and roadsides. Occurs in red/white/grey sand and red-brown clay loam (WAHerb 1998-2016).
**Bidens bipinnata* (Bipinnate Beggartick) 	An erect annual herb growing to 1 m high. Produces yellow flowers from March to September (WAHerb 1998-2016).	Occurs in a variety of soils including alluvium, clay, loam over sandstone and limestone. Habitat preferences include rivers, creeks, coastal areas and rocky hillsides (WAHerb 1998-2016).
**Cenchrus ciliaris* (Buffel Grass) 	A tufted or sometimes stoloniferous perennial grass between 0.2 m and 1.5 m in height with purple, ciliate flowers between February and October. Seedheads form a dense hairy cylindrical spike to 10 cm long (WAHerb 1998-2016).	**C. ciliaris* favours sand but may also establish in loamy and clayey soils. It is a widespread weed of roadsides, creek lines and river edges (WAHerb 1998-2016).

Species	Description	Habitat
**Cenchrus setiger* (Birdwood Grass) 	An erect, tussock, stoloniferous perennial grass that grows to 0.5 m high. It has cream to purple flowers that occur from April to May (WAHerb 1998-2016).	**C. setiger* favours brown sands, red loam and pindan soils. It is often found on sand dunes, plains, rangelands, stony hillsides and floodplains (WAHerb 1998-2016).
* *Chloris barbata* (Purpletop Chloris) 	Annual or perennial (short-lived), grass, between 0.4 m and 1.1 m high. It has purple flowers in February or between April and October (WAHerb 1998-2016).	Occurs on white or red sand, loam, and black clay, often on sand dunes and river levees (WAHerb 1998-2016).
**Citrullus colocynthis* (Colocynth) 	A trailing perennial, herb or climber with deeply lobed, scabrous leaves. It has greenish yellow flowers between January and October. Fruits are a spherical melon, mottled green and yellow or all yellow with dull yellow-brown seeds (WAHerb 1998-2016).	Commonly occurs on sandy, rocky, stony loam, clay and wet soils; often in floodplains and disturbed areas (WAHerb 1998-2016).
**Cynodon dactylon* (Couch Grass) 	A rhizomatous (or stoloniferous), prostrate perennial grass from 0.05 m to 0.3 m high. Flowers are green or purple June to November (WAHerb 1998-2016).	**C. dactylon* occurs in sand, loam or clay habitats (WAHerb 1998-2016).

Species	Description	Habitat
**Datura leichhardtii* (Native Thornapple) 	A stout annual herb, between 0.2 m and 1 m high. It has solitary white flowers between June and October. The fruits are bright green (WAHerb 1998-2016).	Occurs mostly on alluvial soils, often along watercourses (WAHerb 1998-2016).
**Echinochloa colona (*Awnless Barnyard Grass) 	A tufted annual grass between 0.2 m and 0.9 m high. It has a green/purple inflorescence between February and July (WAHerb 1998-2016).	Occurs on black sand and black clay, near watercourses and swamps (WAHerb 1998-2016).
**Euphorbia hirta (*Asthma Plant) 	An erect or prostrate much branched hairy annual herb, growing between 0.1 m and 0.8 m high. Leaves are opposite, narrowly ovate with dark red blotches. Yellow-green-white axillary flowers are produced between January and October (WAHerb 1998-2016).	Occurs on alluvial soils, often along watercourses (WAHerb 1998-2016).
**Flaveria trinervia* (Speedy Weed) 	An erect annual herb, with ovate leaves. It has yellow flowers clustered to form a dense inflorescence (WAHerb 1998-2016).	Occurs in a variety of soils, particularly sandy and clayey sites. Typically occurs in drainage lines (WAHerb 1998-2016).

Species	Description	Habitat
**Lactuca serriola* (Prickly Lettuce) 	Erect annual or biennial herb 0.4 m to 2 m high. Flowers yellow, October to February (WAHerb 1998-2016).	Roadsides, gardens, cultivated fields, disturbed sites (WAHerb 1998-2016).
**Malvastrum americanum* (Spiked Malvastrum) 	An erect, hairy perennial herb or shrub between 0.5 m and 1.3 m in height. Flowers are yellow and orange, between April and July (WAHerb 1998-2016).	**M. americanum* occurs in a variety of sandy and clayey soils, as well as in limestone and calcrete. It typically occurs along stony ridges and hillsides, floodplains and along drainage lines (WAHerb 1998-2016).
**Melochia pyramidata* (Basil) 	A sprawling to erect woody perennial shrub 0.3 m to 1.5 m high. Flowers are white or pink or purple or blue, flowering from March to October (WAHerb 1998-2016).	**M. pyramidata* grows in alluvium, sand and black clay, and occurs along rivers and creeks (WAHerb 1998-2016).
**Ocimum basilicum* (Basil) 	Aromatic annual or perennial herb to 0.6 m high. Blue-purple, pink and/or white flowers from February to August (WAHerb 1998-2016).	Sandy soils and disturbed areas (WAHerb 1998-2016).

Species	Description	Habitat
**Passiflora foetida* var. *hispida* (Stinking Passion Flower) 	A woody climber to 9 m high with an unpleasant smell. It produces cream-white or blue flowers from February to November (WAHerb 1998-2016).	**P. foetida* var. *hispida* is commonly found in coastal areas, rivers and creek banks (WAHerb 1998-2016).
**Phoenix dactylifera* (Date Palm) 	A perennial tree-like monocot (palm) between 0.4 m to 8 m high. It produces flowers from July to September (WAHerb 1998-2016).	It is found on the edges of permanent pools and watercourses (WAHerb 1998-2016).
**Rumex vesicarius* (Ruby Dock) 	An erect, fleshy annual herb to 1 m high. Produces red-pink flowers from July to September (WAHerb 1998-2016).	Occurs in a variety of habitats and soils, including sandy alluvial and gravelly ironstone soils. Often occurs along roadsides and other disturbed areas (WAHerb 1998-2016).
**Setaria verticillata* (Whorled Pigeon Grass) 	A loosely tufted annual grass, 0.1 m to 1.3 m high. It flowers from December to June (WAHerb 1998-2016).	**S. verticillata* is found on sand, clay and loam. It is a common weed of disturbed areas and riverine edges (WAHerb 1998-2016).

Species	Description	Habitat
**Solanum nigrum* (Black Berry Nightshade) 	An erect perennial (short-lived) herb or shrub from 0.3 m to 1 m high. It produces flowers from January to December. It has dull black or purplish fruits (WAHerb 1998-2016).	It is a common weed in agriculture and bushland. Occurs in disturbed areas, pastures, creeklines, wetlands, woodland in sand, yellow-clayey sand, brown gritty clay, red sandy clay (WAHerb 1998-2016).
**Sonchus oleraceus* (Common Sowthistle) 	An erect, fleshy annual herb to 1 m high. Produces red-pink flowers from July to September (WAHerb 1998-2016).	Occurs in a variety of habitats and soils, including sandy alluvial and gravelly ironstone soils. Often occurs along roadsides and other disturbed areas (WAHerb 1998-2016).
**Vachellia farnesiana* (Mimosa Bush) 	An erect, sprawling, thicket-forming shrub or tree up to 4 m in height. It has dark grey, rough bark, pinnate leaves and long stiff thorns at right angles to the stems. Branchlets are also covered in rough, light coloured “wart”-like markings. It produces globular yellow flowers from June to August (WAHerb 1998-2016).	**V. farnesiana* favors low lying areas, disturbed areas and river and creeks banks (WAHerb 1998-2016).

Appendix R: Flora Survey Effort

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410000 415000 420000 425000 430000

7600000

7595000

7590000

Pannawonica

Millstream Rd

Robe River

Jimmawurrada Creek

Legend

- Railway
- Main Road
- River/Creek
- GPS Tracklogs
- Mesa H Riparian Community Survey Area

Robe River Mining Co. Pty Ltd

Mesa H Riparian Community Assessment - June 2016

Figure R.1: Flora Survey Effort

Datum: GDA 1994 - Projection: MGA Zone 50

0 500 1,000 1,500 2,000 2,500 3,000 metres

N

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